

Lessons Learned From Electricity Market Liberalization

Paul L. Joskow*

This paper discusses the lessons learned from electricity sector liberalization over the last 20 years. The attributes of reform models that have exhibited good performance attributes are identified, drawing on empirical analysis of market structure, behavior and performance in many countries. Wholesale and retail market competition and network regulation performance evidence are discussed. Technical, economic, and political challenges to improving the efficiency of what continue to be partial liberalization programs in many countries are considered.

1. INTRODUCTION

It has been almost 25 years since Richard Schmalensee and I published *Markets for Power* (1983), almost 20 years since the UK began to design its innovative and comprehensive electricity sector privatization, restructuring for competition, and regulatory reform program (Henney (2004)), over 15 years since Green and Newbery (1992) published their simulation analysis of market power in the deregulated wholesale electricity markets in England and Wales under alternative market structures, 10 years since Newbery and Pollitt (1997) published their social cost-benefit analysis of the privatization and restructuring program in the UK, and 7 years since the California electricity crisis and the collapse of Enron. Several additional countries (or portions of countries) have followed the UK's lead and introduced comprehensive electricity sector reform programs and, at least in theory, comprehensive electricity sector liberalization principles now apply to all

The Energy Journal, Special Issue. The Future of Electricity: Papers in Honor of David Newbery. Copyright © 2008 by the IAEE. All rights reserved.

* Elizabeth and James Killian Professor of Economics and Management and Director of the Center for Energy and Environmental Policy Research (CEEPR) at the Massachusetts Institute of Technology (MIT). Research support has been provided by the MIT CEEPR.

This paper is based on Joskow 2006c. I recommend highly the book where this paper appears. I am grateful for comments from Richard Green and two anonymous referees.

EU countries.¹ Many other countries have introduced less comprehensive liberalization reform programs. Still others have resisted or slowed down reforms or succeeded in defeating them completely. The U.S. has never enacted a mandatory comprehensive federal restructuring and competition law, leaving the most significant reform decisions to the states. As a result, many U.S. states have introduced only limited liberalization reforms in wholesale markets without fundamental electricity sector restructuring and politicians in several U.S. states that introduced comprehensive reforms prior to 2001 are now calling for “re-regulation.”

During the last 25 years most developed countries have also gone through reasonably comprehensive privatization, restructuring and deregulation programs in sectors that were previously regulated monopolies and/or state-owned: airlines, trucking, telecommunications, natural gas (in the U.S., Canada and the UK anyway), mail and package delivery services, railroads, and other sectors. While these reforms have not always proceeded without controversy or led to precisely the results predicted, the general trend of public policy has continued to support liberalization and to move forward with additional liberalization reforms in sectors that were once dominated by regulated legal monopolies. These reforms are generally widely accepted and “re-regulation” of these sectors is not high on the policy agenda. Electricity sector liberalization (and natural gas sector liberalization in much of Europe) seems to be different from the trends in these other industries. In many countries electricity sector reforms are incomplete, either moving forward slowly with considerable resistance or moving backward, despite the success of these reforms in the UK, the Nordic countries, Argentina (before its macroeconomic collapse), Chile, Texas, portions of Australia and other countries and regions. Why is electricity sector liberalization so difficult and subject to so much opposition? Are there lessons to be learned from the diverse experiences in countries around the world in the last two decades to support renewed liberalization efforts in electricity sectors?

This paper develops the lessons learned from roughly two decades of experience with electricity sector liberalization.

2. BACKGROUND

Electricity sectors almost everywhere on earth evolved with (primarily) vertically integrated geographic monopolies that were either state-owned or privately-owned and subject to price and entry regulation as natural monopolies. The primary components of electricity supply --- generation, transmission, distribution, and retail supply --- were integrated within individual electric utilities. These firms in turn had de facto exclusive franchises to supply electricity to residential,

1. It is sometimes argued that Chile is the first country to liberalize its electricity sector. While Chile did introduce a number of privatization, restructuring and competition reforms beginning in the early 1980s, it did not and has not created a real wholesale market for electricity and for many years the major generating company, distribution company and transmission company were under common ownership. See Joskow (2000b).

commercial and industrial retail consumers within a defined geographic area. The performance of these regulated monopolies varied widely across countries. Sector performance in developed countries was generally much better (Joskow 1997) than in developing countries (World Bank 1994, Bacon and Besant-Jones 2001, Besant-Jones 1993), but high operating costs, construction cost overruns on new facilities, high retail prices, and falling costs of production from new facilities driven by low prices for natural gas and the development of more efficient generating technologies (e.g. CCGT), stimulated pressures for changes that would reduce electricity costs and retail prices (Joskow 1998, 2000a).

The overriding reform goal has been to create new institutional arrangements for the electricity sector that provide long-term benefits to society and to ensure that an appropriate share of these benefits are conveyed to consumers through prices that reflect the efficient economic cost of supplying electricity and service quality attributes that reflect consumer valuations. The benefits are to be realized by relying on competitive wholesale markets for power to provide better incentives for controlling construction and operating costs of new and existing generating capacity, to encourage innovation in power supply technologies, to provide incentives for network operators to provide appropriate levels of service quality, and to shift the risks of technology choice, construction cost and operating “mistakes” to suppliers and away from consumers. Retail competition, or “third party access” is supposed to allow consumers to choose the retail power supplier offering the price/service quality combination that best meet their needs and to allow competing generators and intermediaries to offer these services to consumers. Competing retail suppliers were also expected to provide an enhanced array of retail service products, risk management, demand management, and new opportunities for service quality differentiation to better match individual consumer preferences.

It has also been widely recognized that significant portions of the total costs of electricity supply – distribution and transmission – would continue to be regulated as legal monopolies. Accordingly, reforms to traditional regulatory arrangements governing the distribution and transmission networks have generally been viewed as an important complement to the introduction of wholesale and retail competition to supply consumer energy needs. Privatization of distribution and transmission companies combined with the application of Performance Based Regulation (PBR) imposes hard budget constraints on regulated network firms and provides better incentives for them to reduce costs and improve service quality (Beesley and Littlechild 1989, Joskow 2006b, Jamasb and Pollitt 2007). In addition, the efficiency of competitive wholesale and retail markets depends on a well functioning supporting transmission and distribution network infrastructure.

3. THE STANDARD LIBERALIZATION PRESCRIPTION

While a number of variations are potentially available (Hunt 2002, Joskow 2000a, 2005a), it is my view that the “textbook” architecture of desirable

features for restructuring, regulatory reform and the development of competitive markets for power involves several key components:

- a. Privatization of state-owned electricity monopolies to create hard budget constraints and high-powered incentives for performance improvements and to make it more difficult for the state to use these enterprises to pursue costly political agendas.²
- b. Vertical separation of potentially competitive segments (e.g. generation, marketing and retail supply) from segments that will continue to be regulated (distribution, transmission, system operations) either structurally (through divestiture) or functionally (with internal “Chinese” walls or “ring fencing” separating affiliates within the same corporation). These changes are thought to be necessary to guard against cross-subsidization of competitive businesses from regulated businesses and discriminatory policies affecting access to distribution and transmission networks upon which all competitive suppliers depend.
- c. Horizontal restructuring of the generation segment, to create an adequate number of competing generators to mitigate market power and to ensure that wholesale markets are reasonably competitive.
- d. Horizontal integration of transmission facilities and network operations to encompass the geographic expanse of “natural” wholesale markets and the designation of a single *independent* system operator to manage the operation of the network, to schedule generation to meet demand and to maintain the physical parameters of the network (frequency, voltage, stability), and to guide investments in transmission infrastructure to meet reliability and economic standards.
- e. The creation of voluntary public wholesale spot energy and operating reserve market institutions to support requirements for real time balancing of supply and demand for electric energy, to allocate scarce network transmission capacity, to respond quickly and effectively to unplanned outages of transmission or generating facilities consistent with the need to maintain network voltage, frequency and stability parameters within narrow limits, and to facilitate economical trading opportunities among suppliers and between buyers and sellers.
- f. The development of active “demand-side” institutions that allow consumers to react to variations in wholesale market prices and fully

2. The Nordic countries have had a reasonably successful reform experience without full privatization (Amundsen, Bergman and von der Fehr 2006, Bye and Hope 2006). However, the Nordic model still must face the issue of attracting investment in new generating capacity based on market incentives rather than direct or indirect government mandates or subsidies (Nordic Competition Authorities 2007).

- integrate demand side responses to energy prices and reliability criteria into wholesale and retail markets.
- g. The application of regulatory rules and supporting network institutions to promote efficient access to the transmission network by wholesale buyers and sellers in order to facilitate efficient competitive production and exchange. This includes mechanisms efficiently to allocate scarce transmission capacity among competing network users, and to provide for efficient siting and interconnection of new generating facilities.
 - h. The unbundling of retail tariffs to separate prices for retail power supplies and associated customer services to be supplied competitively from the regulated “delivery” charges for using distribution and transmission networks that would continue (primarily) to be provided by regulated monopolies
 - i. Where policymakers have determined that retail competition will not be available (e.g. for domestic and small commercial customers), distribution companies or alternative designated suppliers would have the responsibility to supply these customers by purchasing power in competitive wholesale markets or, if they choose, to build their own generating facilities to provide power supplies. However, in the latter case the associated charges for power would be subject to wholesale market-based regulatory benchmarks, primarily competitive procurement processes.
 - j. The creation of independent regulatory agencies with good information about the costs, service quality and comparative performance of the firms supplying regulated network services, the authority to enforce regulatory requirements, and an expert staff to use this information and authority to regulate effectively the prices charged by distribution and transmission companies and the terms and conditions of access to these networks by wholesale and retail suppliers of power, are also an important but underappreciated component of successful reforms.
 - k. Transition mechanisms must be put in place to move from the old system to the new system. These mechanisms should be compatible with the development of well functioning competitive markets.

4. LESSONS LEARNED FROM INTERNATIONAL EXPERIENCE

There have been few comprehensive “social cost-benefit” assessments of the effects of electricity restructuring in specific countries. Newbery and Pollitt’s (1997) analysis of the welfare consequences of reforms in the UK is an exception, though it covers a period that precedes the significant reduction in generation concentration in the late 1990s and the introduction of wholesale market institutions (NETA) to replace the pool (Newbery 1998) in 2001. Wholesale markets in

England and Wales appear to have become much more competitive since the late 1990s, increasing efficiency and conveying more of the benefits of liberalization to consumers (Newbery 2006). There has been much more work on individual segments of the liberalized electricity sectors in a number of countries (e.g. labor productivity in generation and distribution; integration of wholesale markets; investment in generation) as well as many “fragments of evidence” associated with specific aspects of performance in particular segments of the sector (Sioshansi and Pfaffenberger 2006).

One of the challenges that must be confronted in doing a performance assessment of electricity sector liberalization is to choose a suitable *counterfactual* benchmark for comparison purposes. That is, we need to measure various performance metrics and compare them with what these metrics *would have been* if the reforms had not been made at all or if they had been made differently, not comparisons with some abstract ideal.

There are various approaches to examining the effects of liberalization reforms (Joskow 2006c): (a) “before and after” studies using time series data; (b) inter-country and inter-state comparisons where liberalization institutions vary from country to country or state to state; (c) structural simulation approaches. All three of these approaches can provide useful insights into the effects of policy reforms on various performance indicia. However, in each case it is important to adopt what Oliver Williamson (1985) refers to as a comparative governance approach to the evaluation of the performance of alternative institutional arrangements for any industry. It has two components: (a) performance assessments must recognize that observed performance should be compared with performance under a clearly defined alternative set of institutional arrangements and (b) “ideal” textbook performance that we associate, for example, with perfectly competitive markets, is never achievable in reality. Policymakers should be looking for the best that they can do in an imperfect world.

In light of the historical experience to date I now turn to a baker’s dozen of lessons learned:

1. *Electricity sector reforms have significant potential benefits but also carry the risk of significant potential costs if the reforms are implemented incompletely or incorrectly:* I believe that it is fair to say that when electricity restructuring and competition programs are designed and implemented well, electricity sector performance, in terms of operating costs, physical network losses, generator availability, theft of service, availability of service, investment, price levels and structures, service quality and other performance variables, can be expected to improve significantly compared to either the typical state-owned or private regulated vertically integrated monopoly. Note that this conclusion is not inconsistent with a finding that there are some regulated vertically integrated monopolies that perform quite well and that, in such cases, the kinds of comprehensive reforms reflected in the textbook model might have little positive effect on performance. Rather, it is a statement about what expectations policymakers, faced with imperfect and asymmetric information about the performance of the regulated sector,

should have in the typical cases. Nor is it a statement that retail electricity prices will always fall in nominal terms as a result of liberalization. In some countries regulated prices were inefficiently low, discouraging investment and wasteful consumption. Liberalization should lead to higher prices and better incentives. Moreover, any analysis of price effects must take account of all exogenous cost drivers, especially fuel costs. Specifically, comparing electricity prices in a regime where natural gas prices are \$2/MCF to a regime where natural gas prices are \$8/MCF without controlling for the effects of changes in natural gas prices on wholesale electricity prices will lead to meaningless results (Joskow 2006a, Harvey, McConihe and Pope 2006).

However, the experience in many countries makes it fairly clear that successful implementation of liberalization reforms is not easy and that there is a risk that costly performance problems may emerge when the transformation is implemented incompletely or incorrectly. California is the textbook case of reforms gone bad, though it is not at all clear that the right lessons have been learned from that experience. Wholesale markets with good performance attributes have been slow to emerge in some countries. Even in England and Wales, major changes were made in the design of the wholesale market in 2001 when NETA replaced the Pool. The promised benefits of retail competition for residential and small industrial customers have been slow to emerge in many countries. The mobilization of adequate investment to expand generation, transmission and distribution capacity has been a (real or imagined) problem in many of the countries that have implemented reforms. These “transition” problems can be minimized by getting the reforms right at the outset.

2. The textbook model of restructuring, regulatory reform and market design is a sound guide for successful reform: The use of the phrase “deregulation” to characterize the attributes of the most successful electricity sector reform programs is misleading. This is not the trucking industry and the traditional industry structure based on vertically integrated regulated monopolies is not conducive to simple “deregulation” without supporting structural, regulatory and market design reforms (Joskow and Schmalensee 1983). Restructuring, regulatory reform, wholesale and retail market design, *and* deregulation of competitive wholesale and retail segments go together. The most successful reform programs have followed the “textbook model” outlined earlier reasonably closely: privatization of state-owned enterprises, vertical and horizontal restructuring to facilitate competition and mitigate potential self-dealing and cross-subsidization problems, PBR regulation applied to the regulated transmission and distribution segments, good wholesale market designs that facilitate efficient competition among existing generators, competitive entry of new generators, and retail competition, at least for industrial customers.

In my view, the gold standard for electricity sector reform is England and Wales (Green and Newbery 1992, Newbery and Pollitt 1997, Green 2005b, Newbery 2006). The reforms followed the basic architecture of the textbook model and have led to significant performance improvements in many dimensions.

This is not to say that everything worked perfectly. Clearly, the decision to create only three generating companies out of the state-owned CEGB, two of which set the clearing price in the wholesale market in almost all hours, led to significant market power problems that persisted for several years (Wolfram 1999, Sweeting 2007). Not only were wholesale prices too high, but there was probably an inefficiently high level of entry of new gas-fired CCGTs during the 1990s attracted by high margins. Congestion on the transmission network made some generators “must run,” creating additional “locational” market power problems. However, a combination of entry of new generators, divestitures of existing generating plants by incumbent suppliers, and transmission investments has made the wholesale market structurally more competitive over time. Price-cost margins eventually fell dramatically and there is a lively debate about whether it was the reduction in seller concentration or the introduction of the New Electricity Trading Arrangements (NETA) to replace the Pool that is the cause of the reduction in market power observed in the last few years (Evans and Green 2005).

Putting generation market power issues aside, there is a lot of evidence that the high-powered incentives created by competitive wholesale electricity networks lead to lower generator operating costs and improved availability (Newbery and Pollitt 1997, Fabrizio, Rose and Wolfram 2007, Bushnell and Wolfram 2005, ISO New England 2005).

Privatization and the application of high-powered regulatory mechanisms to distribution and transmission have led to improvements in labor productivity and service quality in electric distribution systems in England and Wales as well (Domah and Pollitt 2001, Jamasb and Pollitt 2007). The application of incentive regulation mechanisms to the independent transmission company also led to a dramatic reduction in the costs of managing network congestion and the costs of balancing the system and maintaining network reliability. During the 1990s there was substantial entry of new generating capacity, largely replacing existing generating capacity (that eventually retired), rather than to meet a need for new capacity to meet growing peak demand. The retail competition program in England and Wales has been reasonably successful, though there continue to be debates about whether the benefits of extending retail competition to domestic (residential) customers was worth the costs (Newbery 2006, Green and McDaniel 1998 and Salies and Waddams Price 2004).

England and Wales is not the only country that has followed the textbook model. Argentina followed most features of the basic textbook model and, prior to the country’s macroeconomic collapse, currency crisis, and rejection of contractual and regulatory commitments in 2002, experienced excellent performance. Argentina experienced significant improvements in the performance of the existing fleet of generating plants, significant investment in new generating capacity, and improvements in productivity and a reduction in losses (physical and due to thefts of service) on the distribution networks (Dyner, Arango and Larson 2006, Pollitt 2004a, Rudnick and Zolezzi 2001, Bacon and Besant-Jones 2001, Estache and Rodriguez-Pardina 1998). Unlike the case in England and Wales, Argentina made

a serious effort at the outset to create a generation sector that was structurally competitive and there is little if any evidence of market power in the wholesale market there. These improvements in performance indicia were realized despite (or perhaps partially because of) the fact that Argentina did not have a real unregulated spot market for electricity. Following the model established in Chile, Argentina's so-called spot market was structured as a security-constrained marginal cost based (i.e. not bid-based) power pool in which the clearing price is determined mechanically by the marginal cost of the generator that clears the market in an efficient cost-based merit order dispatch. This mechanism effectively caps prices in the spot market at very low levels (about \$150/MWh during the 1990s) under scarcity conditions. However, the spot market revenues are supplemented by revenues from a capacity payment mechanism to support generation investment.

Texas also took a comprehensive approach to restructuring, regulatory reform and market design that followed many of the basic attributes of the textbook model (Adib and Zarnikau 2006). However, rather than adopting a pool-based wholesale market as in the UK and Argentina, Texas took an approach to wholesale market design that relied as much on bilateral contracts and as little on organized public markets operated by the ISO as possible – more like NETA in the UK. Texas also endeavored to implement structural remedies (i.e. generation divestiture) to respond to concerns about market power. However, transmission network congestion management and associated market power issues have been significant issues in Texas. Rather than introducing capacity payments, Texas has also increased the price cap in the balancing markets for energy and ancillary services. Texas adopted an approach to retail competition that is similar to that adopted in the UK, except retail competition was opened to all classes of customers from the beginning. At least in terms of switching behavior, Texas has the most successful retail competition program in the U.S., especially for smaller customers (Adib and Zarnikau 2006).

New Zealand (Bertram 2006), portions of Australia (Moran (2006)) and the Nordic countries (Amundsen, Bergman and von der Fehr (2006), Bye and Hope (2006), Nordic Competition Authorities (2007)), Ontario, and Brazil adopted many of the key components of the textbook model and have had reasonably successful reform programs, though retail competition opportunities vary between these countries. Australia, the Nordic countries, Ontario, Australia and Brazil have proceeded with their reforms without fully privatizing the generation segment of the sector. The continued mix of public and private generating companies raises some interesting issues both for short run market performance and longer run investment incentives. Investments by public sector firms in new generating capacity based on considerations other than market incentives, direct or indirect subsidies can easily undermine private sector incentives to make investments in new generating capacity without similar support payments. This is a serious issue in all of the markets with mixed public-private generation sectors.

Chile is often identified as the first country to adopt the textbook electricity sector reform model (Raineri (2006)). While I believe that the Chilean re-

forms have led to large efficiency improvements compared to what preceded them, and that there is much to be proud of in the reforms that were made there beginning in the 1980s, the Chilean system has involved less restructuring, less competition and more regulation than first meets the eye (Joskow 2000b, Joskow 2006c). Whatever the success that the Chilean reforms achieved, they are not *primarily* the result of vibrant unregulated competitive wholesale or retail markets for electricity or real vertical and horizontal restructuring. Privatization, incentive regulation, a simulated competitive spot market, contractual obligations placed on distribution companies, and free entry by incumbent suppliers in response largely to administratively determined generation prices have all contributed to the performance improvements.

In the late 1990s, California and many of the Northeastern U.S. states appear to have adopted many of the components of the textbook model as well. Yet California is often put forward as the textbook case of “deregulation” gone bad. The California restructuring and competition program (but not the T&D regulatory framework) were heavily influenced by the earlier reforms in England and Wales. The initial reform proposals contained in the so-called “blue book” included many of the features of the reform program in England and Wales. And, although disputes about wholesale and retail market design led eventually to a reform program that departed from several aspects of the textbook model, it still retained many of its basic features.

Many explanations have been advanced to explain what happened in California. One set of interpretations of what transpired and why can be found in Sweeney (2006). My views, written at about the time the crisis was winding down and before the Enron and other marketers tapes were released, can be found in Joskow (2001). The most frequent popular explanation is that there was a shortage of generating capacity in California and that this shortage was a result of poor investment incentives inherent in California’s wholesale market design. This is not an accurate characterization of what actually happened. There was little investment in generating capacity anywhere in the U.S. during the time period when the California reforms were being designed and implemented (1994-98). This is because there was excess capacity in most regions of the U.S. during the early 1990s. Uncertainties about the future path of structuring, regulatory and competitive reforms that began to be discussed seriously at this time was also a deterrent to potential investors waiting until the rules of the game were specified more clearly. Indeed at the time of the crisis there was a long queue of developers that had applied for permits to build new generating plants in California after the market opened in April 1998. It is unrealistic to expect that even under the best of circumstances any significant amount of new generating capacity could have come out of the construction pipeline in two years. Moreover, California is a summer peaking system. The biggest problems, in terms of high prices, operating reserve emergencies and rolling blackouts did not occur until the winter of 2000-2001. The problem was not that there was inadequate physical generating capacity in place, but rather that a large fraction of the existing generating capac-

ity was not available to generate electricity. This has led to debates about whether the generating capacity was being consciously withheld from the market (fake sick leave) to drive up prices or that the generating equipment broke down (real sick leave).

It is true that California's wholesale market would have been stressed due to tight capacity during the second half of 2000 even if there had been no market power problems. Demand was unusually high throughout the Western Interconnection, natural gas prices and NO_x permit prices rose significantly. However, even after taking account of these factors it is hard to explain what happened during the second half of 2000 only as the result of the interplay of supply and demand in a competitive market. The "shortage" of generating capacity may perhaps be explained by older plants breaking down and by their owners' reluctance to supply when it became unclear about January 2001 whether or not they would be paid. However, there is also abundant evidence that some suppliers exploited opportunities to engage in strategic behavior to jack up market prices. At least in the summer of 2000, some generators were taking advantage of a tight supply situation to exercise market power (Borenstein, Bushnell and Wolak (2002), Joskow and Kahn (2002)). The tapes of the conversations of traders for Enron and other companies that subsequently were released make it clear that they saw and took advantage of opportunities to withhold supplies and increase market prices during the crisis.

In my view, if California had implemented similar transition arrangements to those implemented in the Northeast, in particular if the California utilities had more completely hedged their retail supply obligations with forward contracts and had the opportunity to recover from retail customers reasonable costs of the power they purchased in wholesale markets, there would have been no California electricity crisis. This is not to say that deficiencies in the design of California's wholesale markets would not have led to inefficiencies that would have driven up wholesale power costs to some degree. Rather, there would not have been a sudden financial collapse and California would have had time to improve its wholesale market and transmission institutions as in the Northeast. Instead, California responded to the crisis with costly long-term contracts negotiated by the state, long term procurement obligations, a freeze on retail competition, and a strange mix of regulatory obligations and competitive markets that does not bode well for the future (Sweeney 2006).

3. Departing significantly from the textbook model of restructuring, competitive market institutions and regulatory reform is likely to lead to performance problems.

The reforms in much of continental Europe (Spain and the Netherlands being the primary exceptions), in Japan, and in large portions of the U.S. have not followed the textbook liberalization model (Joskow 2006a, Haas et. al. 2006). The alternatives have been partial liberalization or simply continuing with the basic model of regulated vertically integrated monopoly. The initial focus of the EU reforms was on "market opening" for retail customers rather than comprehensive

reforms. That is, the focus was on retail competition. This approach ignores the fact that “market opening” alone will not lead to meaningful retail competition in the absence of appropriate wholesale market and network access and pricing institutions. Retail customers may be given the freedom to shop around for their power needs, but unless they can obtain delivery services on reasonable terms and conditions and there is a well functioning competitive wholesale market where they or their agents can shop, there will be no meaningful opportunity to take advantage of this freedom.

I view the slow pace of development of the development of transparent wholesale, efficient congestion management institutions, and retail competition in many of the countries in continental Europe as being largely attributable to their failure to restructure vertically and horizontally and to create the necessary network access, pricing and wholesale market institutions to create a robust wholesale market (Haas et. al. 2006). Germany provides a good example of how retail competition without restructuring and the creation of competitive market and supporting regulatory institutions leads to performance problems (Brunekreeft and Bauknecht 2006). The German electric power system continues to be dominated by vertically integrated utilities with interests in generation, transmission and distribution. They control the operation of the transmission networks, which are operated as separate control and balancing areas rather than as a single balancing area as in other European countries. There is no independent system operator. Generation ownership is fairly concentrated. Until recently, there was no regulator to determine network costs and prices or to enforce unbundling rules necessary to support retail and wholesale competition. Japan has implemented only very modest structural reforms (Goto and Yajima 2006) and transparent PBR regulatory institutions for distribution and transmission networks have not been introduced. It appears that the development of robust wholesale and retail markets and a network regulatory system with good performance attributes will be a slow process in Japan indeed.

Whether it is by design or accident, however, the EU’s focus on market opening for retail consumers has now led it to look more closely at supporting reforms upstream at the wholesale and transmission levels as time has passed. The EU is now considering requiring the creation of independent system operators and transmission entities, relying either on ownership separation or on functional separation or ring fencing. Germany has been forced to create a regulator to regulate (at least) network charges and unbundling protocols. While the EU and other pan-European institutions have focused on transmission facilities that connect individual member countries, rather than getting involved in intra-country market design or competition issues, system operators are increasingly realizing that efficient use of interconnector capacity requires some compatibility between intra-country wholesale market designs and coordination between them. Accordingly, the EU and members countries are now moving back upstream to implement a variety of structural and institutional reforms that would have, ideally, been done first rather than last.

Another example is Brazil. The reforms in Brazil proceeded without a comprehensive reform blueprint and the blueprint developed for them by a large consulting firm was not implemented (Lizardo and Araujo 2006). The progress of the reform program was further overwhelmed by a water shortage in a system that is heavily dependent on hydroelectricity. This would have led to problems under any circumstances. These problems were probably worse because of the incomplete implementation of the reforms and were blamed unfairly on the reforms themselves.

4. *Transparent organized spot energy and ancillary services markets should be integrated with the allocation of scarce transmission capacity.* The most efficient design of spot wholesale energy markets continues to be a subject of dispute among interest groups and independent experts (Joskow 2005a, Hunt 2002, Stoft 2002, Green 2005a). Should the market be built around a pool or rely on bilateral contracts? Should there be locational pricing of energy and operating reserves? How should scarce transmission capacity be allocated? Should transmission rights be physical or financial (Hogan 1992, Joskow and Tirole 2000, Gilbert, Neuhoff and Newbery 2004)?

While there is some room for flexibility, and some of the disputes reflect the self-serving arguments of interest groups that expect to benefit from inefficient markets, I believe that the experience to date supports the desirability of several basic wholesale market design features. These basic design features include the creation of *voluntary* transparent organized spot markets for energy and ancillary services (day-ahead and real time balancing) that accommodate bilateral contracts and self-scheduling of generation if suppliers choose to take this approach; locational pricing of energy reflecting the marginal cost of congestion and losses at each location; the integration of spot wholesale markets for energy with the efficient allocation of scarce transmission capacity; auctioning of (physical or financial) transmission rights that are simultaneously feasible under alternative system conditions to hedge congestion, serve as a basis for incentives for good performance by system operators and transmission owners, and partially to support new transmission investment³ (Joskow and Tirole 2000); an active demand side that can respond to spot market price signals (Borenstein, Jaske and Rosenfeld 2002). These are the attributes of the PJM markets, as well as those in New England, New York and the Midwest ISO in the U.S. (Joskow 2006a). California is proposing to implement a similar “nodal price” market design, though its implementation has been delayed until 2008 and Texas is considering doing so as well. While markets without transparent locational pricing can work reasonably well (e.g. NETA in the UK), they are more likely to run into problems (as in California, Texas, Alberta and Ontario) without locational pricing based on the integration of wholesale electricity markets and the allocation of scarce transmission capacity.

3. The allocation of transmission rights can, however, affect the incentives of firms to exercise market power and this should be taken into account in the design of rights allocation mechanisms and restrictions on the entities that can purchase these rights (Joskow and Tirole (2000), Gilbert, Neuhoff and Newbery (2004)).

5. *Market power is a significant potential problem in electricity markets, but the cure can be worse than the disease. Try to deal with potential market power structurally ex ante rather than ex post.* The potential for market power to be a particularly severe potential problem in electricity markets was recognized many years ago (Joskow and Schmalensee 1983, Chapter 12) and was reinforced as the reforms in the UK were implemented in 1990 (Green and Newbery 1992) and those in California in 1998 (Borenstein and Bushnell 1999). Generator market power arises as a consequence of transmission constraints that limit the geographic expanse of competition, generation ownership concentration within constrained import areas, the non-storability of electricity, and the very low elasticity of demand for electricity (Joskow 1997, Borenstein 2002). Generator market power was a serious problem for several years following the launch of the privatization, restructuring and competition program in the UK (Wolfram 1999, Sweeting 2007). Concerns about market power in the U.S. were reinforced by the events in California in 2000-2001 (Borenstein, Bushnell and Wolak 2002, Joskow and Kahn 2002) where market power and the exploitation of market design imperfections contributed to the explosion in wholesale prices beginning in June 2000. Market power issues of various kinds have been identified in many other electricity markets, including New Zealand, Chile, Columbia, PJM, Texas, Alberta, Brazil and some areas of continental Europe. The problems can be attributed to the interactions between the attributes of electricity networks noted above, too few competing generating companies, wholesale market design flaws, vertical integration between transmission and generation that creates the incentive and opportunity for exclusionary behavior, excessive reliance on spot markets rather than forward contracts, and limited diffusion of real time prices and associated communications and control technology that facilitates the participation of demand in wholesale spot markets.

Clearly, market power is an issue that must be taken seriously since electricity markets have attributes that are conducive to exercising market power (Borenstein 2000). No market design will work well if there are not an adequate number of competitive suppliers of generation service, adequate demand side responsiveness, or the market power of dominant firms has not been mitigated in some way (i.e. with regulated forward contracts). As a result, market power mitigation strategies have become an important component of wholesale market reforms in many countries. In the U.S., FERC market monitoring and market power mitigation protocols have been a central component of all of its reform initiatives. All of the ISOs in the U.S. have market monitoring units, wholesale price caps have been implemented and special bidding and mitigation restrictions have been placed on generators located in small geographic load pockets. The Energy Policy Act of 2005 expanded FERC's authority to penalize suppliers identified as engaging in "market manipulation" in natural gas and wholesale electricity markets and FERC's rules for implementing this authority have been codified in Order 670 issued in January 2006⁴ and a related Order 674. FERC has used that authority in

4. <http://www.ferc.gov/legal/maj-ord-reg/land-docs/order670.asp>

two recent cases involving alleged market manipulation in natural gas markets.⁵ These market monitoring and mitigation protocols appear to have been reasonably successful in mitigating the ability of suppliers to exercise significant market power in these situations as well. On the other hand, these market power mitigation programs may be too aggressive, constraining prices from rising to competitive levels when demand is high, capacity is fully utilized, and competitive market prices should reflect scarcity values that exceed the price caps in place. Thus, these efforts to mitigate market power in the short run may create adverse generation investment incentives in the long run (Joskow and Tirole 2007), a subject to which I shall return presently.

6. *Good transmission and distribution network regulatory institutions are important but sometimes neglected components of the reform process.* It is important to remember that the textbook model includes the development and application of a well-designed regulatory framework to govern the distribution and transmission networks that will continue to be subject to government regulation of prices, costs, service quality, access rules, and investment programs. These “residual” regulated segments of the electricity sector often represent a significant fraction of the total retail price for services paid for by consumers (prices for competitive plus regulated services). Moreover, the performance of the regulated segments can have important effects on the performance of the competitive segments since the regulated segments provide the infrastructure platform upon which the competitive segments rely (e.g. the electric transmission and distribution networks). Accordingly, the welfare consequences of electricity sector restructuring and competition reforms depend on the performance of both the competitive and the regulated segments of these industries.

Regulatory reform focused on applying PBR mechanisms was a central feature of the liberalization program in the UK and the regulatory institutions and mechanisms that have evolved there also represent the gold standard of effective incentive or performance-based network regulation (Beesley and Littlechild 1989, Joskow 2006b). Privatization and the application of high-powered regulatory mechanisms have led to improvements in labor productivity and service quality in electric distribution systems in England and Wales, Argentina, Chile, Brazil, Peru, New Zealand and other countries (Newbery and Pollitt 1997, Domah and Pollitt 2001, Rudnick and Zolezzi 2001, Bacon and Besant-Jones 2001, Estache and Rodriguez-Pardina 1998, Pollitt 2004, Jamasb and Pollitt 2007). Sectors experiencing physical distribution losses due to poor maintenance and antiquated equipment, as well as resulting from thefts of electric service, have generally experienced significant reductions in both types of losses when appropriate incentive regulation mechanisms have been introduced. Penetration rates for the availability of electricity to the population have increased in those countries where service was not already universally available and queues for connections have been short-

5. <http://www.ferc.gov/EventCalendar/Files/20070726084254-IN06-3-002.pdf>; <http://www.ferc.gov/EventCalendar/Files/20070726084235-IN07-26-000.pdf>

ened. Distribution and transmission network outages have declined. Improved performance of regulated distribution (and sometimes transmission) systems has accompanied privatization and the application of high-powered PBR mechanisms almost everywhere it has been tried.

It is also now widely recognized that cost reduction efforts by network owners could lead to a deterioration of service quality --- increases in network outages, delays in service restoration, delays answering telephone inquiries. Accordingly, well-designed regulatory programs include performance-based regulatory mechanisms that apply to various dimensions of service quality (Joskow 2006b, Jamasb and Pollitt 2007, Yu, Jamasb and Pollitt 2007). These mechanisms reward or penalize network companies based on their performance against pre-specified service quality benchmarks.

One issue that comes up naturally when distribution networks are privatized involves the valuation of distribution assets and how these decisions can affect the prices paid by consumers for distribution service. The typical approach has been to carry forward the existing depreciated book value of historical investments in transmission and distribution into the new regime so that the base level of distribution and transmission charges associated with the recovery of capital-related charges does not change as a consequence of the transition. Incremental investments are then accounted for more or less as they were under the old regime (as in the U.S. and Canada) or economic/inflation accounting methods and approximations to economic depreciation are applied (as in the UK).

Bertram and Twaddle (2005) examine this issue in the case of New Zealand. In New Zealand, however, a decision was made to “write up” the value of distribution assets to reflect a specific measure of their (higher) replacement cost and to use these higher valuations to set the base level of network prices. This valuation method led to higher prices and higher price-cost margins for distribution network owners. The argument for adopting this valuation approach was that this would allow prices to rise to their efficient level and provide consumers with appropriate price signals. The arguments against this revaluation were that (a) it would lead to significant price increases and unfairly burden consumers, (b) non-linear pricing could be used to restore the correct price incentives on the margin, and (c) it created windfall profits for distribution network owners and undermine support for restructuring and competition.

However, and though they do not emphasize it, the empirical results reported in Bertram and Twaddle (2005) also demonstrate that *operating costs* incurred by distribution companies in New Zealand fell very significantly during the same period of time. These cost reductions appear to reflect both the consolidation of small distribution companies through mergers and the incentives for cost reduction provided by a high-powered incentive scheme. Empirical analysis of distribution system productivity in Australia (Moran 2006) also shows significant productivity improvements as well, without any apparent deterioration in network reliability.

Effective regulation of networks does not occur by accident. It requires good regulatory institutions. Regulatory institutions that are independent, are well

staffed and have access to necessary information about costs, prices, and service quality continue to be an important linchpin of successful electricity reform programs. Inadequate attention has been paid to created good regulatory institutions in many countries. Germany and New Zealand's initial decisions to proceed with a liberalization initiative without any sector regulator at all, relying instead on negotiated prices and the constraints of competition law, were clearly a mistake.

7. *Creating a well functioning transmission investment framework is important but continues to be a significant challenge in many countries.* As wholesale markets have developed, congestion on the transmission network has not only increased but is increasingly recognized as a significant constraint on the development of efficient competitive wholesale markets for power. In many countries, states, provinces and regions that have liberalized their electricity sectors, investment in transmission capacity, especially interregional transmission capacity, has not kept pace with the expansion in demand, generating capacity, or the volume of wholesale trade. In Europe and the United States there has been almost no investment in interregional transmission capacity since the early 1990s. Inadequate transmission investment is identified as a problem in Brazil and in Chile as well. Texas (ERCOT) appears to have responded to intra-regional transmission congestion with new investment, but ERCOT is still effectively disconnected from the rest of North America (Joskow 2006d).

In addition to the effects of transmission congestion on wholesale power prices and the associated social costs of congestion, a congested transmission network makes it more challenging to achieve efficient wholesale market performance. Transmission congestion and related reliability constraints create load pockets, reducing effective competition among generators and leading policymakers to impose imperfect market power mitigation rules that create other distortions. Congestion makes it more challenging for system operators to maintain reliability using standard market mechanisms, leading them to pay specific generators significant sums to stay in the market rather than retire and to rely more on out-of-market actions calls that depress market prices received by other suppliers.

In the UK and Argentina (Newbery 2006, Joskow 2006b, Jamasb and Pollitt 2007), the restructuring process included a comprehensive set of institutions and regulatory mechanisms to govern transmission operating cost and reliability, the allocation of scarce transmission capacity and approvals of transmission investment programs, as an integral aspect of the reform process. In many other countries, the regulatory framework governing transmission operation and investment was not given too much attention and allowed to evolve along with the markets. Stimulating performance improvements in the operation of transmission networks and, especially, attracting adequate investment to reduce congestion and to increase the geographic expanse of competition to reduce market power and the associated need to regulate wholesale markets to mitigate it, has been a challenge. The transmission systems that have exhibited the best performance are organized with a single independent transmission company that spans a large geographic area, and integrates system dispatch, congestion management, network mainte-

nance and investment under PBR regulation (e.g. NGC in England and Wales). Fragmented transmission ownership, separation of system operations from transmission maintenance and investment, and poorly designed incentive regulation mechanisms reduce performance (Joskow 2005b). Relying primarily on market-based “merchant transmission” investment, that is where new transmission investments must be fully supported by congestion rents (the difference in locational prices times the capacity of a new link) is likely to lead to inefficient investment in transmission capacity (Joskow and Tirole 2005a).

8. *System reliability, “supply security,” and “resource adequacy” are of great concern to policymakers in almost every country. Even relatively short blackouts carry high political (if not economic) costs. The jury is still out on whether and how competitive power markets can stimulate levels of investment in new generating capacity in the right places at the right times consistent with political preferences for reliability.* Many policymakers are increasingly expressing concerns about “supply security,” “resource adequacy,” and the reliability of their electricity sectors, though there is no evidence that reliability has deteriorated in liberalized markets. It is also not always very clear precisely what phrases like “supply security” and “resource adequacy” actually mean. An excellent conceptual discussion of different dimensions of supply security can be found in Amundsen, Bergman and von der Fehr (2006). One dimension of supply security relates to the operating reliability of the network as measured by involuntary losses of power --- non-price rationing or controlled rolling blackouts-- given the existing stock of capital on the network. Customers may experience blackouts due to failures on the distribution system, the transmission system, or due to inadequate generating capacity and price sensitive/interruptible demand to balance supply and demand in real time consistent with maintaining the physical integrity of the network. Failure to keep the system in balance can lead to cascading uncontrolled blackouts and network collapses affecting large regions (as occurred in the U.S. and Italy in 2003).

There is also a longer run concept of “resource adequacy” that reflects the adequacy of investments in distribution, transmission and generating capacity. Over time, investment in additional capacity should be made as long as the incremental value of the investments exceeds the incremental cost of the investment. If too little investment is made, costs and prices, including the costs associated with non-price rationing of demand and network collapses as discussed above, will be too high. Thus, long run concepts of supply security or resource adequacy are related to short run concepts of supply security or network reliability. I have already discussed network investment issues and will turn now to issues associated with investment in new generating capacity.

Creating appropriate investment incentives for new generating capacity is perceived to be a growing problem in many countries. At first blush, this concern may be surprising since the early experience with reforms during the 1990s suggested that competitive wholesale markets could and would mobilize adequate (or more than adequate) investment in new generating capacity. Substantial amounts of capital were mobilized during the late 1990s to support construction of new

efficient generating capacity in many countries that have implemented reforms. In the U.S., over 220,000 MW of new generating capacity went into service between 1999 and 2006, most of it merchant capacity, an increase of about 30% in total U.S. generating capacity (Joskow 2005b) over ten years. About 40% of the stock of generating plants in service in England and Wales was replaced with modern efficient combined-cycle gas turbine (CCGT) technology between 1990 and 2002 as old coal-burning generators have been closed and expensive dirty coal plants have been displaced by cheaper and cleaner CCGT capacity. Many other countries implementing reforms during the 1990s, including Argentina, Chile and Australia, also attracted significant investment new generating capacity (Jamasp 2002) after the reforms were initiated.

So, why are policymakers so concerned about security of supply today? First, we should recognize that liberalization has evolved in much of Europe during a period when there was significant excess generating capacity, Spain and Italy being the major exceptions. Even in the UK, the quantity of generating capacity in service today is not much greater than it was in 1990, with most of the investment in generating capacity during the 1990s being stimulated by opportunities to replace the inefficient stock of old generators that the state-owned CEBG kept in service to maximize consumption of expensive British coal, long term contracts entered into by retail suppliers early in the UK's liberalization program, and the high prices available in the wholesale market, influenced by the exercise of market power as already discussed. Second, the environment for financing new generating investments has changed dramatically in the last few years as a result of financial problems faced by merchant trading and generating companies in Europe, the U.S. and Latin America, as well as macroeconomic and political instability in Latin America and Asia (Joskow 2005a, Jamasp 2002, De Araujo 2001). Third, policymakers perceive that private sector commitments to build new generating capacity are inadequate to meet growing demand later in this decade consistent with traditional reliability criteria (e.g. North American Reliability Corporation (2007), Nordic Competition Authorities (2007)).

Table 1. Generating Capacity Additions in the U.S.

YEAR	NEW CAPACITY (MW)
1997	4,000
1998	6,500
1999	10,500
2000	23,500
2001	48,000
2002	55,000
2003	50,000
2004	20,000
2005	15,000
2006	11,000

Source: U.S. Energy Information Administration, *Monthly Energy Review*, various issues.

Let's look at the U.S. experience. (See Table 1) After peaking at 55,000 MW of new capacity entering service in the U.S. 2002, only 11,000 MW of new generating capacity entered service in 2006, most of which was built either for municipal utilities that have not been subject to restructuring and competition reforms or wind and other renewable electricity generation projects that benefit from special subsidies and contractual arrangements. Concerns about future incentives for investment in additional generating capacity have been expressed in many other countries. In some cases, state-owned entities have stepped in to contract for additional generating capacity (e.g. Chile, Brazil, New Zealand, Ontario, California) to mitigate resource adequacy concerns. The actions by state-owned entities to support investment in new generating capacity may have salutary short run effects, but these actions are likely to discourage private investment in the longer run. Programs designed to stimulate investments in renewable generation (mostly wind) with special tax subsidies, contractual benefits, or mandatory purchase obligations, further complicate the investment picture for "ordinary" generating plants.

What is the problem? Potential private investors in new generating capacity are looking for stable market rules and longer term contractual commitments before they will commit capital for new generating facilities. Continuous market redesign, regulatory actions that limit wholesale market prices, system operators' "reliability" actions that depress market prices, and other market and regulatory imperfections are being pointed to as deterrents to private investors in unregulated generating plants. Financing investments in peaking capacity, which rely heavily on wholesale market prices creating "rents" to support fixed investment costs in a relatively small number of hours, is especially problematic. Analyses done of regional markets in the U.S. make it fairly clear that "energy-only" markets do not produce adequate revenues to attract investment in generating capacity consistent with the reliability standards that are still applicable to them and have now become mandatory (Joskow 2006a and 2007, Cramton and Stoft 2006).

A number of countries are considering imposing resource adequacy, forward contracting obligations, or providing capacity payments to generators to overcome imperfections in wholesale and retail markets in order to restore incentives for investments in generating capacity and demand response capabilities consistent with traditional reliability levels (Joskow 2006a, 2007, California Public Utility Commission 2005, Cramton and Stoft 2006). The organized markets in the U.S., Chile, Spain, Argentina, and Columbia have such obligations. These policies are and will continue to attract considerable attention, analysis and debate as they should.

9. Retail market design and the terms and conditions of default service provided by incumbents have important implications for the success of retail competition programs. The designs of retail competition programs vary widely from country to country and even within countries where reforms have been driven by states and provinces. All countries that have adopted market liberalization reforms allow large customers to buy power competitively at the outset of their restruc-

turing programs. In some countries, retail competition remains available only to such large customers. Residential and small commercial customers then continue to buy power from their local distribution companies which in turn procure their power in competitive markets and pass along the associated costs in the prices charged to these groups of retail consumers. Other countries have gradually expanded retail competition opportunities to customer classes that consume smaller amounts of power, with the long run goal of opening up the retail market to all customers. In this case, the distribution company (or a retail affiliate) buys power in the wholesale market and passes along the associated costs to the remaining retail customers during a transition period. Finally, retail competition is sometimes (e.g. in the states in the U.S. that have adopted retail competition programs) made available to all customers at the outset of the reforms program. However, since customers, especially smaller customers, do not switch instantly to competitive suppliers, some type of regulated “default service” must be provided to them, typically by their local distribution company or a retail affiliate. Thus, in all cases, there is some period of time during which a significant fraction of retail consumers continue to be served under some type of regulated default service tariff.

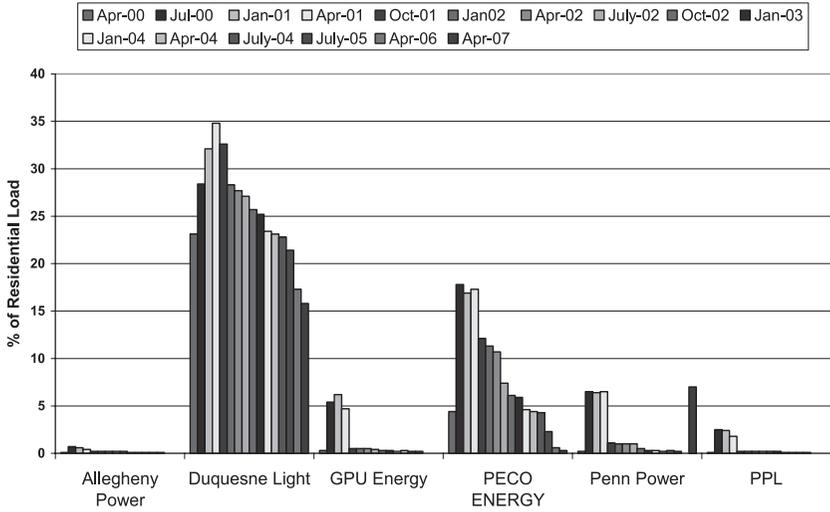
The terms and conditions of retail default service can have significant effects on the ability of competitive retailers to attract customers. In the U.S. (Tschamler 2006) and some other countries (e.g. Spain, France), default service prices or tariffs have been used to support a number of objectives other than promoting a robust retail market. These include commitments that retail customers will receive an immediate and sustained price reduction of some magnitude, stranded cost recovery considerations, income redistribution goals, and consumer protection goals. As a result, default service prices have sometimes been set at levels below the wholesale cost of power, or wholesale prices have risen over time, closing or reversing the gap between default prices and wholesale market prices. Under these circumstances it is impossible for a competitive retailer profitably to offer services that can attract customers away from default service. If as a matter of policy regulators want to protect customers from high market prices by giving them access to regulated tariffs fixed at prices below market then retail competition will never be successful. Such policies may also signal a lack of faith and commitment by policymakers in retail competition.

The experience in Pennsylvania (a state that is part of the PJM wholesale market) provides a good example of the effects of mixing regulated default pricing with retail competition. Different default service prices were set for each utility in Pennsylvania, reflecting historical regulated costs of generation service and stranded cost recovery settlements. The prices were fixed in 2000 for a term of up to ten years (varying from company to company), with some adjustments for fuel and other input price changes. The regulated default service prices are now starting to expire, most recently for Penn Power starting in 2007. Customers who do not choose an ESP are supplied from power purchased in the wholesale market and must pay the associated purchased power costs upon which the distribution company earns no additional profit.

Figure 1 provides time series data on the fraction of residential customers which switched to a competitive retailer for each utility in Pennsylvania. Figure 2 provides the same data for industrial customers. There is both wide variation in the initial fraction of customers who switched to competitive retail suppliers and significant evidence of their switching back and forth between regulated default service and regulated services. The inter-utility variations must be attributable to differences in regulated default service prices since there is no inherent reason why customers in (say) Pittsburgh should be more likely to shop for alternatives than are customers in (say) Philadelphia. By July 2005 nearly all residential customers had returned to regulated default service and a large fraction of the industrial customers who initially opted for competitive service had also returned to default service. This is attributable to rising nominal wholesale prices in PJM which have reduced or eliminated the “headroom” between the regulated default service price and the wholesale market price for power. However, for Duquesne and now Penn Power, large industrial customers have moved relatively quickly into the competitive retail market when the regulated transition default service prices expired and their default service prices then increased to reflect wholesale market condition. The huge rapid shift of Penn Power’s industrial customers to ESPs in 2007 after the regulated default service rates come into effect is especially impressive. In the U.S., the biggest problem faced by competitive retailers is “competition” from default service, a service for which the incumbents typically make no profit either.

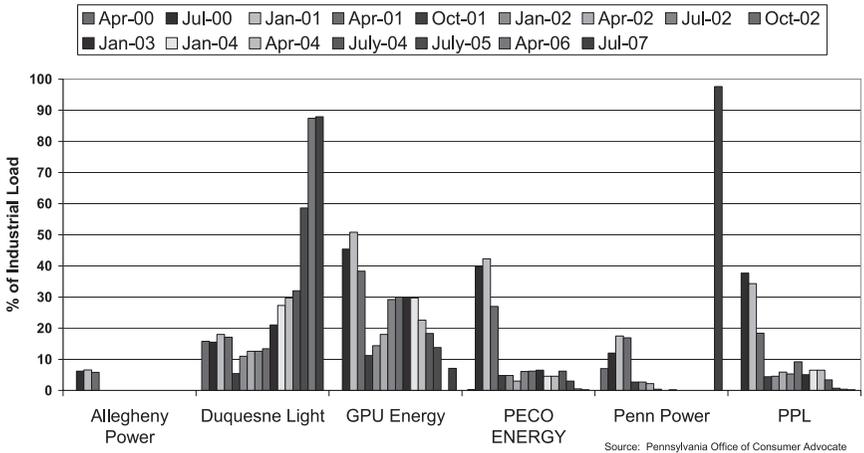
The general pattern of retail switching behavior in most countries is that large industrial customers are more likely to switch and to do so more quickly than smaller industrial and commercial customers. Residential customers switch more slowly and are more likely to remain with the incumbent, especially when the incumbent must offer a regulated default price that is at or below the wholesale market price of power. This phenomenon can be illustrated with the experience in Massachusetts. All customers were given access to competitive retail suppliers in April 1998. However, most customers continued to be eligible for regulated “standard offer service whose prices gradually fell further and further below wholesale market prices. During 2005 the availability of regulated “standard offer” service began to end and distribution companies began to buy default service supplies by taking supply bids with durations of 6 months to two years. Prices for default service from the local distribution company then rose to reflect the costs they incurred to procure power competitively in the wholesale market. Since 2005, the movement to competitive retail suppliers has accelerated, with almost all supplies to large industrial customers provided by competitive suppliers and 50% of demand overall supplied by competitive ESPs.

Figure 1. Pennsylvania Direct Access Load: Residential (%)



Source: Pennsylvania Office of Consumer Advocate

Figure 2. Pennsylvania Direct Access Load: Industrial (%)



Source: Pennsylvania Office of Consumer Advocate

Table 2. Retail Competition in Massachusetts

<i>Type</i>	2002 and 2007	
	<i>Competitive Retail Supply (%)</i>	
	<i>April 2002</i>	<i>June 2007</i>
Residential	0.8%	10.3%
Small Commercial	7.2	31.6
Large Commercial	15.7	47.3
Large Industrial	42.2	85.9

Retail competition starts in April 1998. Regulated Default service ends 2005.

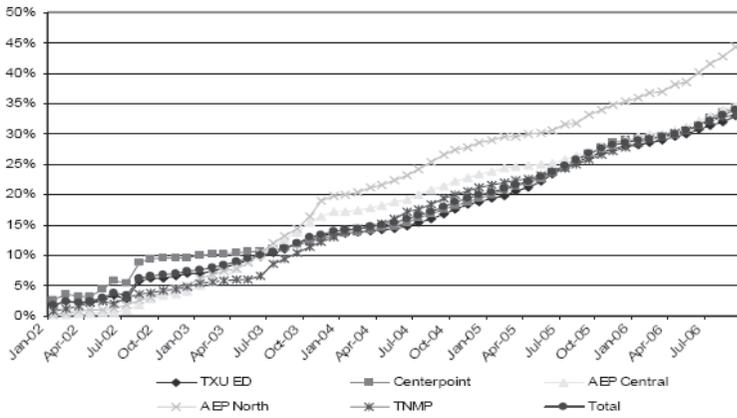
Source: Massachusetts Department of Energy Resources

The Massachusetts experience also indicates that for residential (domestic) customers, even if the regulated default service price is equal to the comparable competitive wholesale market value of the power supplied, retail suppliers need a significant additional margin both to induce sticky retail customers to switch suppliers and to cover their retail supply costs. This margin has turned out to be much larger than anticipated when retail competition was first introduced. In particular, the retail supply costs for the mass market (residential and small commercial) are much higher than many retailers had anticipated. Billing, customer service, bad debt, advertising and promotion costs add up quickly. Accordingly, the default service price may have to be significantly higher than the comparable wholesale market price to induce much customer switching.

The retail competition framework applied in Texas did exactly this. The “price to beat,” the default service price in Texas, was set at a level well above the competitive wholesale price for power and was adjusted for changes in natural gas prices; natural gas fired generation sets the wholesale market price in Texas in a large fraction of the hours of the year and wholesale market prices move very closely with natural gas prices (Public Utility Commission of Texas 2007). This framework provided incentives to retail customers and retail suppliers to participate in the competitive retail market. And the consistent increase in the fraction of retail customers who have switched reflects this framework’s attributes.

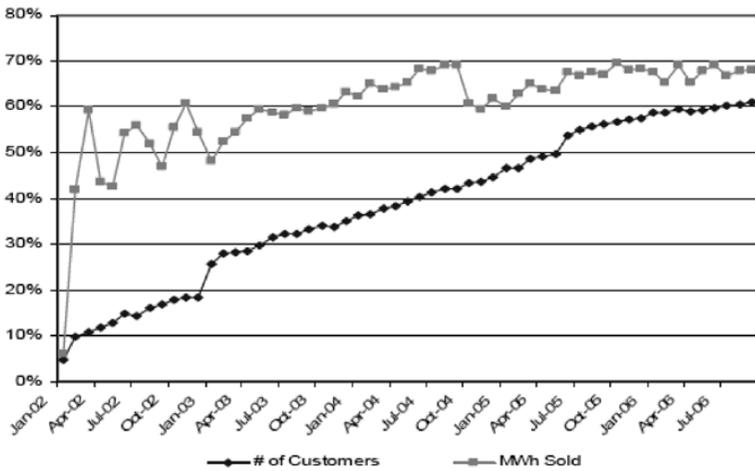
There has been relatively little systematic analysis of the effects of competition reforms on electricity prices --- are they higher or lower than they would have been under the previous regime? This kind of “but for” analysis has been complicated significantly by the dramatic increase in natural gas prices and the resulting increase in electricity prices, especially in regions where the wholesale electricity market clears on natural gas-fired generation during many hours of the year. Newbery and Pollitt (1997) find that there were overall social gains from restructuring, but that a large share of these gains were captured by suppliers. The fall in wholesale margins around the time that NETA was introduced in the UK suggests that this balance has changed. Joskow (2006a) and Harvey, McConihe

Figure 3. Share of Residential Customers Switching to Competitive Supplier



Source: Public Utility Commission of Texas (2007)

Figure 4. Share of Large Industrial Customers Switching to Competitive Retail Suppliers



Source: Public Utility Commission of Texas 2007

and Pope (2006) find that through 2004, retail prices were lower in states that adopted restructuring programs than they would have otherwise been, though the impact of the availability of regulated default service is a more important factor than retail competition during this period. It is fairly clear, however, that the dramatic and unexpected increase in natural gas prices has had a large impact on wholesale electricity prices in some areas. This had led to higher retail prices (in the short run) than would have been the case if electricity consumers had continued to receive the benefit of “rolled in” pricing of pre-existing regulated coal-fired and nuclear plants whose economic value increased dramatically as natural gas prices increased. Basically, these customers are seeing prices below the efficient market clearing level due to continuing regulation.

During the early 1990s, the gap between the regulated cost of generation service (high) and the wholesale market value of generation service (lower) fostered political support for electricity restructuring in many areas. Now that the gap has reversed in these areas, due primarily to large unexpected increases in wholesale electricity prices driven by higher natural gas prices, it has become a deterrent to deregulation of wholesale and retail prices.

This experience naturally leads to the final issue. Is retail competition worth the trouble compared to a regime where the distribution company procures power competitively and resells it at cost to residential and small commercial customers? Unfortunately, there is little if any good empirical analysis available to evaluate this question rigorously, though there is no shortage of strong ideological views. Looking at switching rates alone isn't very informative as an index of the welfare consequences of retail competition. The presumption has been that retail competition is a good thing to offer larger customers, where transactions costs are low, opportunities to offer risk management and demand management products are greater, and customers are expected to be able to shop intelligently. There are also benefits for the development of competitive wholesale market resulting from having more buyers active on the demand side, reducing monopsony problems that might emerge if distributors were the only buyers. Moreover, if the alternative is competitive procurement by the distribution company, regulators must become involved in determining procurement rules, including the attributes of the contracts that will be put out for bids. Industrial customers and their agents should be in a better position to express their risk preferences than are regulators. (See Littlechild (2003) for these and other arguments in support of retail competition.) And indeed, where default prices have been allowed to float to reflect spot wholesale market prices (including capacity prices), large customers appear to migrate fairly quickly to the market and to sign contracts that hedge price volatility from one to three years into the future.

It is far from obvious to me, however, that residential and small commercial customers have or will benefit much, if at all, from retail competition compared to a regime where their local distribution company purchased power for their needs by putting together a portfolio of short term forward contracts (from days to several years) acquired in wholesale markets (Joskow (2000a, 2000b) and

Littlechild 2003 for a different view)) and passing along the associated costs in the prices charged to residential and small commercial customers. Indeed, New Jersey has used the so-called Basic Generation Service (BGS) auction process quite effectively to buy power competitively for residential and small commercial customers and to resell it to default service customers. There is little evidence that residential customers are getting any significant value added services from retail suppliers aside from some billing options and choices between contracts which set the prices for different durations (e.g. one vs. two years). Retail competition with load profiling leads to some inefficiencies (Joskow and Tirole 2006). There is evidence that there are significant costs associated with implementing a retail competition program for residential consumers (Green and McDaniel 1998) and that they may make poor shopping decisions (Salies and Waddams Price 2004).

If policymakers are committed to fostering retail competition for residential and small commercial customers, despite the possibility that retail prices will rise in the short run due to increased transactions costs, switching costs and market power, the frameworks adopted by the UK, Texas, and the Nordic countries is likely to be the most successful in stimulating retail shopping and the development of a viable retail supply sector. If they are not committed to retail competition for smaller customers then they must devise an alternative credible competitive power procurement regime (like the New Jersey BGS) auction that conveys market wholesale market prices in retail prices and also provides good incentives for investment.

10. *Vertical integration between retail supply and generation is likely to be an efficient response to imperfections in wholesale markets. It may also create market power problems. Thus, policymakers must confront a tradeoff:* In several countries with active retail competition programs there appears to be a growing movement to an industry structure where competitive retail suppliers acquire generating capacity to meet a significant fraction of their retail commitments. This trend is likely to reflect an efficient response to relatively high transaction costs associated with real wholesale power markets in practice (Coase 1937, Williamson 1975, Carlton 1979, Joskow 2005d). There is no inherent competition problem with vertical integration of this type as long as there are a sufficient number of vertically integrated suppliers that continue to compete in the market. However, if there is significant market power in the upstream or downstream markets, vertical integration could lead to a further reduction in competition by increasing the operating or entry costs of rival retail suppliers (Ordober, Salop and Saloner 1990, Riordan 1998). Bertram (2006) suggests that in New Zealand the intensity of competition declined significantly as retail suppliers became vertically integrated while Moran (2006) suggests that in Australia vertical integration did not lead to market power problems. See also Bushnell, Mansur and Saravia (2007) and Mansur (2007). Thus, there may be a tradeoff between increases in efficiency and increases in market power.

11. *Expanding demand response in spot wholesale energy markets needs more attention.* In markets for most goods and services, when demand grows and

supply capacity constraints are reached, prices rise to ration demand to match the capacity available to provide supplies to the market. In electricity markets, however, as generating capacity constraints are reached, relatively little demand can be rationed by short term price movements and, instead, must be rationed with rolling blackouts. This reflects both the limited use of real time pricing and the system operator's need to adjust demand very quickly at specific locations. The possibility of broader uncontrolled cascading blackouts and regional network collapses further exacerbates this problem and necessarily leads to regulatory requirements specifying operating reserves, operating reserve deficiency criteria and associated administrative actions by system operators to balance the system to meet voltage, stability and frequency requirements in an effort to avoid cascading blackouts (Joskow and Tiole 2007). In addition, retail competition has more attractive welfare properties if the real time consumption of retail consumers can be measured instead of relying on load profiling (Joskow and Tiole 2006). The challenges faced by network operators to maintain system reliability and avoid non-price rationing of demand would be reduced if additional demand-side response instruments were at their disposal. These instruments include the ability to rely on demand response by more customers who can see and respond to rapid changes in market prices and expanded use of price-contingent priority rationing contracts (Chao and Wilson 1987).

As a general matter, too little demand side response has been developed to date in most countries. The demand response instruments that are available are poorly integrated with spot markets and are likely to have the effect of depressing prices inefficiently. Moreover, the prices that are paid for demand response or the prices that can be avoided by responding to price signals are too low compared to the cost of carrying generating capacity reserves to meet planning reserve margins in some cases. Improving demand response should be given higher priority in wholesale market design.

12. *Electricity sector reform appears to be a continuing process of improvement, but a process of continuing reform of the reforms has both potential benefits and potential costs.* It is quite clear from recent historical experience that none of the reform programs got it all right out of the box. Initial reform programs are followed by additional reforms, some major and some minor, to respond to performance problems that emerge in practice or lessons learned about best practices from other countries. On the one hand, reforms that are needed to fix major performance problems certainly should be considered carefully. On the other hand, a process of ongoing reforms that have significant and uncertain future financial impacts on market participants is not likely to create a framework that is conducive to investment in long-lived assets whose value is subject to policy reform risks. Policy reforms may also be used opportunistically to respond to political pressures that arise under market conditions when investors properly expected that they would achieve high returns, effectively truncating the upper end of the return distribution and leading investors to require higher expected returns from other states of nature than would otherwise be the case.

The search for perfection can be the enemy of the good. Policymakers need to make sure that the benefits of any additional reforms exceed their short run and long run costs, in particular those related to investment incentives. And if there are to be reforms of the reforms it is desirable to package them together so that there can be one reform of the reforms rather than a continuing stream of them. Finally, if policymakers are serious about competitive markets for power they will have to rethink the long tradition of relying on taxation by regulation of the electric power industry to implement policies in ways that hides the associated costs from taxpayers.

13. *A strong political commitment to reform is important.* Implementing a good electricity sector liberalization program is a technical, institutional and political challenge. Almost everywhere, some unanticipated (at least by the policymakers) problems emerged that required major or minor refinements to the original reform program. In some cases (e.g. UK, New Zealand, Alberta, Australia, Texas) the reforms were consistent with the continuing development of competitive markets and in other cases they were not (e.g. California, Ontario, Brazil). It appears that reforms that have strong pro-competition political support are more likely to respond to problems by identifying market or institutional imperfections and trying to fix them in ways that are consistent with the continued successful evolution of competitive wholesale and retail markets. They are also likely to be willing to live with some imperfections, recognizing that no market is perfect and that the cures can be worse than the disease. Where the commitment to competitive electricity markets is weak, when problems emerge policymakers are more likely to seek what appear to be quick fixes that undermine continued evolution of competitive markets or just cut and run from the competitive market agenda. If the commitment to competition is not strong in the first place, of course, the reforms are likely to be timid and have little effect on the status quo anyway, Japan and many U.S. states being the prime examples.

5. CONCLUSION

Structural, regulatory and market reforms have been applied to electricity sectors in many countries around the world. Significant performance improvements have been observed in some of these countries as a result of these reforms, especially in countries where the performance of state-owned monopolies was especially poor. Privatization combined with the applications of good PBR mechanisms to regulated distribution companies has generally yielded significant cost reductions without reducing service quality. Wholesale markets have also stimulated improved performance from existing generators and helped to mobilize significant investments in new generating capacity in several countries.

We must recognize, however, that creating well functioning competitive wholesale and retail markets for electricity is very challenging both technically and politically. The California electricity crisis, electricity crises in Brazil, Chile, Ontario, and elsewhere, scandals involving energy trading companies like Enron,

the failure of poorly designed reforms in countries such as Brazil, macroeconomic problems undermining investments in generally well designed systems as in Argentina, increases in wholesale electricity prices driven by unexpected increases in natural gas prices and (in Europe) the price of CO₂ emissions permits, have certainly made policymakers more cautious (but not necessarily more thoughtful) about electricity sector reforms.

However, these problems and challenges do not imply that restructuring, regulatory reform, and promoting the development of competitive wholesale and retail markets for power, are ill-advised. The problems that have emerged are now much better understood and solutions to many of them are at hand. The primary question is whether governments properly can choose between competing solutions and have the political will to resist interest group pressures and pursue reforms that will lead to more efficient markets and better performance of the network platforms upon which competition depends.

REFERENCES

- Adib, P and J. Zarnikau. (2006). "Texas: The Most Robust Competitive Market in North America," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 383-418.
- Amundsen, E, L. Bergman and N-H von der Fehr. (2006). "The Nordic Electricity Markets: Robust By Design?," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 145-170.
- Bacon, R. W., and J. E. Besant-Jones. (2001). "Global Electric Power Reform, Privatization and Liberalization of the Electric Power Industry in Developing Countries." *Annual Reviews of Energy and the Environment* 26: 331-59.
- Beesley, M. and S. Littlechild. (1989). "The Regulation of Privatized Monopolies in the United Kingdom," *Rand Journal of Economics*, 20:3 454-472.
- Bertram, G. (2006). "Restructuring the New Zealand Electricity Sector 1984-2005," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 203-234.
- Bertram, G. and Twaddle, D. (2005). "Price-Cost Margins and Profit Rates in New Zealand Electricity Distribution Networks: The Cost of Light Handed Regulation", *Journal of Regulatory Economics* 27(3): 281-307.
- Besant-Jones, J. E., ed. (1993). "Reforming the Policies for Electric Power in Developing Countries." Washington, D.C.: World Bank.
- Borenstein, S. and J. Bushnell. (1999). "An Empirical Analysis of The Potential for Market Power in California's Electricity Industry," *Journal of Industrial Economics*, 47(3):285-323.
- Borenstein, S. (2000). "The Trouble with Electricity Markets: Understanding California's Restructuring Disaster," *Journal of Economic Perspectives* 16(1): 191-211 .
- Borenstein, S., J. Bushnell and F. Wolak. (2002). "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market," *American Economic Review*, December, 92(5), 1376-1405.
- Borenstein, S., M. Jaske and A. Rosenfeld. (2002). "Dynamic Pricing, Advanced Metering and Demand Response in Electricity Markets," Center for the Study of Energy Markets Working Paper, University of California at Berkeley, October.
- Brunekreeft, G. and D. Bauknecht. (2006). "Energy Policy and Investment in the German Power Market," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 235-264.
- James B. Bushnell and Catherine Wolfram. (2005). "Ownership Change, Incentives and Plant Efficiency: The Divestiture of U.S. Electric Generation Plants," University of California Energy Institute, Center for the Study of Energy Markets, Working Paper WP-140. <http://www.ucei.berkeley.edu/PDF/csemwp140.pdf>

- Bushnell, J., E. Mansur and C. Saravia. (2007). "Vertical Arrangements, Market Structure, and Competition: An Analysis of Restructured U.S. Electricity Markets," *American Economic Review*, forthcoming.
- Bye, T. and E. Hope. (2006). "Electricity Market Reform: The Norwegian Experience," in T. Sorgard (ed), *Competition and Welfare: the Norwegian Experience*, Norwegian Competition Authority, <http://www.kt.no/iKnowBase/Content/427537/CAPACITY%20FOR%20COMPETITION.PDF>
- California Public Utilities Commission. (2005). "Capacity Markets White Paper," August 25.
- Carlton, Dennis. (1979). "Vertical Integration in Competitive Markets Under Uncertainty," *Journal of Industrial Economics*, 27: 189-209.
- Chao, H. and R. Wilson. (1987). "Priority Service: Pricing, Investment and Market Organization." *American Economic Review* (77): 899-916.
- Coase, Ronald. (1937). "The Nature of the Firm," *Economica*, 4:386-405.
- Chisari, O., A. Estache, and C. Romero. (1997). "Winners and Losers from Utility Privatization in Argentina: Lessons from a General Equilibrium Model." World Bank Working Paper No. 1824, World Bank, Washington, D.C.
- Cramton, P. and S. Stoft. (2006). "The Convergence of Market Designs for Adequate Generating Capacity," Working Paper, April, <http://stoft.com/metaPage/lib/Cramton-Stoft-EOB-2006-04-ICAP-energy-convergence.pdf>
- De Araujo, J. L. R. H. (2001). "Investment in the Brazilian ESI — What Went Wrong? What Should Be Done?" Institute of Economics, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.
- Domah, P.D. and M.G. Pollitt. (2001). "The Restructuring and Privatisation of the Regional Electricity Companies in England and Wales: A social cost benefit analysis," *Fiscal Studies*, 22(1):107-146.
- Dyner, I., S.Arango and E. Larsen. (2006). "Understanding the Argentinian and Columbian Electricity Markets," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 595-616.
- Estache, A. and M. Rodriguez-Pardina. (1998). "Light and Lightening at the End of the Public Tunnel: The Reform of the Electricity Sector in the Southern Cone," World Bank Working Paper, May.
- Evans, J.E. and R.J. Green. (2005). "Why Did British Electricity Prices Fall After 1998?," Department of Economics Working Paper 05-13, University of Birmingham. <http://ideas.repec.org/p/bir/birmec/05-13.html>.
- Gilbert, R., K. Neuhoff, and D. Newbery. (2004). "Allocating Transmission to Mitigate Market Power in Electricity Networks," *Rand Journal of Economics*, 35(4), 691-709.
- Goto, M. and M. Yajima, "A New Stage in Electricity Liberalization in Japan: Issues and Expectations," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 617-644.
- Green, R. (2000). "Can Competition Replace Regulation for Small Utility Customers?," Centre for Economic Policy Research, Discussion Paper 2405.
- Green, R. (2005a). "Electricity and Markets" *Oxford Review of Economic Policy*, vol. 21, no.1, pp. 67-87.
- Green, R. (2005b). "Restructuring the Electricity Industry in England and Wales" in Griffin, J.M. and S.L. Puller (eds) *Electricity Deregulation: Choices and Challenges*, pp. 98-144, Chicago, The University of Chicago Press.
- Green, R. and McDaniel, T. (1998). "Competition in Electricity Supply: Will '1998' Be Worth It?," *Fiscal Studies*, Vol.19, No.3, pp.273-93.
- Green R. and D. Newbery. (1992). "Competition in the British Electricity Spot Market," *Journal of Political Economy*, 100(5), 929-53.
- Harvey,S, B. McConihe, and S. Pope. (2006). "Analysis of the Impact of Coordinated Electricity Markets on Consumer Electricity Charges," November, mimeo. LECG, Inc.
- Haas, R. et. al. (2006). "Competition in the Continental European Electricity Market: Despair or Work in Progress in F. Sioshansi and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 265-316.
- Henney, A. (1994). *A Study of Privatization of the Electricity Supply Industry in England and Wales*, EEE Limited, London.

- Hogan, W. (1992). "Contract Networks for Electric Power Transmission," *Journal of Regulatory Economics*, 4: 211–242.
- Hunt, S. (2002). *Making Competition Work in Electricity*, New York, Wiley.
- ISO New England. (2005). "2004 Annual Markets Report." http://www.iso-ne.com/markets/mkt_anlys_rpts/annl_mkt_rpts/2004/2004_annual_markets_report.doc.
- Jamasb, T. (2002). Reform and Regulation of The Electricity Sectors in Developing Countries, June 2002, Department of Applied Economics, University of Cambridge.
- Jamasb, T. and M. Pollitt. (2007). "Incentive Regulation of Electricity Distribution Networks," June. <http://www.electricitypolicy.org.uk/pubs/wp/eprg0701.pdf>.
- Joskow, P. L. (1998a). "Electricity Sectors in Transition." *Energy Journal* 19:25–62.
- Joskow, P.L. (1989). "Regulatory Failure, Regulatory Reform and Structural Change In The Electric Power Industry." *Brookings Papers on Economic Activity: Microeconomics*. 125-199.
- Joskow, P.L. (1997). "Restructuring, Competition and Regulatory Reform in the U.S. Electricity Sector." *Journal of Economic Perspectives* 11(3): 119-138.
- Joskow, P. L. (1998). "Electricity Sectors in Transition." *Energy Journal* 19:25–62.
- Joskow, P.L. (2000a). "Deregulation and Regulatory Reform in the U.S. Electric Power Sector." In Sam Peltzman and Clifford Winston, eds., *Deregulation of Network Industries: What's Next?* Washington, DC: Brookings Institution Press.
- Joskow, P.J. (2000b). "Regulating the Electricity Sector in Latin America, Comments 2000b," *Economia*, 1:199-215.
- Joskow, P.L. (2001). "California's Electricity Crisis," *Oxford Review of Economic Policy*, 17,(3), 365-388.
- Joskow, P.L. (2003). "Electricity Sector Restructuring and Competition: Lessons Learned," *Cuadernos de Economia (Latin American Journal of Economics)*, 40: 548-558.
- Joskow, P.L. (2005a). "The Difficult Transition to Competitive Electricity Markets in the United States." *Electricity Deregulation: Where To From Here?*. (J. Griffin and S. Puller, eds.) , Chicago, University of Chicago Press.
- Joskow, P.L. (2005b). "Transmission Policy in the United States," *Utilities Policy*, 13, 2005, 95-115.
- Joskow, P.L. (2005c). "Regulation and Deregulation After 25 Years: Lessons for Research," *Review of Industrial Organization*, 26: 169- 193.
- Joskow, P.L. (2005d). "Vertical Integration," in C. Menard and M. Shirley, eds., *Handbook of New Institutional Economics*, Springer.
- Joskow, P.L. (2006a). "Markets for Power in the U.S.: An Interim Assessment," *The Energy Journal*, 27(1), 1-36.
- Joskow, P.L. (2006b). "Incentive Regulation in Theory and Practice: Electric Transmission and Distribution," *Economic Regulation and Its Reform: What Have We Learned* (Nancy Rose, ed.), University of Chicago Press, forthcoming. http://econ-www.mit.edu/faculty/download_pdf.php?id=1220.
- Joskow, P.L. (2006c). "Introduction to Electricity Sector Liberalization: Lessons Learned from Cross-Country Studies," in Sioshansi, F. and W. Pfaffenberger. *Electricity Market Reform: An International Perspective*, 1-32.
- Joskow, P.L. (2006d). "Patterns of Transmission Investment," *Competitive Electricity Markets and Sustainability* (Francois Leveque, ed.), Edward Elgar, 2006.
- Joskow, P.L. (2007). "Competitive Electricity Markets and Investment in New Generating Capacity," in *The New Energy Paradigm*, Dieter Helm, ed., Oxford University Press, 2007.
- Joskow, P.L. and E. Kahn. (2002). "A Quantitative Analysis of Pricing Behavior in California's Wholesale Electricity Market During Summer 2000," *The Energy Journal*, 23(4),1-35.
- Joskow, P.L. and N.L. Rose. (1989). "The Effects of Economic Regulation," *Handbook of Industrial Organization*, (R. Schmalensee and R. Willig, eds), North-Holland.
- Joskow, P.L. and R. Schmalensee. (1983). *Markets for Power: An Analysis of Electric Utility Deregulation*, Cambridge., MIT Press.
- Joskow, P.L. and J. Tirole. (2000). "Transmission Rights and Market Power on Electric Power Networks," *Rand Journal of Economics*, 31(3), 450-487.

- Joskow, P. L. and J. Tirole. (2005). "Merchant Transmission Investment." *Journal of Industrial Economics* 53(2): 233-264.
- Joskow, P.L. and J. Tirole. (2006). "Retail Electricity Competition," *Rand Journal of Economics*, 37(4), 799-815.
- Joskow P.L. and J. Tirole. (2007). "Reliability and Competitive Electricity Markets," *Rand Journal of Economics*, 38(1), 60-84.
- Littlechild, S. C. (2003). "Wholesale Spot Market Passthrough," *Journal of Regulatory Economics*, 23(1), 61-91.
- Lizardo, J. and R.H. de Araujo, "The Case of Brazil: Reform By Trial and Error," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 565-595.
- Mansur, Erin T. (2007). "Upstream Competition and Vertical Integration in Electricity Markets," *Journal of Law and Economics*, 50(1): 125-56.
- Moran, A. (2006). "The Electricity Industry in Australia: Problems Along the Way to a National Electricity Market," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 173-202.
- Newbery, D. (1995). "Power Markets and Market Power," *Energy Journal*, 16(3), 41-66.
- Newbery, D. (1998). "The Regulator's Review of the English Electricity Pool," *Utilities Policy*, 7(3), 129-41.
- Newbery, D. (2006). "Electricity Liberalization in Britain and the Evolution of Market Design," in Sioshansi, F. and W. Pfaffenberger. *Electricity Market Reform: An International Perspective*, Elsevier, 109-144.
- Newbery, D., and M. Pollitt. (1997). "The Restructuring and Privatization of Britain's CEGB – Was it Worth It?" *Journal of Industrial Economics*, 45(3), 269-303.
- Nordic Competition Authorities. (2007). *Capacity for Competition*, No. 1/2007, <http://www.kt.no/iKnowBase/Content/427537/CAPACITY%20FOR%20COMPETITION.PDF>
- North American Reliability Corporation. (2007). *Long Term Reliability Assessment*, October. ftp://www.nerc.com/pub/sys/all_updl/docs/pubs/LTRA2007.pdf
- Ordober, Janusz, Steven Salop and Garth Saloner. (1990). "Equilibrium Vertical Foreclosure," *American Economic Review*. 80:127-42.
- Pollitt, Michael. (2004a). "Electricity Reforms in Argentina: Lessons for Developing Countries," CMI Working Paper 52, Electricity Policy Working Group, University of Cambridge <http://www.econ.cam.ac.uk/electricity/publications/wp/ep52.pdf>.
- Pollitt, Michael. (2004b). "Electricity Reforms in Chile: Lessons for Developing Countries," CMI Working Paper 51, Electricity Policy Research Group, University of Cambridge. <http://www.econ.cam.ac.uk/eprg/pubs/index.html?paper=EP51&year=2004>
- Public Utility Commission of Texas. (2007). *Scope of Competition in Electricity Markets: Report to the 80th Texas Legislature*, January. <http://www.puc.state.tx.us/electric/reports/scope/index.cfm>
- Raineri, Ricardo. (2006). "Chile: Where it All Started," in Sioshansi, F. and W. Pfaffenberger. *Electricity Market Reform: An International Perspective*, Elsevier, 77-108.
- Riordan, Michael. (1998). "Anticompetitive Vertical Integration by a Dominant Firm," *American Economic Review*, 88: 1232-48.
- Rudnick, H. (1996). "Pioneering Electricity Reform in South America," *IEEE Spectrum*, August, 38-45.
- Rudnick, H. (1998). "Market Restructuring in South America," *IEEE Power Engineering Review*, June, 3-6.
- Rudnick, H., and J. Zolezzi. (2001). "Electric Sector Deregulation and Restructuring in Latin America: Lessons to be Learnt and Possible Ways Forward." In *IEEE Proceedings Generation, Transmission and Distribution* 148: 180-84.
- Salies, E. and C. Waddams Price. (2004). "Charges, Costs, and Market Power: The Deregulated UK Electricity Retail Market." *The Energy Journal* 25(3): 19-37.
- Schmalensee, R. (1989). "Good Regulatory Regimes," *Rand Journal of Economics*, 20:3 417-436.
- Sioshansi, F. and W. Pfaffenberger. (2006). *Electricity Market Reform: An International Perspective*, Elsevier, Kidlington, Oxford, UK.
- Stoft, S. (2002). *Power System Economics*, Wiley Interscience.

- Sweeney, J. (2006). "California Electricity Restructuring, Crisis and Its Aftermath," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 319-382.
- Sweeting, A. (2007). "Market Power in the England and Wales Wholesale Electricity Market," *Economic Journal* 117 (520), 654-685.
- Trebilock, M. and R. Hrab, "Electricity Restructuring in Canada," in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 419-450.
- Tschamler, Taff, "Competitive Retail Power Markets and Default Service: The U.S. Experience, in Sioshansi, F. and W. Pfaffenberger, eds., *Electricity Market Reform: An International Perspective*, Elsevier. 529-562.
- Williamson, Oliver. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.
- Williamson, Oliver. (1985). *The Economic Institutions of Capitalism*. New York: Free Press.
- Wolfram, Catherine. (1999). "Measuring Duopoly Power in the British Electricity Spot Market," *American Economic Review* 89(4), 805-826.
- World Bank, (1994). *Infrastructure for Development: World Development Report 1994*.
- Yu, W., T. Jamasb, and M. Pollitt. (2007). "Incorporating the Price of Quality Into Efficiency Analysis: The Case of Electricity Distribution Regulation in the UK," Electricity Policy Research Group, Working Paper EPRG 0713, University of Cambridge, <http://www.econ.cam.ac.uk/eprg/pubs/index.html?paper=EPRG0713&year=2007> .