International Perspectives on Electricity Market Monitoring and Market Power Mitigation

JOSÉ A. GARCÍA

The Brattle Group

JAMES D. REITZES *

The Brattle Group

Abstract

We review the different market monitoring and market-power mitigation policies that arise in world electricity markets. Regulators for electricity markets apparently respond to differences in underlying market structure and design features when choosing between ex-ante (that is, rule-based) behavioral restrictions as opposed to ex-post enforcement (that is, investigations and sanctions) as the principal means for deterring abuses of market power. Particular design features that influence market-monitoring policies are whether the market is one-part (energy only) versus two-part (energy and capacity), and whether there is centralized or bilateral trading. Information-disclosure requirements also are a key element of market monitoring.

1 Introduction

Market power concerns are perhaps the most controversial and complex challenges facing electricity regulators worldwide in the wake of the market restructuring process that has arisen in recent years. Regulators often encounter a difficult balancing act between protecting the interests of consumers and providing appropriate incentives for electricity generators. On the one hand, prices are expected to be high enough to appropriately reflect resource scarcity and thereby encourage generation investment during conditions when there is little excess capacity in the market. On the other hand, regulators need tools at their disposal to address abuses of market power and so-called acts of market manipulation by any individual market participant or group of market participants.

The potential for market power, exercised either unilaterally or collectively, is particularly worrisome in electric power markets due to a variety of industry factors, including concentrated generation ownership, transmission system limitations that may create small, concentrated geographic markets (from an antitrust standpoint), a low derived

*Contact author. The Brattle Group, 1850 M Street, NW, Suite 1200, Washington DC 20036-5823. Email: james.reitzes@brattle.com We thank Greg Basheda for discussion and an anonymous referee for helpful comments, as well as participants in the CRRI’s (Center for Research in Regulated Industries’) Advanced Workshop in Competition and Regulation (January, 2007 in Newark).

demand elasticity for wholesale power due to the prevalence of fixed-price retail customer arrangements (and outdated metering technology), and the inability to store power. As a result, monitoring and mitigating market power in electric power markets likely will be a major concern of energy regulators and competition authorities for the foreseeable future. Many jurisdictions have regulatory authorities set up specifically to perform these oversight functions separate from traditional antitrust authorities.

The purpose of this paper is five-fold. First, we provide a brief description of why market power issues arise in electric power markets and why they sometimes lead to the establishment of a separate market-monitoring apparatus just for electricity markets. Second, we examine episodes of significant market power that arguably may have occurred in three relevant electricity markets; the United Kingdom, California and New Zealand. Third, we describe some of the more common approaches used to monitor electric power markets and mitigate market power. Fourth, we try to relate the particular approach used to monitor the market and mitigate exercises of market power in specific electricity markets with those markets' underlying market structure and design features. Lastly, we draw some conclusions as to the reasons for certain common market monitoring and market-power mitigation practices across markets, as well as the drivers behind differences in these policies.

Certainly, no single mitigation model fits all electricity markets. The market monitoring and market-power mitigation framework ideally should respond to differences in market structure, design and other characteristics. Factors to consider when formulating appropriate market-power monitoring and mitigation policies are: (i) specific market design characteristics (for example, one-part versus two-part markets, bilateral or centralized trading, information released to market participants); (ii) the degree of market concentration; (iii) the fuel and technology mix involved in power production; and (iv) the nature of transmission constraints (affecting both import capability and internal system operation). A periodic reassessment and adjustment of market-power monitoring and mitigation policies is needed as market conditions and design features change.

Some interesting observations are implied by our analysis. First, the need to use aggressive market-power monitoring and mitigation measures in certain markets may be evidence that the market's structure or design features may not be conducive to robust competition. Further structural or design remedies may need to be considered (see, for example, the past experience in the United Kingdom). Second *ex-ante* behavioral mitigation measures (for example, price caps, bidding restrictions, and restrictions against certain types of physical and economic withholding) are common, especially in so-called "two-part" markets where generators earn revenue from selling both energy and capacity. "One-part" markets, where generators receive revenues from energy sales only (and perhaps ancillary services), tend to rely more heavily on *ex-post* enforcement. Third, two-part markets tend to have lower energy price caps than one-part markets.

Fourth, markets that depend either exclusively or principally on bilateral trading rely more on *ex-post* enforcement capabilities to deter exercises of market power or market manipulation, including after-the-fact investigations and sanctioning of abusive conduct, than markets with centralized "exchange-based" trading.[1] That may be because it is more difficult to both apply and enforce *ex-ante* behavioral rules in bilateral markets.

[1] In bilateral markets, an individual seller engages in independent transactions with each buyer under potentially unique prices and conditions. Under centralized trading, the needs of multiple buyers and sellers are met simultaneously through a centralized market-clearing mechanism (for example, an auction process).

Additionally, some markets with predominantly bilateral trading exhibit a heavy reliance on longer-term contractual arrangements and it has been argued that longer-term energy trading is less inherently susceptible to exercises of significant market power.[2]

Fifth, one-part markets, such as the National Electricity Market (NEM) in Australia, Nord Pool, and the reformulated Texas market rely heavily on information disclosures to alleviate information asymmetries, increase market liquidity, encourage efficient resource-allocation decisions, and stimulate price undercutting by rival competitors. It seems that, in general, regulatory authorities view the economic benefits of releasing market information (including information on bidding practices, plant availability and market demand) to exceed the potential costs, including the risk of increased collusive activity.

Finally, it appears that US markets generally rely more on *ex-ante* rulemaking than their European counterparts and the Australia market, which depend more on the antitrust authorities to investigate abuses of market power in electricity markets after they occur.

2 Electric markets' susceptibility to market power

2.1 Market characteristics of electricity markets

Market power is commonly defined by the antitrust authorities as the unilateral or coordinated ability of market participants to profitably increase prices above competitive levels for a significant period of time.[3] The Federal Energy Regulatory Commission (FERC), in the United States, in its proposed rules regarding Standard Market Design defines market power as the "ability to raise prices above competitive levels".[4]

FERC's definition of market power has some interesting elements. First, it does not include the temporal provision that the ability to alter prices away from the competitive level must be maintained for a "significant period of time". Second, it does not include specifically a profitability requirement. Thus, FERC may be concerned that: (i) short episodes of dramatic high prices can seriously damage consumers and competition in electricity markets; and (ii) including profitability requirements in the definition of market power may be undesirable since it may be easier to identify the ability to raise price, as opposed to the incentive to raise price.

In practice, it is difficult to identify and measure market power in wholesale electricity markets. High prices do not necessarily indicate market power but instead may represent "scarcity" rents needed to cover the sunk costs incurred in providing peak-load capacity.[5]

---

[2] This apparently stems from the notion that competition for longer-term contracts is stimulated by the ability of entrants or existing market participants to build capacity in order to meet the contracted output requirements. Also, long-term energy demand is more price-elastic than short-term energy demand, and some regulators believe that effective mitigation of market power in the spot market will serve to constrain long-term power prices.

[3] US Department of Justice and Federal Trade Commission, Horizontal Merger Guidelines, issued April 2, 1992 (revised April 8, 1997), Section 0.1.

[4] FERC, *Notice of Proposed Rulemaking on Standard Market Design*, Docket No. RM01-12-000, *Remedying Undue Discrimination through Open Access Transmission Service and Standard Electricity Market Design*, 100 FERC 61,138 (2002) (SMD NOPR) at 393.

[5] Scarcity rents occur when the level of demand is such that there is virtually no unused capacity. In these instances, prices reflect consumer willingness to pay for the product, rather than the marginal cost of supply.

Episodes of high prices play a crucial role in providing incentives for long-term investment during conditions when there is limited excess generation capacity in the market.

The challenge for regulators and antitrust authorities is to distinguish the exploitation of market power from the presence of scarcity rents. One could argue that excessive attention has been paid to this issue already. So-called electricity price "spikes" typically occur when there is extremely high utilization of available generation capacity. Thus, extremely high prices are typically observed on a few high-temperature days where there is high demand, and that demand is highly inelastic. Whether these high prices represent true scarcity rents or reflect an exercise of market power may have limited consequences for social welfare on these days because the presence of highly inelastic demand implies that there is limited potential deadweight loss. However, from the perspective of consumer welfare, this exercise of market power on high-demand days can have significant consequences.

Further complicating the notion of high prices as scarcity rents in electric power markets is the fact that electricity supply and demand must be in continuous balance, or the reliability of the entire electric system is potentially compromised. If electricity demand is not price-responsive, this creates a need for avoiding conditions of insufficient generation capacity. Consequently, regulators often take actions to ensure that sufficient generation capacity is available to meet extremely high demand conditions. With an inability for (marginal) generators to earn scarcity rents in this regulatory environment, commentators have argued that an exercise of some degree of market power may be needed to achieve the prices required to permit the recovery of capital costs.

However, as is well known, the exercise of market power is associated with various economic inefficiencies. An exercise of market power induces allocative inefficiency by lowering the aggregate quantity of market consumption, thereby causing a deadweight loss when the price of electricity exceeds its associated marginal cost of supply.[6] It also results in productive inefficiency since production costs are not minimized. In addition, market power can create dynamic inefficiency when market participants on both the supply and demand sides of the market make investment decisions based on distorted price expectations. As noted by Wolak (2004), the exercise of market power in electricity market can result in enormous transfers of rents from consumers to producers in very short periods of time. Several recent analyses also have demonstrated that the exercise of market power can greatly increase the level of congestion in electricity networks.[7]

Restructured electricity markets are especially susceptible to the exercise of market power by suppliers for several reasons:

(1) Suppliers in electricity markets face high sunk costs with lumpy, irreversible and long-lived investments. These characteristics limit quite substantially the entry of new players in the market in reaction to relatively short-term price increases.

(2) Network limitations of transmission systems impede the movement of electric power across geographic areas when transmission lines are congested. Transmission constraints can temporarily isolate geographic regions, allowing local generators to exercise market power by withholding capacity and artificially boosting prices.

[6] In markets with perfectly inelastic demand, there is no allocative-efficiency loss associated with the exercise of market power. However, there may be a substantial redistribution of rents from consumers to producers.

[7] See, among others, Borenstein, *et al* (2000); and Joskow and Tirole (2000).

(3) Short-term demand for electricity is very inelastic,[8] largely because of the currently limited exposure of consumers to real-time prices under the prevalent fixed-priced service offerings, as well as the limited use of technology to monitor the real-time energy use of residential electricity customers.

(4) Electricity typically cannot be stored. Since system reliability requires that supply and demand has to be balanced instantaneously at every instant in time and at every location in the transmission network, and since intertemporal demand substitutability by consumers is limited, the inability to store electricity (except in hydroelectricity systems and through deferred maintenance) implies that intertemporal supply substitutability cannot constrain attempts to exercise market power over relatively short time periods (for example, a few hours of a given day).

(5) The supply of electricity is fairly inelastic in the short-run, and the supply curve often increases substantially when output is close to full capacity. Moreover, electricity "supply curves" (based on the marginal cost of production) are often like "step" functions, where each step change represents a movement to a different fuel source (for example, from nuclear, to coal, to natural gas and to fuel oil) or a change in technology. This implies that, under certain demand conditions, the withholding of small amounts of electricity output may produce a large impact on energy prices since the market-clearing price moves to a higher step in the supply curve.

(6) In wholesale electricity markets (mainly those organized as auctions), sellers and buyers meet regularly, typically every hour. Repeated multimarket contact in electricity markets may enhance firms' abilities to tacitly collude and consequently achieve higher prices and lower quantities.

(7) Some argue that electricity markets are characterized by "boom-bust" investment cycles due to the high sunk costs involved in building generation plants. According this view, boom periods in power generation construction are followed by periods of insufficient generation investment. When generation demand grows sufficiently, this leads to episodes of high prices induced by the presence of limited excess generation capacity.

The high sunk costs facing generation suppliers and the limitations of the transmission system in moving power across geographic areas, coupled with the inherent difficulty in siting new transmission lines, may often lead to highly concentrated, localized generation markets. In addition, electricity markets in many countries prior to market liberalization were characterized by vertically integrated monopolistic structures. Market reforms in the majority of the affected countries imposed limited divestiture conditions on the incumbent

[8] Empirical studies indicate that the price elasticity of demand for electricity is quite low, typically ranging from -0.15 to -0.25 for households. In a study of market power in the electricity market of England and Wales, Wolfram (1999) used an elasticity of -0.17. That number was based on a study by Green and Newberry (1992), who also examined competition in the England and Wales power pool. Patrick and Wolak (2001) analyzed the price elasticity of demand for electric power, using four years of data from a regional electricity company in the United Kingdom. They found that the demand elasticity for most consumer classes was below 0.1 (in absolute value). Branch (1992) estimated a demand elasticity of -0.2 for California customers. Finally, in an analysis of the Norwegian electricity market, Bye, *et al* (2003) estimated a demand elasticity of -0.23 using data from October 2002 to April 2003.

utilities.[9] As a result, it can be concluded that market power concerns arising from market concentration and the inherent conditions affecting electric power markets (as described above) are a worldwide issue for electricity markets.

One principal structural issue affecting these markets is the potential for dominant or "pivotal" suppliers. In the case of a pivotal supplier(s), the market reaches a point as demand rises where customer demand cannot be met without including the output of the pivotal firm (or pivotal firms) because of capacity limitations affecting other market participants. With a highly inelastic short-run elasticity for electric power, the situation is ripe for the pivotal supplier to exercise substantial market power. Even if a supplier or group of suppliers are not pivotal producers, the supply conditions in electric power markets are such that individual firms may perceive that the "residual demand" for their output is relatively insensitive with respect to price.[10] This provides incentives for those suppliers to withhold output to boost market-clearing prices or directly raise the asking prices at which they are willing to sell power.

As illustrated in Figure 1 below, it is often profitable to raise prices through the "physical withholding" of generation capacity (for example, through an unplanned maintenance outage), or "economic withholding" where suppliers knowingly offer a portion of their generation capacity at prices that are expected to exceed the market-clearing price. In Figure 1, total electricity demand is represented by the perfectly inelastic level, Q^*. Firms A, B, and C participate in the market and are assumed to bid in their generating units at marginal cost, except for any units that they withhold from the market. In the absence of withholding, the market-clearing price equals the marginal cost P_6.

However, by withholding unit 4 from the market, Firm A sacrifices a modest profit per unit of output, while forcing Firm C to serve the market at the market-clearing price P_7. Withholding unit 4 is a profitable strategy for Firm A as long as the forsaken profit on that generating unit is less than the increased profits earned on its other three units as a result of the price increase (from P_6 to P_7).

This type of behavior is frequently profitable in electricity markets, as the market supply curve has "steps" (corresponding to different plant technologies and fuel types) which may cause substantial price increases to result from a modest amount of generation withholding. Moreover, generating companies frequently own diversified portfolios that operate at differing marginal costs, allowing them to potentially withhold output from a relatively high-cost unit that is earning only a small profit margin on its output.

---

[9] Of course, some countries have more successfully divested generation assets. For instance, in the United Kingdom, generation assets of the former state-owned monopoly were divested through a variety of means. While the UK Electricity Pool appeared to have suffered from substantial exercises of market power (as described below), the mandated divestiture of generation assets and institution of the New Electricity Trading Arrangements (NETA) appear to have mitigated market power concerns to some extent. A similar approach was followed in Australia when the government decided to deregulate its electricity market. In the United States, New York and most of the PJM member states also have forced their utilities to divest generation ownership in order to facilitate increased wholesale and retail competition.

[10] The residual demand curve of a firm is defined as the total market demand less the supplies (or capacity) offered by rival producers at any given price. Wolak (2003a) examines residual demand elasticities in studying unilateral market power in the California wholesale electricity market for the period from 1998 to 2000.

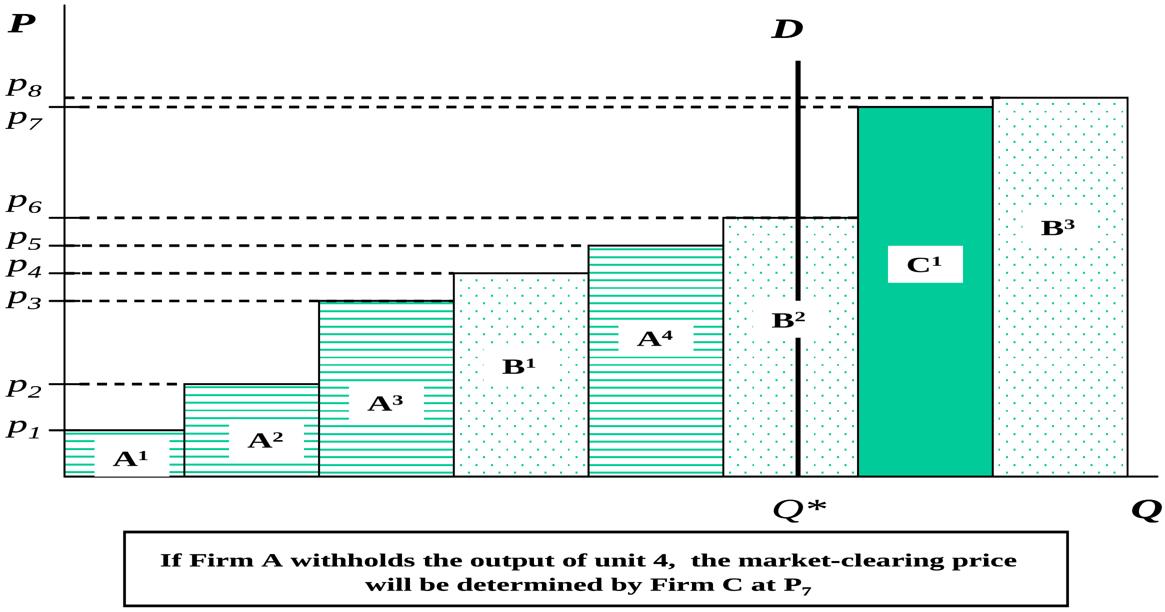

Figure 1: Exercise of market power by withholding generation output

2.2 Examples of market power abuses in electricity markets

We can find examples suggesting that significant market power may have been exercised in electricity markets around the world. Among the most heavily analyzed examples are the electricity markets in the United Kingdom, California and New Zealand.

2.2.1 Market power in the United Kingdom

The Power Pool of England and Wales served as the market for electricity trading beginning March 1990 and then was replaced in March 2001 by the New Electricity Trading Arrangements (NETA). During the period of its operation, the majority of electricity trading took place through the centralized pool. Under NETA, the predominant form of energy trading is through bilateral transactions, including contractual arrangements. There also is an auction-based "balancing mechanism" to alleviate any imbalances between supply and demand.[11] Since the formation of NETA, there are no capacity payments and no minimum reserve generation margins in the UK market.[12]

Several authors have analyzed whether market power was exercised in the England and Wales Electricity Pool during the late 1980s and early 1990s. Green and Newbery (1992) analyzed competition between the two leading generators, National Power and PowerGen, as a non-cooperative game involving the setting of supply schedules. They concluded that

[11] A recent report by the European Commission noted that spot trading in the organized UKPX power exchange represented only about 2.2 percent of the total national electricity consumption during the period from June 2005 to May 2006. Spot volumes traded on bilateral over-the-counter (OTC) markets amounted to 8.6 percent of total national electricity consumption over the same period. The remaining power was traded through bilateral forward transactions (or contractual arrangements). For more details, see the European Commission (2007) Report.

[12] On April 1, 2005, the market was expanded to cover Scotland as well as England and Wales, by the implementation of the British electricity trading and transmission arrangements (BETTA).

the generators possessed substantial market power in the UK electricity markets in the late 1980s and that market power could be reduced by increasing the number of competitors in the market. Their findings were supported by von der Fehr and Harbord (1993) in a different methodological setting, where they modeled electricity prices as the outcome of a first-price, sealed-bid, multiple-unit auction.[13]

Newbery (1995) analyzed the use of capacity-withholding behavior to raise capacity payments in the England and Wales market, where capacity payments represent the revenues earned from selling capacity into the market separately from energy.[14] Newbery found that the specific design of the capacity-payment mechanism made it susceptible to manipulation if generators had a sufficiently high market share (typically more than 25 percent, depending on contract positions).

Patrick and Wolak (1997) also suggest that because of the rules governing the price-determination process in the England and Wales electricity markets (before the New Electricity Trading Arrangements were instituted), National Power and PowerGen would have been able to exercise market power by physically or economically withholding capacity from the market. These generators, however, were viewed as preferring to boost electricity prices by physically withholding capacity from the market, as opposed to "economically withholding" capacity from the market by knowingly raising energy bids for particular infra-marginal generating units above the market-clearing price. This was because capacity withholding at an opportune time could be more readily explained away to regulators as an "unexpected" maintenance and repair outage that kept a plant from using some or all of its generating capacity.

Patrick and Wolak (1997) maintain that four main characteristics of the UK market contributed to the ability of National Power and PowerGen to maintain prices well above its average costs:

(1) both generators knew that their generation was essential to meeting market demand;

(2) both generators served a large share of market demand;

(3) both generators were able to predict accurately the residual demand they faced in each trading period;[15] and,

[13] Wolfram (1999) reaches a similar conclusion in her study of the British electricity industry. Her analysis suggests that estimated prices, while higher than marginal costs, are not nearly as high as those predicted by most oligopoly models with inelastic market demand. Wolfram points to regulatory constraints, the threat of entry, and financial contracts between the suppliers and their customers as possible explanations for the observed price levels.

[14] Some market rules require companies with "load" obligations (that is, retail customer obligations) to purchase separately the capacity from which energy is produced. Capacity markets are viewed as a means of facilitating generators' recovery of the capital costs needed to finance new plant construction, thereby encouraging investment in additional capacity that both puts downward pressure on energy prices and increases electric system reliability. Those generators selling into the capacity market are also obligated to sell the energy produced from that capacity into the market. Some commentators have considered the presence of capacity-plus-energy markets to represent a form of "two-part" pricing, while energy-only markets are considered equivalent to "one-part" pricing.

[15] As Wolak and Patrick (1997) note, the pool rules required generators to make public their annual capacity-availability plans. This made it easier for National Power and PowerGen to estimate the residual demand for their power supplies.

(4) both generators owned a mix of generating capacity in terms of plant technology and fuel types (including baseload, intermediate and peaking plants) that helped them profitably exercise market power under a variety of demand conditions through the withholding of generation output.

In the early 1990s, then-UK regulator OFFER opened an investigation that concluded that National Power and PowerGen had exercised market power in the UK electricity markets. As a result, price caps were instituted beginning in 1994 and continuing into 1996. More importantly, the agreement settling the investigation (reached on February 11, 1994) included the mandated divestiture by National Power and PowerGen of 4 GW and 2 GW, respectively, of coal and oil-fired generation.[16] Further, to obtain merger clearance for buying retail electricity supply businesses, National Power and PowerGen offered to divest an additional 4 GW of generation capacity each.

In spite of these earlier investigations, numerous concerns were brought to the UK energy regulator, OFFER, during late 1997 and early 1998 by regional electricity companies and electricity traders regarding exercises of market power in the Power Pool. It was suggested that National Power and PowerGen were acting to force the market-clearing energy price (that is, System Marginal Price) upward in order to compensate for relatively low payments in the capacity markets.

Consequently, the belief persisted that the pool was vulnerable to the exercise of strategic behavior (both in the energy and capacity markets) and characterized by the presence of substantial margins earned by generators in the sale of electricity. This situation triggered a review of trading arrangements by the UK regulatory authorities and the replacement of the UK Power Pool by NETA over the period 1998 to 2001.

It has been discussed extensively whether changes in market structure (mainly divestiture requirements placed on National Power and PowerGen) or changes in market design (through the introduction of NETA) deserve the major credit for mitigating market power in UK electricity markets. Those pointing to changes in market structure as the key impetus to improve market efficiency include Bower (2002), Newbery (2004), and Evans and Green (2005). By contrast, a report by UK energy regulator OFGEM (2001) maintains that the design changes under NETA were essential in reducing wholesale electricity prices. Fabra and Toro (2003) maintain that both changes in market structure and market design have played an important role in creating a more competitive UK market. Newbery (2005) concludes that “where the market design was reasonably sensible, market structure was determinative” in explaining unsatisfactory outcomes (high prices, manipulation of capacity payments, and high payments for resolving transmission constraints) in the UK electricity markets.

2.2.2 Market power in California

During the mid 1990s, important regulatory changes were promoted in the California electricity market. The major elements of California’s restructuring plan included: (1) requiring the state’s three major investor-owned utilities – Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E) – to sell half of their fossil-fuel capacity (they eventually sold all of it); (2) transferring

[16] Green (1996) simulated the impact of the partial divestiture of National Power and PowerGen using a linear supply-function equilibrium model. He concluded that the divestiture policy would lead to a substantial increase in the competitiveness of the market, although not as large of an increase as would occur by dividing National Power and PowerGen into smaller companies.

control of electricity transmission to the California Independent System Operator (CAISO); (3) creating the California Power Exchange (PX) to institute centralized auction-based day-ahead electricity trading; and (4) freezing retail electricity prices until 2002.

In addition to these changes, utilities were required to meet their net demand needs by purchasing power from the newly created spot wholesale market. This requirement effectively precluded the utilities from entering into long-term contracts with independent power producers.

Concerns about the potential exercise of market power in California electricity markets arose before the CAISO and California PX began operating in April 1998, even though this issue became prominent during the "energy crisis" of 2000 when the market was characterized by periods of extremely high prices and rolling blackouts. Borenstein and Bushnell (1999) used a Cournot model to simulate the prospective performance of the restructured California market, finding potential for significant exercises of market power during relatively high demand hours throughout the year. In examining the restructured markets' initial years of operation, Wolak (2003b) noted that California's energy and ancillary services markets experienced their first episode of significant market power in the summer of 1998. Most notably, the price of replacement reserves reached $2,500 per MW on July 9, 1998 and then $9,999.99 per MW on July 13, 1998.[17] In the summer of 1998, the CAISO's Market Surveillance Committee identified major market-design issues that facilitated market inefficiencies, including: (i) excessive reliance on spot trading as opposed to long-term contracts between generation suppliers and utilities; and (ii) the lack of retail price signals consistent with underlying wholesale costs (since consumer rates were frozen at their 1996 levels until September 2001).[18]

As for the California energy crisis itself, Borenstein, Bushnell, and Wolak (2002) found that electricity expenditures in California's restructured wholesale market rose 340 percent between summer 1999 and summer 2000 (from $2.04 billion to $8.98 billion). Of the total dollar increase, 21 percent was attributable to increased production costs, 20 percent was attributable to increased competitive rents and the remaining 59 percent was attributable to increased market power. In addition, Joskow and Kahn (2002) found evidence of capacity withholding by large players in the California market during the summer of 2000.

With highly inelastic energy demand and limited excess generation, substantial exercises of market power could be achieved in the California market by withholding relatively modest quantities of generation output. Facing these conditions, Bushnell (2003) suggested that further generation divestiture, increased use of long-term contracts, and widespread implementation of price-responsive demand would be necessary to limit the exercise market power. In fact, Wolak (2004) maintains that the California Department of Water Resources' purchase of substantial quantities of forward electricity contracts for the summer of 2001 helped alleviate market power concerns during that summer.

FERC investigated the origins of the energy crisis and concluded in 2003 that "supply-demand imbalance, flawed market design and inconsistent rules made possible significant

[17] Replacement reserves represent standby generation capacity that must be made available with 60-minutes advanced notice.

[18] See Nordhaus, Shapiro, and Wolak (1998).

market manipulation" in California in 2000 and 2001.[19] FERC further concluded that many trading strategies employed by Enron and other companies violated the anti-gaming provisions of their FERC-approved tariffs for the CAISO and PX markets. Anticompetitive behavior included economic withholding, inflated bidding, and so-called "megawatt laundering".[20]

2.2.3 Market power in New Zealand

The New Zealand Electricity Market (NZEM) has operated as a full wholesale market since 1996. NZEM is a voluntary market involving power generators, retailers and large wholesale customers. All trading is bilateral and there is very limited financial hedging through long-term contracts or other products. Currently, the New Zealand market is served mainly by five generating companies with a combined market share of 95 percent, who also are the principal retail suppliers of electricity.

Market power concerns have arisen periodically in the NZEM, particularly during the winter seasons (June to September) of 2001 and 2003 when average monthly prices reached NZ$225 (about US$153) and NZ$200 (about US$136) per MWh, respectively. Although the evidence of outright market manipulation is quite limited, it appears that the concentration of generation ownership, combined with limited hydroelectric reservoir capacity (due to dry conditions), may be key factors in inducing these high-priced periods.

Regulation of the NZEM started in a light-handed fashion but regulatory oversight appears to have increased since the price spikes of winter 2003.[21] The preference for light-handed regulation was initially based on a view that the threat of further regulation would discipline anticompetitive behavior. However, in 2003 the Government installed a sector-specific regulatory agency, the Electricity Commission whose roles include monitoring the electricity market.[22] Also, the Commerce Commission technically has the power to impose price controls if needed.[23]

Most recently, wholesale prices above NZ$150 (about US$102) per MWh were observed during February and March 2006, fostering additional concerns regarding the competitiveness of the NZEM. A recent report by the International Energy Agency (IEA) concludes that the small number of market participants – exacerbated by the vertical integration between generators and retailers – is a cause for concern (IEA, 2006). Furthermore, the lack of liquid and transparent financial markets to hedge location-based electricity pricing risk is cited as contributing to market power problems and market riskiness.

[19] See FERC Docket No. PA02-2-000, March 2003 for a summary of the findings. A more complete description of the whole procedure is available at http://www.ferc.gov/industries/electric/indus-act/wec.asp#skipnavsub.

[20] Megawatt laundering describes the process of obscuring the true origins of specific quantities of electricity being sold on the energy market. The California energy market allowed for energy companies to charge higher prices for electricity produced out-of-state. Megawatt laundering (nicknamed "Ricochet" by Enron traders) allowed the company to buy power in California under the state's price-cap limits, ship it outside the state, and then buy it again. Because the energy was coming from outside California, it was not subject to price limitations.

[21] See Wolak (2004), p.7.

[22] See http://www.electricitycommission.govt.nz.

[23] While the Commerce Commission is charged with investigating "anti-competitive" practices under the Commerce Act of 1986 in a backward-looking approach, the Electricity Commission focuses on a proactive approach to mitigating the scope for market power. The Electricity Commission has been granted substantial powers to intervene in the market to prevent gaming practices and anticompetitive behavior.

Although spot prices are not capped in the NZEM, the IEA maintains that the Government's generation capacity agreement with the Whirinaki reserve power plant operates in a way that acts as a "soft" electricity price cap. According to this agreement, the Whirinaki plant offers capacity into the wholesale market whenever wholesale prices reach NZ$1000 per MWh (about US$680 per MWh) *or* reach NZ$200 per MWh (about US$136 per MWh) for four hours. IEA recommends that the New Zealand government revise the triggering mechanism for the Whirinaki plant to eliminate the current soft price cap on its electricity prices. EIA maintains that the revision of the reserve power mechanism will help to encourage additional generation investment that will lessen market concentration and ultimately reduce long-term market prices.[24]

3 Ex-ante (proactive) versus ex-post (reactive) approaches to market-power mitigation

Remedies to market power and market inefficiencies can arise in the form of ex-ante (proactive) mitigation or the use of ex-post (reactive) investigative authority. Ex-ante mitigation focuses on identifying when conditions are present that enhance the potential for market power (for example, through market concentration analysis, identification of potentially pivotal suppliers, residual demand analysis or simulation analysis), and then imposing restrictions or rules that eliminate the potential for abuse in the presence of those conditions. Ex-ante mitigation measures include bid caps, other limitations on bidding behavior, and advance approval of plant maintenance schedules so that capacity is not withheld during high-demand periods. By contrast, ex-post mitigation focuses on identifying after-the-fact instances of anticompetitive conduct by individual suppliers (for example, through evidence of physical or economic withholding of generation, market bids substantially above generation costs, or market-clearing prices substantially in excess of competitive "benchmark" prices) and punishing such behavior through fines or other actions.

In general, advocates for *ex-ante* mitigation argue that market participants prefer this approach as opposed to *ex-post* enforcement, due to its greater transparency and the reduced risk of after-the-fact review (Wolak, 2004; Hope, 2005). In addition, *ex-post* mitigation involves investigations that are potentially costly, uncertain and burdensome to both the regulator and market participants (Hope, 2005). Wolak (2005) maintains that *ex-ante* mitigation as well as an industry-specific market monitor are necessary because "unilateral market power problems can be extremely difficult to predict", and "they can impose significant economic harm for a sustained period of time when they do occur". FERC also appears to prefer *ex-ante* mitigation procedures, as stated in a notice of proposed rulemaking:

> "…[t]o be effective, market power mitigation measures must be applied before the fact, since remedies after the withholding has occurred are disruptive to the market and increase regulatory risk to its participants, which increases costs to customers."[25]

[24] Similar recommendations are contained in Dupuy (2006), where the author analyses the actual degree of competition in the NZEM.
[25] SMD NOPR, 100 FERC 61,138 (2002) at 396.

Advocates for *ex-post* mitigation claim that while *ex-ante* mitigation is quick and automatic, it risks being overly broad and having unintended consequences. When applied injudiciously, *ex-ante* mitigation can suppress legitimate price signals that would induce investment needed to attain a more efficient long-term market outcome. By contrast, *ex-post* mitigation may be more specifically tailored to those instances in which a market participant is demonstrated to have engaged in anticompetitive behavior. It does not automatically limit the flexibility of market participants since it allows sanctions to be imposed only if anticompetitive behavior is discovered. Tabors and Cardell (2003) compare *ex-ante* and *ex-post* approaches to market-power mitigation with specific reference to the California market. The authors conclude that both *ex-ante* and *ex-post* price mitigation distort price signals.

Some may argue that *ex-post* regulatory enforcement in electric power markets is insufficient to constrain exercises of market power (or market manipulation) when the prospect for anticompetitive behavior is sufficiently great due to underlying structural conditions. These commentators argue that *ex-ante* mitigation should represent not a substitute for, but a complement to, *ex-post* enforcement. If significant exercises of market power are likely during peak demand periods, for example, then there may be a high consumer cost of failing to take *ex-ante* regulatory actions that produce more efficient pricing (such as bid constraints or price caps).

However, because it represents a potentially more precise method of fostering market efficiency than an overly restrictive set of *ex-ante* rules and regulations, the use of *ex-post* mitigation mechanisms becomes more attractive in less concentrated markets where both the likelihood and frequency of abuse of market power is theoretically lower. In these types of markets, *ex-post* mitigation can be applied more surgically to instances in which it is demonstrated that a market participant committed an actionable violation.

3.1 Ex-ante versus ex-post market monitoring in world electricity markets

In contrast to the proactive (*that is*, *ex-ante*) approach toward market-power mitigation used in most US markets with Regional Transmission Organizations (RTOs, such as PJM, Midwest ISO, ISO - New England, CAISO, and New York ISO), European markets, such as the United Kingdom and Nord Pool, and the Australian market rely on reactive (that is, *ex-post*) monitoring and punishment of observed market-power abuses.

The use of *ex-ante* market-power mitigation in US RTO markets arguably involves two different approaches: (i) a "conduct-and-impact" approach; and (ii) a "direct-mitigation" approach.[26] Under the "conduct and impact" approach, the market monitor reviews the bids of market participants and analyzes their individual impact on the market-clearing price. If a participant's bid has a substantial effect on the market-clearing price (as determined by the conduct and impact tests), that party will have its bid replaced by a default bid. Several electricity markets, including ISO - New England, New York ISO, CAISO, and Midwest ISO, use this approach in mitigating market power in their wholesale day-ahead and real-time electricity markets.

The alternative direct-mitigation approach is based on a structural rather than behavioral test. In transmission-constrained areas, the bids of pivotal suppliers or supplier groups (as well as generation units that must be dispatched to maintain system reliability)

[26] For further discussion of these different approaches, see Isemonger (2007).

are automatically mitigated to a "default" level.[27] So far, direct mitigation in US markets has been used primarily by PJM.[28] While the conduct-and-impact approach automatically imposes mitigation when individual participant behavior produces substantial price elevation that appears consistent with exercises of market power, the direct-mitigation mechanism is triggered merely by structural conditions that support the exercise of market power.

Unlike the US RTO approach, the United Kingdom relies on the prospect of *ex-post* enforcement to deter exercises of market-power. Currently, no *ex-ante* mechanisms exist to prevent the exercise of market power by generators in the United Kingdom. All electricity prices are set by the market; there are no caps or other direct regulatory controls applied to prices. However, UK generators are subject to certain sector-specific regulations which are conditions of their operating licenses.[29]

In the United Kingdom, the antitrust laws are the basis of any *ex-post* actions taken by the energy regulator OFGEM against electricity generators engaged in alleged anticompetitive conduct. OFGEM (along with its governing body, the Gas and Electricity Markets Authority) is both the energy-sector regulator and the competition authority with full antitrust powers in the energy sector, which is similar to the energy regulatory and enforcement structure used in the NEM in Australia.

Nord Pool appears to mainly rely on *ex-post* enforcement mechanisms, where its markets are monitored for potential abuses that are addressed subsequently through an investigative process and fines. At the end of 2000, Nord Pool decided to strengthen its market-surveillance capabilities by establishing an independent Market Surveillance department, which is responsible for overseeing the Nordic Power Exchange's physical and financial markets.[30] Similar to the European markets, Australia relies on an antitrust-based approach to mitigate market power within its electricity markets. In addition, Australia periodically audits market participants for compliance with market rules.

The European markets' reliance on antitrust enforcement suggests that their market-monitoring activities may focus more on collective exercises of market power (for example, collusion) rather than unilateral (that is, single-firm) strategic behavior, such as economic or physical withholding. An exception to this would arise in situations where a single firm (or, possibly, a small number of firms) acquired a dominant market position and "abused" that position.

Lastly, the FERC in the United States has a variety of *ex-post* enforcement methods at its disposal to punish market manipulation that results in "unjust and unreasonable" electricity prices, including disgorgement of undue profits and the suspension or

[27] PJM uses a "three- pivotal-supplier" test to assess whether a localized market is sufficiently competitive. If consumer demand within a specified transmission-constrained area cannot be satisfied without the participation of three or fewer pivotal suppliers located in that area, then the bids of those suppliers are mitigated to a default level. The CAISO intends to implement a similar procedure.

[28] Effective November 2007, CAISO will switch from its current conduct-and-impact approach to a direct-mitigation approach.

[29] The relevant primary legislation is the Electricity Act 1989 and the Utilities Act 2000. Electricity generation licenses are granted under this legislation.

[30] Financial electricity products in the Nord Pool, such as options, futures and contracts for differences, are monitored to protect against market manipulation and regulated so that market information is released in a manner that supports market liquidity and appropriate price signals. The actual monitoring of the day-ahead physical energy market reflects a similar philosophy.

revocation of generators' ability to set market-based rates. FERC was granted enhanced authority to assess civil and criminal penalties under the Energy Policy Act of 2005.[31]

4 Market structure, market design, and its relationship with the market-monitoring approach

Mitigating market power in electric power markets is likely to remain a major concern of energy regulators and competition authorities for the foreseeable future, largely due to concentration in generation ownership, constraints in the transmission system, inelasticity of demand, and difficulties in entry that characterize most electric power markets. Since the structure and design of electricity markets vary substantially across jurisdictions, it is not surprising that we observe differences in the approach to market monitoring and market-power mitigation arising from differences in these features.

For example, the preference for *ex-ante* (proactive) rule-oriented enforcement versus *ex-post* (reactive) enforcement depends on the degree of market concentration. Regulators monitoring highly concentrated markets appear to be more proactive in setting rules to prohibit certain types of conduct (that is, an *ex-ante* mitigation approach), while regulators monitoring less concentrated markets are more reactive to observed abuses (that is, an *ex-post* mitigation approach). The intuition behind these differences in regulatory approach is that the likelihood and frequency of market power abuse is potentially greater in highly concentrated markets.

As we discuss below, market-design features also are critical determinants of the regulatory approach toward market-power mitigation and market monitoring. Among the key design features that influence the philosophy of market monitoring is whether the market is "two-part", where generators earn revenues from both energy and capacity sales, or "one-part", where generators earn revenues from energy sales only (and possibly sales of ancillary services). Regulators appear to be relatively more tolerant of high prices, thus are more likely to rely on *ex-post* enforcement in one-part markets where generators derive revenues from energy sales only.

Another interesting issue that affects the attitude toward market monitoring and the ability to engage in such monitoring is whether centralized trading is present or whether only bilateral trading exists. Although price discovery may be easier and price dispersion may be more limited in markets with centralized exchange, it also may be argued that collusive agreements can be more readily policed by their participants in a centralized market. However, in markets with exclusively bilateral trading, information limitations may impede a market monitor's ability to impose effective *ex-ante* behavioral restrictions.

4.1 Relationship between market structure and market monitoring

Market-power mitigation approaches differ depending on the structure of the specific electricity market under analysis. We observe a stronger preference for *ex-ante* regulation in markets characterized by highly concentrated generation ownership and significant internal and external transmission constraints. On the contrary, regulators that monitor less concentrated generation markets seem to prefer a more reactive approach (that is, an

[31] FERC can now pursue civil penalties up to a maximum of $1 million per violation and refer criminal violations to the Department of Justice (DOJ) for prosecution and potential incarceration for as much as five years. See Energy Policy Act of 2005, Pub. L No. 109-058, 119 Stat. 594 (2005), §§ 314 and 1284.

ex-post mitigation approach), using the threat of investigations and sanctions to deter exercises of market power.

Arguably, the approach toward electricity market monitoring is also influenced by the mix of generation owned by firms with relatively large market shares. Some authors, for instance Patrick and Wolak (1997), have argued that electricity markets are more vulnerable to exercises of significant market power if large generators own a mix of low-cost (for example, nuclear, coal, and combined-cycle gas technology), intermediate-cost (for example, single-cycle gas technology), and high-cost (for example, oil-fired combustion turbine technology) generating units. The importance of owning a mix of generation is that strategic withholding behavior is more profitable when output can be reduced from relatively high-cost generating units (that are still at or below market prices). Also, when a generator owns a significant amount of capacity at specific “steps” in the supply curve, a substantial price increase may be achieved through relatively modest amounts of output withholding. Given that electricity market demand varies widely based on seasonal weather factors (as well as the time of day), ownership of a broad generation portfolio may provide the generating firm with the ability and incentive to exercise market power over a wide array of demand conditions. Thus, regulators are apt to be more proactive in mitigating generator market power under these circumstances.

Of course, the assessment of whether an electricity market is highly concentrated requires a definition of the geographic extent of the market. With respect to electric power, the presence of binding transmission constraints can create a “relevant” geographic market that is comprised of a relatively small area with few generation owners. Thus, the presence of transmission constraints and the conditions under which they are binding are important considerations in determining whether the market monitor imposes significant *ex-ante* restrictions on the pricing behavior of generators. Conversely, regulators in highly interconnected electricity markets with limited congestion find it easier and preferable to rely more on *ex-post* mitigation enforcement.

In the next section, we briefly examine the link between structural conditions and the regulatory preference for either *ex-ante* or *ex-post* market-power mitigation. We also describe the use of “structural” market-power mitigation measures in electricity markets, including forced divestitures, transmission expansions, and other actions that have aided market competitiveness.

4.1.1 Structural conditions and preference for ex-ante versus ex-post enforcement

For the most part, markets with more reactive enforcement policies, such as those of the United Kingdom, Australia and Nord Pool, have previously undertaken structural mitigation and market-design measures that arguably make them less vulnerable to exercises of market power. These changes have included forced divestitures, privatization and division of former state-owned enterprises or a requirement that generators offer hedge contracts.

In 2001, OFGEM decided to modify the electricity market design in the United Kingdom to further increase competition. It abolished the compulsory England and Wales “pool” market, which, as we previously discussed, had arguably been vulnerable to exercises of market power. A bilateral trading market was instituted instead but these market design changes followed a series of asset divestitures by the two largest generators, National Power and PowerGen. Moreover, additional asset divestitures and other structural mitigation measures were instituted, such as the imposition of forward contract obligations on generators.

A similar approach was followed when the Australian government decided to deregulate its electricity market. These measures included mandating divestitures of generation assets and the division of former state-owned generation companies. Also, generators were mandated to offer hedging contracts that allowed retailers to obtain energy supplies at effectively fixed prices. These longer-term forward sales arguably reduced the incentive and ability of generators to exercise market power in short-term electricity markets since they reduced the "short" position of retailers looking to satisfy their customer needs and the "long" position of the generators themselves.

The Nordic regulatory authorities have tried to reduce generator market power by promoting regional integration. The expansion of the transmission system, the imposition of homogeneous market rules and the elimination of border transmission tariffs are some of the "mitigation" remedies imposed by the Nordic regulatory authorities to expand the "relevant" geographic market over which suppliers are competing and to induce entry that lessens market power concerns.

That is not to say that regulators in the United States did not impose structural changes along with deregulation. The formation of RTOs in North America (such as the New York ISO, CAISO, Midwest ISO, ISO – New England and PJM) has resulted in improved transmission system coordination and reduced transmission tariffs within RTO boundaries. Also, New York, the New England states and some of the PJM member states have forced their utilities to divest generation ownership in order to facilitate increased wholesale and retail competition. Moreover, part of the transitional regulation plan in certain states involved the use of longer-term supply contracts between large generators (or power marketers) and utilities seeking to satisfy the needs of their customers on regulated fixed-price service.

4.2 Market-design features affecting market-monitoring approach

This section analyzes how different market-design features have led to differences in the approach to market-power mitigation and market-monitoring. Our analysis focuses on three particular market-design features: (i) whether the market is "one-part" (that is, energy only) or "two-part" (that is, energy and capacity); (ii) whether the market relies on centralized or bilateral trading; and (iii) whether the market releases extensive information to its participants.

4.2.1 One part (that is, energy only) and two-part (that is, energy and capacity) markets

With one-part (or energy only) markets, plant capital costs are recoverable only through revenues earned in the energy markets (plus possibly ancillary services), whereas these costs additionally can be recovered through capacity-market payments in two-part markets. In two-part markets, those entities serving retail customers are typically under a regulatory obligation to make capacity purchases from generators as a means of ensuring that their customers' energy needs will be served. The generator is then obligated to produce energy from the purchased capacity, where the sale of energy constitutes another source of revenue for the generator.

Without capacity markets to facilitate the recovery of generator capital costs, one-part markets must rely on energy prices alone to signal the need for additional generation investment. As a result, one-part markets tend to be less rule-oriented and less constraining in their energy price caps relative to two-part markets. If some degree of "scarcity pricing" is not allowed in one-part markets and marginal generation units only recover their short-term marginal costs, then certain generation units may be unable to recover their long-run costs. Consequently, insufficient generation investment may occur so the electric system may be less reliable during high-demand periods.

In two-part markets, generators typically are under a regulatory obligation to provide energy to the market commensurate with their sold capacity. Consequently, two-part markets, such as the PJM, New England, and New York markets in the United States, impose rules that impede the physical or economic withholding of generation by those entities which sell capacity. Moreover, as noted earlier, monitors for these US markets use other proactive measures to prevent exercises of market power, such as directly mitigating bids or other actions by generators that significantly increase the market-clearing price. PJM, for example, effectively enters a default bid for an individual supplier (or a group of no more than three suppliers) in situations where that supplier's participation is needed to meet market demand or otherwise ensure electric system reliability.

By contrast, regulators in one-part markets may be more reluctant to engage in *ex-ante* enforcement actions for fear of excessively constraining energy prices through formulaic rules and regulations. One-part markets, such as Texas (ERCOT), the NEM in Australia, Nord Pool, and the United Kingdom, appear to have a more reactive (that is, *ex-post*) market-monitoring approach.

As mentioned previously, one-part markets also tend to be less restrictive in their imposed price caps than two-part markets. One-part markets, such as the United Kingdom, New Zealand and Nord Pool, are not subject to any price caps. In ERCOT, the electricity market for (most of) Texas, a new scarcity pricing program will gradually increase the system wide price cap from $1,000 per MWh to $1,500 per MWh beginning March 1, 2007, and then to $3,000 per MWh by March 1, 2009 (when centralized trading is expected to begin). In the NEM in Australia, the price cap for any one hour is equal to the "Value of Lost Load" (VoLL), which presently equals AUS$10,000 per MWh (about US$7,750 per MWh). A much stricter administered price becomes effective if prices over a seven-day period exceed AUS$150,000 (about US$116,250), which is equivalent to AUS$893 (about US$692) per MWh.

These price-cap levels (or lack thereof) contrast with those imposed in two-part markets, such as electricity markets in the eastern United States (that is, New York ISO, ISO – New England, and PJM), where the energy price cap is set at $1,000 per MWh. In two-part markets, there arguably is an operating presumption that capacity market payments should ideally cover plant capital costs and fixed maintenance costs for marginal generating units (for example, combustion turbines) while energy market payments should cover fuel and other operating costs. Thus, there is less tolerance for allowing energy prices well in excess of underlying marginal costs.

4.2.2 Bilateral versus centralized markets

The UK electricity market has transformed from centralized day-ahead energy trading to bilateral trading only,[32] analogous to the situation in California, although California is

[32] Under bilateral trading, a seller engages in an independent transaction with each buyer and can potentially quote a unique price to any of them. Moreover, information about trade prices and quantities typically remains private, thus is not readily accessible to other market participants.

planning to return to centralized trading by late 2007.[33] The Texas (ERCOT) market also is in the process of instituting centralized auction-based trading to complement bilateral trading. Similarly, auction-based trading has co-existed along with bilateral trading in the PJM, New York ISO, and ISO – New England markets, as well as the Nord Pool market for the Nordic countries.[34] By contrast, much of the southern United States, as well as parts of the central United States, still rely exclusively on bilateral wholesale trading. However, in these areas, many utilities remain vertically integrated into the production of electric generation.

A question naturally arises as to whether the incentives to exercise market power differ between purely bilateral trading environments and centralized auction-based trading environments. Certain unilateral anticompetitive strategies, such as the economic (as opposed to physical) withholding of capacity, may be more readily achieved in centralized auction-based markets as compared to purely bilateral markets. With auction-based trading, a generator can economically withhold capacity from the energy market by knowingly submitting a bid at "above-market" price with the intent of increasing the market-clearing auction price. With purely bilateral trading, a generator withholds capacity by either refusing to sell energy from that capacity or quoting sufficiently high prices such that output from that capacity is not needed. Since the prospect of price discrimination inherently arises in a bilateral market (where a seller can potentially quote a unique price to any given buyer), there may be an incentive to offer lower prices or sell off unused capacity to buyers that show up to purchase "late" in the sales process. This may impede the effectiveness of a unilateral withholding strategy in markets with predominantly bilateral trading.

There also arises the question as to the need for and effectiveness of *ex-ante* mitigation in electricity markets with only bilateral trading, given that certain bilateral markets (for example, the UK market) are associated with more contract-based medium-term and long-term sales than their counterparts with auction-based trading. Although it may be in the process of reconsidering this position, FERC appears less concerned that competition for longer-term contracts will elicit anticompetitive behavior by itself. Specifically, FERC states that:

> " ...[b]ilateral contracts generally reflect buyer and seller expectations of prices in spot markets. Therefore, market power mitigation in the organized spot market will effectively discipline market power in bilateral markets as well."[35]

Of course, this statement suggests that contract prices will be at supra-competitive levels if the spot market is susceptible to exercises of market power. Thus, it does not

---

[33] The CAISO filed its proposed Market Redesign and Technology Upgrade (MRTU) Tariff on February 9, 2006 (in Docket No. ER06-615-000), requesting an effective date of November 1, 2007. The Commission conditionally accepted the MRTU on September 21, 2006. Significant components of the MRTU Tariff include: (i) a day-ahead auction market for trading and scheduling energy; (ii) a LMP pricing system that varies by location and time; and (iii) improved market-power mitigation measures.

[34] In the PJM market, any participant has the right to procure energy through bilateral contracts, subject to the RTO's requirement that market participants must make capacity resources available for dispatch under specified conditions. Similarly, the use of the New York ISO's auction markets is not mandatory. Market participants have the option of procuring energy and other services through bilateral transactions, provided that they inform the transmission operator of the quantities scheduled in such transactions. A similar situation occurs in Nord Pool.

[35] SMD NOPR, 100 FERC 61,138 (2002) at 405.

forgo the need for monitoring spot market transactions. Nonetheless, the statement does suggest that there is no need to be concerned separately about anticompetitive behavior with respect to the sale of longer-term power supply arrangements.

This perhaps represents a view that longer-term power purchases are more price-sensitive and consequently less susceptible to exercises of market power than shorter-term purchases. In theory, short-term purchases can be substituted for long-term purchases if the long-term price of power increases substantially above risk-adjusted expected spot prices.[36] Such intertemporal arbitrage may not be accomplished so readily, though, if purchasers view long-term power supply commitments as a product with different characteristics than a series of shorter-term power purchases. Often, utilities with customer load obligations are under pressure from regulators to make long-term power purchases to reduce risk and provide rate stability to their customers.

So, one may argue that there is less need for *ex-ante* market-power mitigation in markets with predominantly bilateral trading. The United Kingdom and New Zealand electricity markets, which are heavily reliant on contract transactions and bilateral trading, depend on *ex-post* antitrust enforcement to mitigate market power. Similarly, in the non-RTO markets in the United States, which are characterized by bilateral wholesale power trading, market-power mitigation necessarily focuses on *ex-post* enforcement against abusive behavior.[37]

The use of *ex-post* enforcement in bilateral markets may arise because of the inability to effectively impose *ex-ante* enforcement measures. Barmack, *et al* (2006) examine an appropriate market-monitoring approach for western US power markets. Their analysis suggests that the absence of “publicly and/or centrally collected data” in bilateral markets makes it “necessary to approach market monitoring in a different way” than that used in RTO markets with centralized trading (for example, PJM, ISO – New England, Midwest ISO, and New York ISO).[38] Although the role of *ex-ante* market-power mitigation is more prominent in markets with centralized trading as opposed to purely bilateral trading, it is not necessarily the case that structural market conditions and market-design features eliminate the inherent need for *ex-ante* rulemaking in bilateral-trading environments.

4.2.3 Transparency and release of information

Several electricity markets worldwide, including the Nord Pool,[39] United Kingdom, Australia,[40] New Zealand,[41] and Texas (ERCOT)[42] markets, have either implemented

[36] It also may be argued that capacity can be built to satisfy particularly long-term power purchases, therefore entry serves to discipline the price of these types of purchases.

[37] *Ex-ante* enforcement does occur through the FERC process of approving applications by market participants to sell power to third parties at market-based rates, as opposed to cost-based rates. Approval of those applications is conditional on the applicant meeting certain structural criteria, including it not being a pivotal supplier or accounting for a market share greater than 20 percent.

[38] Barmack, *et al* (2006), p.1.

[39] In the Nord Pool, participants in the financial markets are required to submit a report on all non-exchange trades which the market participant is involved. Reporting must take place within 15 minutes. Moreover, both participants of the financial and physical market shall immediately disclose to Nord Pool all “inside information” which is likely to impact prices (for instance, incidental or planned limitations related to production, consumption and transmission facilities). Such price-relevant information must be provided to the Nordic Power Exchange before being publicly available for the market. The Nord Pool’s distribution of information is based on the following principles: (a) the information comprises data and events that can influence prices in the power market; and (b) the information shall be aggregated to a level that does not disclose information specific to any market participant, nor any participant’s positions or exposure in the

information-disclosure requirements or are quite aggressive in releasing proprietary information (*for example*, energy-market bid data) with a very limited time lag. By contrast, US RTOs, such as PJM, ISO – New England, New York ISO, Midwest ISO and CAISO, release bid data after six months but the bidders are not identified.[43,44]

The public release of proprietary electricity-market data offers several potential benefits. By reducing information asymmetries among actual and potential players, market participation may increase, thereby increasing market competitiveness and liquidity, and reducing observed risk premiums. Providing information about rival bidding strategies also may provoke sharper competitive responses, which may serve to reduce market power. Also, the ability of regulators to bring information about individual firm actions to public attention may deter firms from undertaking activities that are perceived to harm the public, such as exercises of market power or acts of market manipulation.

In its position paper on transparency and availability of information in electricity markets, the European Federation of Energy Traders (2003) advocates a more aggressive information-release policy for European electricity markets with respect to transmission, demand, and generation data. The authors maintain that greater market transparency helps to: (i) reduce barriers to entry in the market; (ii) increase liquidity; and, (iii) reduce risk premiums. An updated version of the same paper (EFET, 2006) further notes that:

> "[S]ome European markets - notably the UK and Nordic markets - are already very transparent with hundreds of thousands of data items being released every day. Many other markets remain opaque…"[45]

A similar opinion was shared by the European Regulators Group for Electricity and Gas (2006) in a public consultation regarding methods for improving information

---

markets. The information is distributed simultaneously to all participants. For a more extensive discussion regarding market conduct rules in the Nordic electricity markets, see the Nord Pool website at http://www.nordpool.com/products/clearing/rulebook/ClearingAppendix6MarketConductRules.pdf.

[40] One of the characteristics of the NEM Australian market surveillance system is the very short lag in releasing bid data pertaining to the wholesale electricity market. NEM discloses all bids, schedules and output levels on the next trading day. Anyone can consult this information at http://www.nemweb.com.au and NEMMCO website at http://www.nemmco.com.au/data/csv.htm.

[41] Initially, starting April 2002, energy bids and offers in the NZEM were made public four weeks after the trading period. In April 2003, NZEM reviewed the length of the delay in publishing energy bids and offers and implemented a rule change reducing the lag to two weeks.

[42] Since October 2006, the Texas (ERCOT) market releases aggregate data on quantities and bid prices for energy and ancillary services (in the form of supply curves); quantities of self-supplied energy and ancillary services; actual resource output and scheduled and actual load levels with a two-day lag. Moreover, ERCOT also posts the highest-priced energy offer selected and the name of the entity submitting the offer with a two-day lag. Entity-specific information, such as portfolio offer curves for balancing energy and ancillary services, are posted with a 30-day lag. More detailed data is released with a three-month lag.

[43] See *for example*, *California. Independent System Operator Corp.*, 90 FERC 61,316 at 62,047 (2000); *San Diego Gas & Electric Co.*, *et al*, 95 F.E.R.C. 61,115, slip op. at 27 (2001); *NSTAR Services Co. v. New England* Power Pool, 92 F.E.R.C. 61,065 at 61,201 (2000), *reh'g pending*; *PJM Interconnection, L.L.C.*, 86 F.E.R.C. 61,247 at 61,890 (1999); *Midwest Independent Transmission System Operator, Inc.*, *et al*, 108 FERC 61,163 at 559 (2004); and *Central Hudson Gas & Electric Corp.*, 86 F.E.R.C. at 61,224.

[44] Interestingly, in January 2007, ISO – New England recommended a revision to its Information Disclosure Policy. This included a request to reduce the lag in reporting bid data from six months to as little as three months. For more details, see http://www.iso-ne.com/regulatory/ferc/filings/2007/jan/er07-444-000 1-18-07_info_policy_bid_data.pdf.

[45] See EFET (2006), p.1.

disclosure and transparency in electricity markets. In a recent report, the European Commission (2007) also criticized the lack of transparency in European electricity markets, maintaining that market participants need to know more about demand conditions, the availability of transmission, current requirements for balancing and reserve power, and outages and other conditions affecting electricity generators.

Wolak (2005) has criticized US RTOs' data-release policy, which masks the identity of individual market participants and typically involves a six-month lag in releasing energy bid data. He maintains that the extensive time lag in releasing data imposes potential costs on consumers that should be balanced against the potential benefits of delay (mainly reducing the ability to monitor and punish coordinated behavior). He proposes two solutions: (i) rely on antitrust law enforcement to tackle collusive concerns; and (ii) establish a clear boundary between the types of data that the regulator can request and receive from market participants, and the types of data that must be released to the public.

As mentioned above, there also are costs associated with releasing data. For instance, the disclosure of certain types of market data may force firms to reveal "business sensitive" information that compromises the execution of particular business strategies. This may harm firms, customers, and the market in general if excessive disclosure requirements prevent generators or utilities from entering into efficient contractual arrangements or other types of efficiency-enhancing transactions. In this regard, stakeholder concerns about the disclosure of commercially sensitive information were a key factor behind the Alberta Electric System Operator's (AESO) review of its information-release policies in 2003.[46]

The hasty release of bidding and other market information also may facilitate collusive behavior in an environment where the same players bid against one another on a frequent (daily and/or hourly) basis. Specifically, disclosure of firm-specific information regarding prices and quantities may make it easier to monitor a coordinated "agreement" and punish defections from such an agreement. It also may make is easier for firms to "signal" one another in a manner that leads to anticompetitive price increases. FERC has admitted that the purpose of its policy regarding a six-month lag in releasing bid data is "to help prevent collusive behavior".[47]

One may argue that the prospect of encouraging collusive behavior is limited because collusion is prohibited by the antitrust laws. Nonetheless, information disclosures that facilitate the ability of cartel members to monitor and police a collusive agreement arguably place a heavier burden on the antitrust authorities to discover and sanction this type of coordinated conduct. Also, certain types of signaling behavior (or tacit collusion) induce price elevation but are difficult to identify and prosecute successfully as illegal conduct. The European Commission (2006), however, downplays this potential cost of disclosing information:

> "[T]he risk of collusion does not outweigh the advantages of more transparency…In any case, the risk of facilitating collusion could be reduced by only publishing figures on an aggregated rather than individual basis (at least in advance of trading)."[48]

[46] The AESO recommended that its historical trading report continue to be published but with an unspecified delay. See AESO (2003).
[47] *Central Hudson Gas & Electric Corporation et al*, 88 FERC 61,138 at 61,397 (1999).
[48] See European Commission (2006), Preliminary Report, part 2, p.524.

From these differing approaches to the issue of information disclosure, a few observations can be made. First, mandated information disclosures apparently serve three main purposes in the eyes of regulators: (i) they boost the liquidity of both physical and financial markets by reducing information asymmetries among potential market participants; (ii) they lead to more efficient resource allocation decisions (for example, releases or price or bidding information potentially encourage generators to expand output); and (iii) they may reduce market power by reducing barriers to entry and facilitating quicker and more aggressive competitive responses.

Second, certain markets release proprietary bid data quite quickly, such as those in Australia (which releases the next day), New Zealand, the United Kingdom and Texas. Evidently, these markets believe that the quick revelation of participant pricing strategies will lead to aggressive competitive responses and price undercutting, with limited risk of facilitating collusive behavior. Other markets, such as the US RTO markets, are more cautious in their information-release policies.

Third, one-part markets (for example, Nord Pool, United Kingdom, Texas, New Zealand and Australia) appear to impose somewhat stronger disclosure requirements than two-part markets (such as PJM, New York ISO, or ISO – New England in the United States), possibly because these markets are less reliant on *ex-ante* rulemaking and other upfront restrictions on competitor conduct. These markets are relying more heavily on rival reactions as a source of competitive discipline.

Lastly, it appears that regulators generally believe that the benefits of releasing information largely outweigh any potential costs, such as an increased prospect of collusion. Perhaps, the backstop threat of antitrust action is a sufficient deterrent so that there is a limited likelihood of increased collusion.

5 Conclusion

Electricity markets arguably have a variety of characteristics that make them susceptible to exercises of market power in general. However, our review of world electricity markets indicates that significant differences exist in the policies implemented to constrain or deter unilateral or coordinated exercises of market power, depending on the particular structure and design features of the market under consideration. The appropriate framework for monitoring a specific electric power market and mitigating misconduct must consider the likely frequency and impact of exercises of market power based on that market's underlying features.

The prospect of frequent and sizeable exercises of market power may favor the use of *ex-ante* market-power mitigation, such as tight price caps and explicit restrictions on potentially exploitative bidding behavior (or other actions that cause the inefficient withholding of generation output). If the prospect of market power abuse is less likely, then the threat of *ex-post* enforcement, such as after-the-fact investigations and sanctioning of abusive behavior, may be sufficient to substantially deter such behavior.

Indeed, we find evidence that the choice between *ex-ante* (that is, rule-based) and *ex-post* market enforcement does appear to be influenced by market structure and design features. A periodic reassessment and adjustment of market-power mitigation may be needed as structural conditions and design features change. When structural remedies are not readily available as a means of allaying market power concerns, regulatory authorities may then be forced to resort to *ex-ante* rulemakings that affect participant behavior.

The evidence also suggests that one-part markets (that is, energy only markets, such as those in Australia, New Zealand, Nord Pool, the United Kingdom and Texas) appear to have a more reactive market-monitoring approach than two-part markets (that is, energy and capacity markets, such as those in ISO – New England, New York ISO, and PJM in the United States). One-part markets arguably have higher energy price caps in order to facilitate the ability of generators to recover their capital costs. In fact, the United Kingdom and Nord Pool do not have price caps, relying instead on *ex-post* antitrust enforcement to serve as a deterrent to high prices produced by anticompetitive behavior. The reliance of one-part markets on *ex-post* mitigation may reflect a desire to not impede generation investment that produces dynamic efficiencies through overly broad *ex-ante* restrictions aimed at improving short-term market performance. In two-part markets, where the additional revenues realized through sales in the capacity market are seen as a stimulus to investment and the achieving of dynamic efficiency, the exercise of market power in the energy market appears to be less tolerated and more aggressively mitigated through *ex-ante* enforcement.

Although the role of market-power mitigation (especially *ex-ante* mitigation) is more prominent in markets with centralized trading, mitigation can still play a relevant role in markets with principally bilateral trading. However, other than imposing an explicit price cap in certain cases, bilateral markets are more reliant on *ex-post* enforcement mechanisms. This may be due to several factors, including: (i) the inherent difficulty in enforcing *ex-ante* rules against certain types of pricing or output-withholding behavior in bilateral markets, where less information is typically collected from participants; (ii) the complexity involved in successfully engaging in certain types of unilateral or coordinated anticompetitive conduct in markets with bilateral trading (as a result of the informational asymmetries facing market participants and commitment issues); and (iii) the reliance on longer-term contractual arrangements in many of these markets.

Finally, certain markets that depend principally on ex-post enforcement against abuses of market power (for example, Nord Pool, United Kingdom, Texas, New Zealand and Australia) impose strong information-disclosure requirements on their participants. Also, ISO – New England (and other US RTOs) is considering shortening its lag in releasing bid information and broadening the types of information released. In these markets, the regulatory view appears to be that reducing informational asymmetries and providing information about rival behavior will provoke pro-competitive responses by market participants and increase market liquidity. Regulators apparently view these benefits as greater than the potential costs of these information releases in terms of their potential to facilitate collusive behavior.

6 References

Alberta Electric System Operator (AESO) (2003) "Market & Strategic Initiatives: September 2003," available at http://www.aeso.ca/development/offline/market/files/info_requirements.pdf

Barmack, M., E. Kahn, S. Tierney and C. Goldman (2006) "A Regional Approach to Market Monitoring in the West," Working Paper LBNL-61313, Lawrence Berkeley National Laboratory.

Branch, E. R. (1992) "Short Run Income Elasticity of Demand for Residential Electricity Using Consumers Expenditure Survey Data," *Energy Journal*, 14: 111-21.

Bolle, F. (1992) "Supply Function Equilibria and the Danger of Tacit Collusion: The Case of Spot Markets for Electricity," *Energy Economics*, April: 94-102.

Borenstein, S. and J. Bushnell (1999) "An Empirical Analysis of the Potential for Market Power in California's Electricity Industry," *Journal of Industrial Econo*mics, 47: 285-323.

Borenstein, S., J. Bushnell and S. Stoft (2000) "The Competitive Effects of Transmission Capacity in a Deregulated Electricity Market," *RAND Journal of Economics*, 31: 294-325.

Borenstein, S., J. Bushnell, and F. Wolak (2002) "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market," *American Economic Review*, 92: 1376-1405.

Bower, J. (2002) "Why Did Electricity Prices Fall in England & Wales: Market Mechanism or Market Structure?" Working Paper EL02, Oxford Institute for Energy Studies.

Bushnell, J. (2003) "Looking for Trouble: Competition Policy in the US Electricity Industry," in J. Griffin and S. Puller (ed.), *Electricity Deregulation*: *Choices and Challenges*, University of Chicago Press: Chicago.

Bye, T., N. M. von der Fehr, C. Riis and L. Sørgard (2003) "*Kraft og Makt. En Analyse av Konkurranseforholdene i Kraftmarkedet*," Report for the Norwegian Ministry of Labour and Administration.

Dupuy, M. (2006) "Electricity Generation: Competition, Market Power and Investment," New Zealand Treasury, Policy Perspectives Paper 06/04.

European Commission (2006) "Sector Inquiry under Art. 17 Regulation 1/2003 on the Gas and Electricity Markets," Preliminary Report of 16 February 2006, available at http://ec.europa.eu/comm/competition/antitrust/others/sector_inquiries/energy/index.html

European Commission (2007) "DG Competition Report on Energy Sector Inquiry, Final Report," SEC(2006)1724, available at http://ec.europa.eu/comm/competition/antitrust/others/sector_inquiries/energy/#final

European Federation of Energy Traders (EFET) (2003) "Position Paper: Transparency and Availability of Information in Continental European Wholesale Electricity Markets," available at http://www.efet.org/default.asp?Menu=76

European Federation of Energy Traders (EFET) (2006) "Updated Position Paper: Transparency of Information about the Availability and Use of Infrastructure and the

Promotion of Competition in European Wholesale Power Markets," available at http://www.efet.org/default.asp?Menu=76

European Regulators Group for Electricity and Gas (ERGEG) (2006) "Guidelines for Good Practice on Information Management and Transparency in Electricity Markets," Ref: E05-EMK-06-10, available at ERGEG web page, http://www.ergeg.org

Evans, J. and R. Green (2005) "Why did British Electricity Prices Fall After 1998?" Mimeo, Birmingham Institute for Energy Research and Policy.

Fabra, N., and J. Toro (2003) "The Fall in British Electricity Prices: Market Rules, Market Structure, or Both?" Mimeo, Universidad Carlos III.

Federal Energy Regulatory Commission (FERC) (2002) *Notice of Proposed Rulemaking on Standard Market Design*, Docket No. RM01-12-000, *Remedying Undue Discrimination through Open Access Transmission Service and Standard Electricity Market Design*, 100 FERC 61,138 (2002) (SMD NOPR).

Federal Energy Regulatory Commission (FERC) (2003) "Final Report on Price Manipulation in Western Markets," Docket No. PA02-2-000, March.

Green, R. J. and D. M. Newbery (1992) "Competition in the British Electricity Spot Market" *Journal of Political Economy*, 100: 929-53.

Hope, E. (2005) "Market Dominance and Market Power in Electric Power Markets," Mimeo, Norwegian School of Economics.

International Energy Agency (IEA) (2006) "Energy policies of IEA countries: New Zealand," Paris, OECD.

Isemonger, A. (2007) "Conduct and Impact versus Direct Mitigation," *The Electricity Journal*, 20: 53-62.

Joskow, P. and J. Tirole (2000) "Transmission Rights and Market Power on Electric Power Networks," *RAND Journal of Economics*, 31: 450-487.

Joskow, P. and E. Kahn (2002) "A Quantitative Analysis of Pricing Behavior in California's Wholesale Electricity Market during Summer 2000: The Final Word," *Energy Journal*, 23: 1-35.

Littlechild, S.C. (1998) "Report on Pool Price Increases in Winter 1997/98," available at http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/2363_winterpool.pdf?wtfrom=/ofgem/whats-new/archive.jsp

Newbery, D. (1995) "Power Markets and Market Power," *Energy Journal*, 16: 39-66.

Newbery, D. (2004) "Electricity Liberalisation in Britain: The Quest for a Satisfactory Wholesale Market Design," *Energy Journal*, Special Issue on European Electricity Liberalisation: 43-70.

Newbery, D. (2005) "Refining Market Design," Paper presented at the Sustainable Energy Specific Support Assessment (SESSA) Conference "Implementing the Internal Market of Electricity: Proposals and Time-Tables" on Friday, 9 September 2005 in Brussels.

Nordhaus, R., C. Shapiro, and F. Wolak (1998) "Preliminary Report on the Operation of the Ancillary Services Markets of the California Independent System Operator," Market Surveillance Committee Report, August 19, 1998.

The Office of Gas and Electricity Markets (OFGEM) (2001) "Review of the New Electricity Trading Arrangements (NETA) and the Impact on Smaller Generators," available at OFGEM web page, http://www.ofgem.gov.uk

Patrick, R. and F. Wolak (1997) "The Impact of Market Rules and Market Structure on the Price Determination Process in the England and Wales Electricity Market," available at http://www.stanford.edu/~wolak

Patrick, R. and F. Wolak (2001) "Estimating the Customer-Level Demand for Electricity Under Real- Time Market Prices," NBER Working Paper 8213, National Bureau of Economic Research, Cambridge MA.

Tabors, R. and J. Cardell (2003) "Ex Ante and Ex Post Designs for Electric Market Mitigation: Past and Present Experience and Lessons from California," *Proceedings the 36th Hawaii International Conference on System Sciences*; available at http://csdl.computer.org/comp/proceedings/hicss/2003/1874/02/187420055.pdf

von der Fehr, N. M. and D. Harbord (1993) "Spot Market Competition in the UK Electricity Industry," *Economic Journal*, 103: 531-546.

Wolak, F. (1999) "Report on the Redesign of the California Real-Time Energy and Ancillary Services Markets," MSC Report, October 18.

Wolak, F. (2003a) "Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Market 1998 – 2000," Center for the Study of Energy Markets, Working Paper CSEMWP-114.

Wolak, F. (2003b) "Diagnosing the California Electricity Crisis," *The Electricity Journal*, 16: 11-37.

Wolak, F. (2004) "Lessons from International Experience with Electricity Market Monitoring," Center for the Study of Energy Markets (CSEM) Working Paper 134, University of California - Berkeley.

Wolak, F. (2005) "Managing Unilateral Market Power in Electricity," World Bank Policy Research, Working Paper 3691.

Wolak, F., R. Nordhaus and C. Shapiro (1998) "Preliminary Report on the Operation of the Ancillary Services Markets of the California Independent System Operator (ISO)," August 19, 1998, available at http://www.caiso.com/docs/1998/12/18/1998121806493813577.pdf

Wolfram, C. D. (1998) “Strategic Bidding in a Multiunit Auction: An Empirical Analysis of Bids to Supply Electricity in England and Wales,” *RAND Journal of Economics*, 29: 703-725.

Wolfram, C. D. (1999) “Measuring Duopoly Power in the British Electricity Spot Market,” *American Economic Review*, 89: 805-826.