

ELECTRICITY MARKETS : The Price of Power

INTRODUCTION

ENERGY is a newsletter produced by The Brattle Group that examines issues that arise in energy markets and regulation. This issue reports on two cases dealing with the assessment of the extent of market power and potential for future exercise of market power in domestic and international electricity markets. Several techniques are used to measure market power, including concentration indices and market simulation models. This article discusses the uses of these techniques and their application to two real-world markets.

For more information please contact Paul Carpenter in Cambridge at 617.864.7900, Peter Fox-Penner in Washington at 202.955.5050, or Carlos Lapuerta in London at 0207.491.0843.

Power industry restructuring efforts seek to foster competitive markets. The benefits of competitive markets – price signals to consumers and to producers that induce efficient allocation of scarce resources both in the short and long run – are largely achieved without significant government intervention. However, only workably competitive markets, where no participant exercises significant *market power*, can fully realize such benefits.

Market power is the ability to raise prices above competitive levels, thereby harming consumers and leading to less consumption than would prevail under competition. Whether market power is exercised indirectly by withholding output or directly by setting supra-competitive prices, it results in essentially the same outcome. A seller, or group of sellers, who can *sustain* prices above competitive levels, and do so profitably, will have met the Department of Justice's ("DOJ") and Federal Trade Commission's ("FTC") standard for exercising market power.¹

Several conditions facilitate the exercise of market power in restructured electricity markets, including:

- Limited ability of consumers to respond to price changes in the short run;
- Relatively high sunk costs of suppliers;
- Limitations of the transmission system to move power across different geographic areas;
- Concentration of generating assets among relatively few owners.

Given the complexity of these sources of market power, what are the state-of-the-art techniques for determining whether market power exists and is being exercised in real-world markets?

MEASURING POTENTIAL MARKET POWER

The techniques used to assess *ex ante* the potential for market power differ from *ex post* evaluations of actual market behavior. *Ex ante* analyses examine whether the market's proposed or new *structure* will likely support competition, prior to the formation of the market or before any significant changes occur among sellers in the market (such as through mergers or acquisitions). These analyses typically quantify the concentration of competitors' sales of productive capacity under the new market structure in order to measure their potential influence on the market. A measure of market concentration frequently used in the United States is the Herfindahl-Hirschman Index ("HHI").²

Although market concentration indices, like the HHI, may indicate the potential for exercising significant market power, economic theory makes no firm predictions concerning the relationship between market concentration and competitive interaction. Extremely concentrated markets may exhibit competitive behavior, and market rules and institutions may have profound impacts on competitive interaction. The competitive behavior of electricity suppliers in the markets of California, Pennsylvania-New Jersey-Maryland ("PJM"), New England ("ISO NE"), and New York ("NY ISO") have demonstrated the effect of different designs of energy, ancillary services, and transmission market rules and regulations. Dissatisfaction with market concentration measures has prompted regulators to make increased use of computer simulations to model sellers' strategic behavior and its likely impact on market prices.

Ex post analyses focus on sellers' *conduct* or the overall *performance* of an existing market. Relevant issues include tacit or explicit collusion among sellers, purchase restrictions on buyers through tying arrangements, predatory pricing to prevent entry or induce exit, or withholding product from the market. Often the relationship between market prices and the underlying costs of production is assessed with tools such as the Lerner Index.³

The cases described below illustrate both *ex ante* and *ex post* types of analyses. The first, *The Brattle Group's* analysis of the UK Pool, examines the market structure of the UK Pool, the conduct of its dominant generators, and the Pool's performance as a market. The second case describes our assessment of the competitiveness of new electricity markets that would result from the post-merger generation divestiture of two integrated utilities in Nevada. This analysis assumes particular conduct by market competitors and uses a computer simulation model to examine the resulting market performance.

CASE STUDY I: MARKET POWER IN THE UK POOL

In April 1990, England and Wales privatized their electric generation market, resulting in almost immediate improvements in efficiency. However, the success of the UK restructuring effort appeared weakened by the exercise of market power by its two largest generating companies, National Power and PowerGen. In November 1997, *The Brattle Group* completed a study of generation market structure, market conduct, and market performance in the Pool.⁴ The study concluded that the 1996 divestiture of 6,000 MW by National Power and PowerGen did not prevent generation companies from continuing to exercise market power and manipulating the market. We relied in part on HHIs to assess the potential competitiveness of the market, but we also examined the participants' historical bidding behavior and the Pool price levels to reveal direct evidence of the exercise of market power.

We focused on the period following National Power's and PowerGen's lease of 6,000 MW to Eastern Group in June 1996. Specifically, we studied the generating companies' control of marginal generating units, defined as units that set the system marginal price (SMP). We defined "marginal" in three ways. The first definition included those units that collectively set SMP over 90 percent of the time, the second definition included all coal and pumped-storage units, and the third included the "black fossil" units (coal, oil, and orimulsion stations but not gas-fired or hydro stations).

ELECTRICITY MARKETS : THE PRICE OF POWER

Our analysis revealed HHIs associated with each definition of marginal plant that exceeded the relevant standards of market concentration applied by government agencies and economists in several countries.

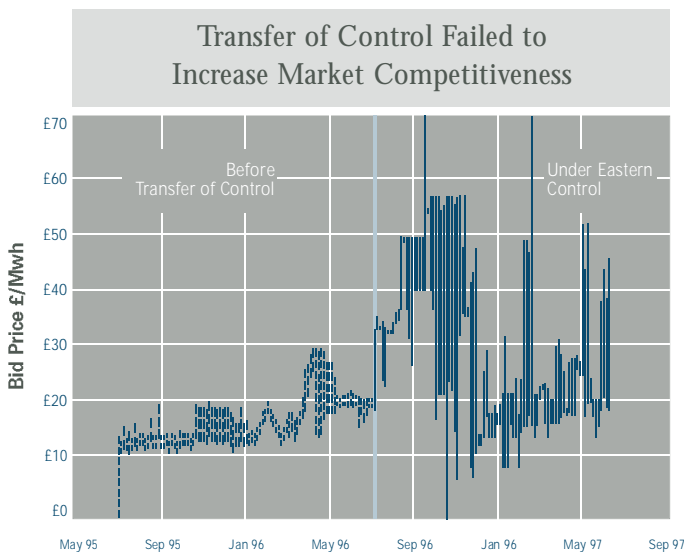
HHIs provide a measure of the potential to exercise market power but are not evidence of its actual exercise. To assess the extent of market power exercised in the UK Pool, *The Brattle Group* analyzed the bidding behavior of the Eastern Group. We focused on Eastern because, as the smallest of the three dominant generators, Eastern would have the greatest incentive to bid at competitive levels and to undercut its rivals. Furthermore, the lease of National Power's and PowerGen's capacity to Eastern had been expected to enhance competitive bidding in the generation market. Our analysis examined bidding behavior before and after the

In addition, Eastern's bidding behavior was much more volatile than its underlying costs. We inferred that Eastern clearly engaged in strategic bidding behavior after the lease of generation.

Finally, *The Brattle Group* assessed market performance by examining both generator profitability and electricity prices. The accounting and stock returns of both National Power and PowerGen significantly exceeded the returns on alternative investments of equivalent risks. Although SMP exceeded competitive levels before the lease, SMP further increased in the twelve months after the lease of generation to Eastern. The persistence of high prices could be explained by neither changes in fuel costs, demand, nor unit availability.

The Brattle Group's market power analysis demonstrated that prices in England and Wales continued to exceed competitive levels following the lease to Eastern Group. We developed a model that predicted what Pool prices would be if generators bid competitively. The model's predictions were compared to actual Pool prices following the transfer of control to Eastern Group. We found that non-competitive bids were responsible for excessive Pool prices totaling at least £700 million per year.

To mitigate market power, we recommended additional divestiture of generation plants, improvements to the forward market in electricity, and the implementation of demand-side participation. *The Brattle Group* concluded that both market power and a lack of transparency had inhibited the development of a liquid forward market in electricity. We described the incentives of existing generators to reduce liquidity, and proposed the disclosure of summary information from confidential forward contracts to help restore transparency. We explained that the introduction of full demand-side participation would help mitigate market power by improving the capability of demand to respond to high or volatile market prices.



SOURCE : A Report on Generator Market Power in the Electricity Market of England and Wales, by Richard Brealey and Carlos Lapuerta on behalf of Enron Europe, Ltd., The Brattle Group, November 7, 1997.

transfer of control. Contrary to expectations, we found that Eastern's plants submitted higher bids and set SMP at higher levels than when the same capacity was under the control of National Power and PowerGen. The figure above shows Ironbridge One's (one of the plants leased to Eastern Group) bidding pattern before and after the lease, which clearly reveals higher bid prices following the transfer of control.

The Brattle Group's study was cited in the trade press and by the Office of Electricity Regulation ("OFFER") in its subsequent investigation of generator market power. Our recommendations for further divestiture of generating plants have been implemented, and full demand-side participation has been accepted as a cornerstone of the reforms to current trading arrangements. The amount of disclosure under the revised trading arrangements is yet to be determined.

CASE STUDY II: THE POTENTIAL FOR MARKET POWER IN A NEW MARKET – NEVADA

In a recent utility merger case, *The Brattle Group* employed a Cournot model to analyze whether effective retail competition was likely to result under the market structure proposed in a recent merger case for Nevada in 2000.⁵ The model assisted in assessing whether newly divested generators would likely earn profits in excess of competitive levels.

From a regulatory standpoint, Cournot models provide a conservative assessment of potential market power, because of the particular strategic interaction assumed. In a Cournot model, a competitor raises market prices by reducing its quantity of product when profitable. A firm's calculation of its own profit-maximizing output level takes into account their rivals' profit-maximizing output levels.

Our market simulation model was particularly relevant to Nevada because of the existence of load pockets in the merging companies' service territories. A load pocket occurs when local generators must operate in order to ensure local electricity demand can be met reliably. This situation arises when there is insufficient capability to import power into portions of the companies' control areas.

The existence of a load pocket does not necessarily imply market power. Market power depends on a number of factors, including:

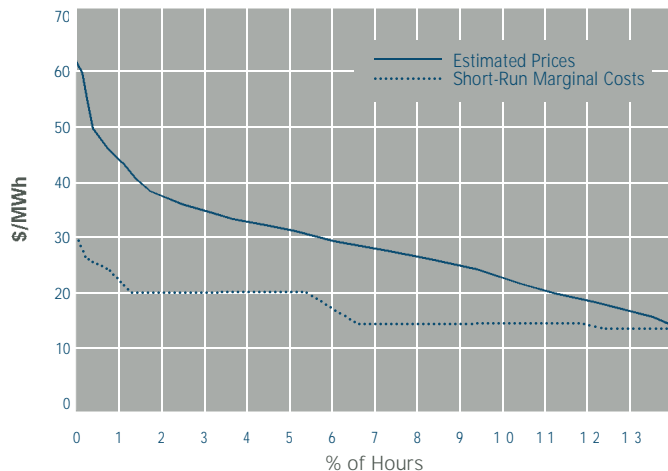
- The number of generation owners in the load pocket area;
- The amount of generation owned by each supplier;
- The marginal costs of the generating units;
- The sensitivity of electricity demand in the load pocket to price changes;
- And, most importantly, the relationship between the level of internal generation and the residual demand remaining after all of the load pocket import capability is exhausted.

In particular, load pockets potentially enable the exercise of market power when there is considerable concentration in the ownership of generating units within the load pocket area and when there are significant time periods during which load pocket conditions occur.

In *The Brattle Group's* market power analysis, the market simulation model treated each demand period as a separate product market with its own unique price. Unique market demand curves were constructed for individual period of the day and year, using actual load and price data for each company. It was assumed that imported power flowed into the companies' service territories until the transmission transfer limit was reached. The model assumed that external markets were competitive, using the California Power Exchange ("PX") prices as proxies for the exogenously determined competitive market prices outside of the companies' load areas. Based on these and other assumptions, an equilibrium output and price level were simulated for the demand conditions in each company's service area.

ELECTRICITY MARKETS : THE PRICE OF POWER

Simulation Indicates Lack of Market Power in Southern Nevada



SOURCE : Analysis of Market Power in Nevada's Retail Electric Market, Report of Dr. Peter Fox-Penner on behalf of Nevada Power Company and Sierra Pacific Power Company, The Brattle Group, August 6, 1998.

To determine the extent of market power in each load pocket area, the simulated Cournot prices were compared to both the California PX price and the price that would arise if all firms offered each unit of electrical power at short-run marginal costs. The figure above shows the difference between the simulated-Nevada price and short-run marginal costs during the summer months in southern Nevada. Based on this comparison, we concluded that generation owners would be minimally able to exercise market power in southern Nevada under retail competition and only under the most extreme demand conditions. Market power would exist in northern Nevada, however, if local generation was owned by too few separate firms and until sufficient generation or transmission capacity was added to the area. Due to the transitional and geographically-specific nature of the problem, we dubbed this phenomenon "transitional locational market power."

The Brattle Group's simulation model determined not only the potential for market power but also the level of market power within Nevada's service territories. This kind of insight would not have been possible had not the model gone beyond the traditional use of market share indices and simulated the potential strategic behavior of generation owners within load pockets. Cournot models provide an excellent approach for assessing the potential exercise of market power where there are significant transmission constraints.

CONCLUSION

As long as historical data on market performance and conduct exist, regulators and analysts will continue to use market power measures similar to those measures used in our UK Pool study. These measures provide useful insight regarding the behavior of market participants, as demonstrated by the UK Pool's adoption of our policy recommendations for mitigating market power. For prospective analyses, simulation models are excellent tools for understanding suppliers' potential strategic behavior. Simulation models will increasingly be used to study the impact of certain types of strategic interactions on prices and will, more often, replace concentration measures of market power for purposes of regulatory analysis. Market participants contemplating mergers, or opposing one, should, however, employ the full spectrum of structural and conduct models in order to see if their strategies are likely to be effective.

ENDNOTES

- 1 U.S. Department of Justice and the Federal Trade Commission, Horizontal Merger Guidelines, Section 0.1, Revised April 8, 1997.
- 2 An HHI is calculated by summing the squares of the individual market shares of all market participants. The FTC and DOJ guidelines classify a highly concentrated market as having HHIs greater than 1800, a moderately concentrated market as having HHIs higher than 1000, and an unconcentrated market as having HHIs less than or equal to 1000. For example, a market of five identical firms would result in an HHI greater than 1800 (5×20^2) while a market of 12 identical firms would result in an HHI less than 1000 (12×8^2).
- 3 Lerner Index = (Price-Marginal Cost)/Price. Sometimes referred to as a "price-cost markup." Jean Tirole, *The Theory of Industrial Organization* (Cambridge, Massachusetts : The MIT Press, 1988).
- 4 Richard Brealey and Carlos Lapuerta, "A Report on Generator Market Power in the Electricity Market of England and Wales," Commissioned by Enron Europe, Ltd., November 1997.
- 5 Analysis of Market Power in Nevada's Retail Electric Market Report, Dr. Peter Fox-Penner on Behalf of Nevada Power Company and Sierra Pacific Power Company, The Brattle Group, August 6, 1998 and Direct Testimonies of Peter Fox-Penner and Philip Q. Hanser on behalf of Sierra Pacific Power Company and Nevada Power Company, FERC Docket No. ER99-2238-001, March 31, 1999. The Brattle Group Senior Advisor, Steven Stoft, also participated in these assignments.

ROBERT BORLICK JOINS *THE BRATTLE GROUP* AS A SENIOR ADVISOR

Robert Borlick has more than 20 years of experience in providing counsel and litigation support for the electric and natural gas utility industries. Mr. Borlick has participated in projects related to the restructuring and/or privatization of the electric power sectors of Australia, Canada, New Zealand, Russia, Singapore, and the UK, among others. He has been involved in the development of the rules governing the pricing and operation of wholesale electric energy markets and in the procurement and pricing of ancillary services. Mr. Borlick has also worked on the valuation of private power projects, advising the developer in some projects; the purchaser in others. Mr. Borlick authored the popular Department of Energy report, *Nuclear Plant Cancellations: Causes, Costs and Consequences*.

RECENT *BRATTLE* PUBLICATIONS

Members of *The Brattle Group* have recently published several articles on topics of interest to energy specialists.

- Lessons from the First Year of Competition in the California Electricity Markets
- Opportunities for Electricity Storage in Deregulating Markets
- Transmission Access, Episode II: FERC's Journey Has Only Begun

If you would like a copy of any of these articles, please contact us at publications@brattle.com.

RICHARD E. GOLDBERG JOINS THE ENERGY PRACTICE

Richard E. Goldberg is an energy industry leader in the use of financial techniques for calculating the value of and managing the risks associated with physical assets (*e.g.*, power plants), contract commitments (*e.g.*, fuel purchase agreements), and retail customers. He applies these techniques to asset buy/sell decisions, asset management, capital budgeting, commodity trading, retail service design, and corporate risk management. Prior to joining *The Brattle Group*, Dr. Goldberg led the Electric Power Research Institute's research and consulting effort in asset and risk management.

THE BRATTLE GROUP'S NEWSLETTER SERIES

Our newsletter series includes the:

- ENERGY newsletter, which discusses current issues in energy markets and regulation;
- ECONOMICS newsletter, which focuses on current topics in economic litigation and strategy, such as the estimation of patent damages; and
- ENVIRONMENT newsletter, which reports on issues in environmental litigation.

For more information on any of these newsletters, please contact us at publications@brattle.com.

Copyright © 2000 The Brattle Group, Inc.

Next Issue: COST OF CAPITAL FOR GAS PIPELINES AND ELECTRICITY TRANSMISSION

The risks associated with transporting gas and electric energy from source to sink are increasing as these markets become further deregulated. Our next issue discusses the issues that have arisen in recent gas pipeline and electricity transmission cost of capital cases.

The Brattle Group

44 Brattle Street
Cambridge, MA 02138-3736
Voice 617.864.7900
Facsimile 617.864.1576

1133 Twentieth Street NW
Washington, DC 20036-3408
Voice 202.955.5050
Facsimile 202.955.5059

5th Floor 8-12 Brook Street
London W1Y 1AA
Voice (0207)491.0843
Facsimile (0207)491.0846

email.office@brattle.com

www.brattle.com