Chapter #7

How to Make Power Markets Competitive

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Abstract: In the face of high transactions cost and externalities, firms often seek to internalize resource allocation through *vertical integration* – the integration of multiple stages of the production process under one roof. This paper discusses the applicability of economic theories of industrial organization to the electric power industry, and suggests that an integrated grid operator with ownership and control of balancing resources, combined with active bilateral trading in prescheduled markets, may be the most efficient means to achieve a competitive power market. The alternative, markets for balancing energy, must operate twenty-four hours per day and involve complex accounting and scheduling procedures. Furthermore, market-based congestion pricing, too, has proven costly. Large numbers of bidding rounds and adjustment periods would be needed to attain optimal scheduling and pricing, since decisions regarding market transactions and physical scheduling of load are interdependent and interwoven, with each influencing the other.

Key words: Competition, vertical integration, transactions costs, restructuring, markets, electricity.

1. INTRODUCTION

For a century, most private utilities in the United States have exhibited a straightforward industrial structure. The companies were "vertically integrated," in the sense that they produced, transmitted and distributed electricity to customers from the same organization. In almost all cases private utilities faced cost-plus (return-on-investment) regulation, skewing managerial choices towards capital-intensive projects. Combined with the

A. Faruqui and B.K. Eakin (eds.), Electricity Pricing in Transition, 99-111.

"obligation to serve," these incentives led to gold plating of the electric infrastructure, in which reliability, rather than least cost, was the main objective.

In the last three decades a number of public policy changes have worked to loosen the tight structure. The Public Utility Regulatory Policy Act (PURPA) of 1978 introduced the notion of independent power producers (IPPs), interstate transmission lines were built to connect local grids, and the Federal Energy Regulatory Commission (FERC) relaxed regulations in interstate commerce beginning with the Western Systems Power Pool (WSPP), which allowed market-based transmission rates and market-based wholesale pricing. Despite the overtures towards liberalized electricity markets, imperfections remained as incumbent utilities were thought to be restricting access to their transmission lines and favoring the use of their own power generators rather than buying (possibly cheaper) power on the open market.[1] In the view of many regulators and analysts in California, the integrated structure was inhibiting the formation of a competitive market and resulting in unnecessarily high retail rates.

When California began the process of restructuring its electricity industry in 1996, it took as its model the experiment in the United Kingdom. The U.K. had sought to privatize a nationalized monopoly and create a competitive market for electricity. However, the situation in California was quite different. The utilities were already private companies, owning generation resources and various components of the distribution and transmission grid in regulated service areas. While the U.K. broke apart a government-owned utility into generation, transmission, and distribution companies, California forced the divestiture of generating assets from its utilities in order to reduce market concentration. The utilities also relinquished control of their separate pieces of the transmission grid to a centralized grid operator. California's private utilities agreed to the restructuring because the new system allowed for the recovery of "stranded costs," i.e., the recovery of capital from investments and contractual obligations no longer thought to be competitive in the new structure.

The experiment in the U.K. had its problems – there were too few generating companies and the mandatory power pool proved to be unnecessarily rigid and constraining. In April 2001, the U.K. shifted to a more liberal system of bilateral trading and private exchanges. Ironically, the new U.K. power market has evolved toward a structure that in many respects is similar to the system of trading in the WSPP that was abandoned by California in 1998.

[1] Such barriers to trade have been observed by the FERC (1998), particularly in the Midwest.

In the meantime, California's market restructuring has failed, blown apart by unlucky timing, mismanagement, poor market design, defaults, bankruptcies, and claims of market power abuse. In response, California's political leaders are moving towards consolidating the state's electricity infrastructure into a centralized State Power Authority, modeled after the New York Power Authority created in the 1920s by then-governor Franklin Delano Roosevelt. If some or all of the assets of California's private utilities are consolidated within the new Power Authority (which seems a distinct possibility), the state will end up with an electric industry structure similar to the one dismantled by the U.K.

With hindsight, the California energy market structure is easy to criticize. Retail power rates were frozen, while wholesale rates were allowed to vary; utilities were discouraged from hedging spot market purchases; load balancing generators were sold by the incumbent utilities, while base load resources were kept; natural gas buyers were too dependent on the spot market; gas storage was inadequate, emission controls were excessive and often irrational, and California depended on unreliable hydropower from the Pacific Northwest to balance its load. Each of these issues is worthy of further investigation and analysis, but this paper concentrates on an issue that has largely been overlooked. The consolidation of the California's privately owned transmission systems into the California Independent System Operator (CAISO) has been extremely costly, has led to bungling and mismanagement, and may have been unnecessary. This is an important issue, as federal policy has encouraged consolidation of individual utility operating areas into centralized grids. These initiatives, however, could prove destabilizing, leading to unexpected problems and slower liberalization of the power market.

Breaking apart vertically integrated electric companies has revealed hidden costs. For years engineers have managed the grid in real time. Through experience they frequently know how to optimize the system—to dispatch the least cost set of generators and avoid congestion. Dividing distribution, generation, and transmission activities into separate companies requires that some sort of market replace the minute-to-minute decisions of a utility's experienced dispatchers. But, the grid balancing market is one like no other, it must run twenty-four hours a day and requires continuous costly information if decentralized decision makers are to make rational bids and the market is to be competitive. Moreover, the balancing market was meant to be tiny – never accounting for more than 5 or 10% of the total energy delivered. Operation of the small and highly complex real-time market has involved extremely high transactions costs, and it is not at all clear that the existence of such a market has yielded net benefits, either in the form of lower prices or enhancements in reliability. More to the point, are there lower cost alternatives that would allow competition between generators and an efficient wholesale market?

This paper will first explore the classic reasons why companies choose to vertically integrate. It will examine the specific characteristics of the power industry and conclude that in many circumstances it would be more cost-effective for the grid operator to own and control sufficient resources to balance the grid, rather than attempt to operate a real-time market. Furthermore, such a system is not inconsistent with policy objectives aimed at promoting competitive wholesale and retail markets.

2. VERTICAL INTEGRATION

In 1937, Ronald Coase, who would later go on to win a Nobel Prize, questioned the very existence of a firm. Why, Coase asked, if markets work so well, do firms organize in the first place? Why are there multiple production processes (such as the manufacture of component parts and assembly of the final product) taking place under the same roof? The answer, he reasoned, was that firms existed because use of the price mechanism (i.e., the market itself) imposes costs on its users. Final products in the retail market could be the result of hundreds of individual transactions (and prices), with separate contracting for each tier of the chain of production, or the activity could be housed in a single firm in which the resources are allocated on the basis of internal decisions.

Economists have long focused on two broad approaches to explain why firms vertically integrate. One school of thought analyses the problem with the conventional tools of neoclassical economics. Firms, for example, may integrate in order to take advantage of economies of scale or scope, or to diversify in the face of uncertainty.

The second school of thought has emphasized the role of "transactions" costs. These are, according to Arrow (1974), the "costs of running the economic system." The transactions cost approach focuses on the implicit or explicit costs of participating in a market. Transactions cost may include the cost of information, brokerage fees, enforcement costs, and certain types of insurance. Economic theory often ignores transactions costs. In many economic models, for example, auctions are held without having to pay the auctioneer or coordinate a group of auction participants. Most economists were ready to admit that such simplifying assumptions were false but maintained that such costs were small, in any case.

Perry (1989) discusses types of transactions costs that, when large, are likely to lead to vertical integration. Such costs include gathering market

information, the risks associated with incomplete or incorrect information, and investments in firm- or industry-specific assets.

Information costs are a powerful motive for vertical integration. Commodities that enjoy a broad market, are homogenous, and cheaply stored are easier to market than those with narrow markets and conspicuous heterogeneity. The agriculture industry is typically not integrated because farming is constrained by geography and climate. It requires a great deal of specialized knowledge to optimize output from a particular farm. On the other hand, the products a farmer typically producers – grains, meats, and so forth – are most economically processed and marketed in larger-scale operations. Information on the value of various agricultural commodities is cheap and easy to obtain, due to mature futures markets and information systems.[2]

Asset specificity, as defined by Williamson (1975), and discussed by Perry (1989) and Dietrich (1994) is the investment by firms in assets that have little use or value other than to the task to which they are applied. Markets for specialized assets are inherently narrow, and often times result in "bilateral monopoly," in which the "market" consists of a single seller and a single buyer. Such a narrow market creates an incentive for opportunistic behavior, where, for example, the seller may threaten to withhold supply or the buyer may threaten to close down. Firms whose products depend on specialized assets might integrate backwards or forwards (say, by extracting raw materials themselves rather than purchasing from someone else or by constructing their own retail marketing outlets) to shield themselves from such opportunistic behavior and ensure themselves a steady supply of key production inputs.[3]

Asset specificity need not be limited to physical assets, such as machines or raw materials. Human capital specialized to a particular industry or firm can involve sufficiently high costs as to incite vertical integration. Technologically intense industries with an array of sophisticated products are naturally run by managers who have extensive knowledge of the industry and the intricacies of each step in the supply process. For example, in the oil industry, production companies know quite a bit about the crude oil they

[2] Various satellite systems designed specifically for farmers give minute-to-minute details on spot and futures prices of all major agricultural products. These systems are available for as little as $45 per month.

[3] Adam Smith captured this idea in *The Wealth of Nations* with the doctrine, "The division of labor is limited by the extent of the market." George Stigler's 1951 essay in *The Journal of Political Economy*, which shares the same name as Smith's doctrine, noted that Adam Smith was only partly correct. The level of maturity of the industry, as well as its cost structure, also influence the extent of firms' vertical integration. Perhaps the maxim of "If you want something done right, do it yourself" (sometimes attributed to Benjamin Franklin) is even more succinct.

extract from the ground. The composition of the oil, its density and type of contaminants, affects how it will be refined. A refining company will not have the same level of knowledge as the producer and would have to constantly check the quality of crude oils being purchased. Therefore, refiners may want to own (or share ownership and operation of) oil fields and pipelines to ensure the quality and reliability of raw materials.

Firms may also integrate in order to avoid the costs or capture the benefits associated with externalities (benefits or costs of a good or service not reflected directly in its price). Computers, operating systems and applications, for instance, can be viewed as three tiers of a production process. They are also "complementary" products. That is, the usefulness of computing is derived from all three products taken together. Apple has always included its own operating system with its computers, but relies on third-party vendors to supply applications. Its principal motive to produce an operating system is to sell computers. In contrast, PCs are produced independently and standardized by Microsoft's Windows operating system. Microsoft, however, is also a major producer of application software for its own operating system. Microsoft is highly motivated to develop and market applications software, because it enhances the value of Windows. That is, consumers derive a benefit from the seamless integration of applications and operating system, because it saves time and minimizes confusion.

A similar motive for vertical integration can be observed in other industries. For example, brand-name restaurant companies (such as McDonalds, Burger King, etc.) are vertically integrated in order to standardize the quality of their products. Unhappy experiences by consumers in one outlet could reduce demand across the whole retail chain.

Diversification is often a motive for vertical integration. All industries are prone to cyclical changes, but the impact may not be consistent across all segments. For example, increasing crude-oil prices often causes refinery margins to decline. Higher crude-oil prices are passed through to the product market and the drop in demand for gasoline, diesel, jet fuel, and other products results in spare refining capacity, which leads to declining margins. If a firm is balanced between crude oil production and refinery capacity, increasing profits in one segment offset declining profits in another. Even if profitability in any given segment of an industry is independent of profitability in other segments, vertical integration allows a firm to diversify while retaining its core identity and expertise.

Not all of the classic reasons for vertical integration are applicable to the electric power industry, whose structure is as much the result of regulation as it is natural economics. Nonetheless the industry has certain unique characteristics, which may make operating a real-time or balancing market for the industry prohibitively costly and inefficient. In an unregulated

environment, firms would likely seek to internalize these costs, through vertical integration. However, most economists also believe that transmission grids are natural monopolies. If utility companies integrate upstream through investments in generation assets, and integrate downstream through monopoly control of transmission assets, what then becomes of a competitive market for electricity? As will be argued, the economic impetus for utility companies to vertically integrate, combined with the natural monopoly of the grid, need not sound the death knell for competition in electricity markets. Before exploring this further, however, it will be useful to review the industry's unique characteristics.

3. SPECIAL CHARACTERISTICS OF THE POWER INDUSTRY

Five aspects of the power industry suggest that there may be substantial economies in a partially integrated structure — one that encompasses grid operation and sufficient generating resources necessary for load balancing. First, the information and contracting costs of operating real-time or balancing markets are extremely high. Second, the economies of scale in trading twenty-four hours per day suggest a natural monopoly market structure in the provision of real-time power. Third, any efficiency gains that might be obtained from auctions and other bidding mechanisms are likely nullified by externalities in the management and pricing of transmission congestion. Fourth, efforts to value congestion differentials in real time will inevitably fragment the market, enhancing the market power of some generators. Finally, in a real time environment load is far less flexible than generation. This makes the grid operator continuously vulnerable to the exercise of market power by suppliers.

The widespread penetration of computers has reduced information costs and made real time trading possible, but it is still a costly undertaking. In a conventional setting, dispatchers have at their command minute-to-minute information on load, output of generating units, unit availability, weather, and other factors likely to influence the demand for base-load and balancing energy. Ideally, traders should have the same information set in order to make rational decisions about scheduling generation or load. However, a grid manager responsible for procuring balancing energy will likely not want to share this information. The information asymmetry gives grid operators a bargaining advantage, and ultimately reduces market efficiency as real-time traders are forced to make costly investments to obtain or estimate the system conditions known by the grid operator.

Invoicing and settling real time markets is an accounting nightmare. A good share of the costs incurred by the CAISO and the CalPX arose from the accounting adjustments involved in running the real time market. The greater the number of small generators, or a move to nodal pricing (as some have suggested) would make the accounting activity more complex and costly, whittling away any net benefits.

From the point of view of generating companies or load managers there are substantial economies of scale in real-time trading. This is because the real-time trading desk has to be manned twenty-four hours a day with a continuous flow of complex data. This has concentrated the number of active firms and makes it all but impossible for speculators to participate. That is, only a few utilities and large marketing companies have the resources to maintain active real-time desks. Instead, the responsibility is frequently contracted to another company. With so few participants in the real-time market, the incentives for opportunistic behavior by sellers are high, particularly in emergency conditions such as unplanned generation outages.

As discussed in the previous section, externalities may explain why some industries tend to vertical integration. Electricity markets have a particularly strong supply externality that arises from transmission congestion, in the sense that final congestion prices are uncertain and difficult to forecast. Consider how a decentralized market actually works. Buyers and sellers must decide how much to buy or sell and at which delivery point, based on bid and offer prices. But, optimal allocation is unknown until load and resources are actually scheduled. Whatever the system used for determining congestion differentials, locational marginal pricing (LMP) or California's system of adjustment bids followed by zonal increments and decrements, market participants should be given enough time to change their bids and offers and readjust planned deliveries. This may require a large number of bidding rounds and substantial re-contracting before an efficient solution is found. Even a brief review of location differentials in either the CAISO or PJM, as shown in Figure 1, suggests that congestion pricing is inefficient: outcomes are frequently unpredictable and seem to bear little relationship to the natural flow of energy.

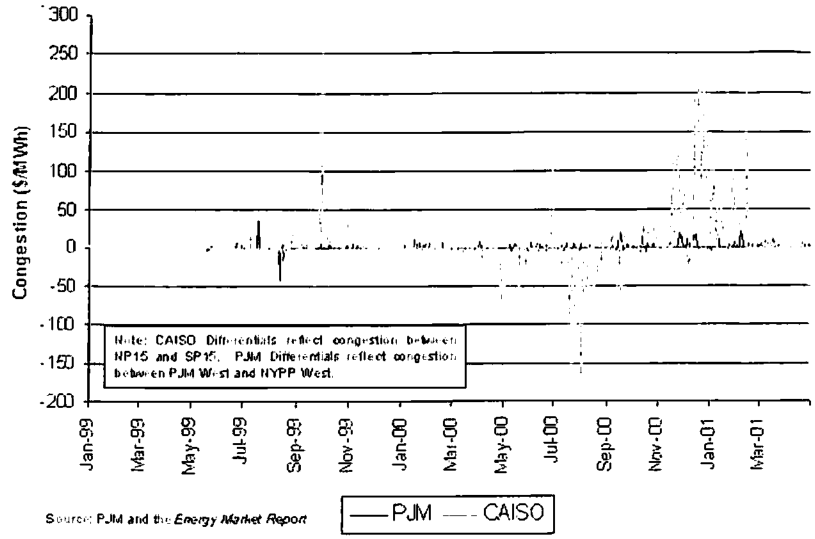

Figure 1. Congestion Differentials in California and PJM

Attempts to calculate congestion prices based on nodes or zones naturally increase asset specificity in each node or zone. In the extreme, the several thousand nodes in the PJM system and even the broader zones of the CAISO grid all suffer from the problem of "bilateral monopoly" discussed in the previous section. For example, assume that congestion exists between two nodes or zones, unless *all* the load-balancing generators in the first area are running. Further, assume that one company owns all the balancing capacity in the area. A small reduction in output by that company may earn it a huge premium. Both theory and practice suggest that the grid operator would be much better off to integrate upstream through ownership of balancing resources.

As a second-best alternative, grid operators whose balancing resources have already been divested (as in California) should consider signing contracts for real-time energy. However, as Klein, Crawford, and Alchian (1978) have noted, asset specificity and bilateral monopoly give rise to a high-cost contracting process, as each side attempts to extract pricing concessions from the other.[4] Klein, Crawford, and Alchian also pointed out an obvious problem inherent in contracts: they are not always honored. Incentives for opportunistic behavior are present in any system of rules,

[4] This game of "chicken" may have particularly high stakes when the assets in question have little value in alternative uses. This is certainly the case with balancing resources. Since the real-time market represents the shortest-term market, there is no practical alternative use for a generator once it enters the balancing market.

regulations, and contracts, so the provision of proper punitive measures becomes vital. Indeed, one of the biggest problems with the California system was its implicit encouragement of opportunistic behavior in its real-time markets by failing to take steps to encourage use of the day-ahead or other forward markets. The bilateral market in the WSPP uses a system of "liquidated damages" in its firm, prescheduled contracts. If a seller fails to deliver firm energy to a buyer, for example, the seller must then bear the specific replacement cost of that energy, no matter how high. California would have done well to implement a similar system in its own markets instead of aggregating transmission costs and real-time prices. Overuse of the real-time market or large deviations from forward schedules imposes costs on grid operators and system planners (as well as consumers and other market participants), and should be severely punished.

The bilateral monopoly problem of the real-time market is compounded by the fact that last-minute electricity demand is almost perfectly price inelastic. This makes it very easy for shrewd suppliers that have more flexibility to take advantage of the grid operator. The extreme prices seen in California, PJM, and the Midwest have, for the most part, been for electricity supplied to the real time market. Buyers with adequate time may choose to cut back demand or can do a more complete survey of alternative suppliers.

4. HOW TO SIMULTANEOUSLY INTERNALIZE COSTS AND PROMOTE COMPETITION

The market structure transformations in the U.K. and in California were radical and neither experiment has proven to be a success. In contrast, the much slower evolutionary process at PJM appears to be producing superior results.[5] Although analysts have asserted that PJM's success is due to its method of managing congestion pricing, there may be a much simpler explanation. The utilities that participate in the pool have retained their integrated structure and the expertise garnered in managing day-to-day operations has been developed and enhanced as its market has evolved. Far and away the most abrupt and revolutionary change occurred in California, where a whole new grid operation and management process was designed and implemented in fifteen months.

[5] It is important to note, however, that the PJM system has not been without its own disadvantages. The PJM system is largely self-contained, and opportunities for export to other areas of the Eastern Interconnect have been limited by restrictions on when energy can be sold outside of the pool. Fewer export restrictions, for example, may have been able to soften the impact of the price spikes in the Midwest in the summer of 1998.

All experimental power markets have suffered from an undue emphasis on the real time market and congestion pricing. Ninety-five percent of the effort has been focused on what ought to be no more than five percent of the market. Base load and intermediate resource costs have historically been the main determinant of regulated retail rates, since these costs are far more stable and predictable. Base load resources are usually not suited for load balancing since they face large start-up costs and ramping times. Load balancing resources have volatile costs, resulting in extremely volatile spot prices. If balancing resources are allowed to set prices for all electricity delivered, then electricity prices are unacceptably and impractically volatile to consumers. Such a pricing scheme, based solely on short-run marginal costs, would be unique among fixed-cost network industries, and with good reason. Airlines, for example, generally follow longer-term marginal cost pricing and adjust load factors of specific flights using a variety of techniques – stand by passengers to cover "no shows" and cash and other benefits to persuade flexible passengers to give up their seats.

Operating load balancing with an integrated structure – the grid manager owning and/or controlling key resources – does not eliminate the possibility of efficient and competitive power markets. The present regulatory emphasis on consolidating operating areas into ISOs and ISAs, congestion pricing, and other radical restructuring may be inhibiting rather than encouraging a practical market structure. While the standardization of transmission protocols may have its advantages, the transactions costs involved in implementing any such scheme will certainly be large, and will not solve the problems of congestion pricing uncertainty or localized market power at specific nodes or in specific zones.

It is instructive to observe which market structures have performed well. The WSPP was a model of an efficient power market before the California restructuring tore it in half. In this system competition was achieved through the interconnection of multiple operating areas. Integrated companies, controlling both transmission assets and balancing resources, managed each operating area. Originally, the system had its disadvantages – retail prices did not reflect the movement of wholesale energy costs, and the vertically-integrated structure of the utilities (along with regulation) was an effective barrier to entry into retail markets. Since then, however, the FERC has opened transmission access and individual states are allowing more and more retail buyers to purchase power directly from wholesale sellers. Similar market structures have been implemented in several European countries (see Table 1).

Table 1. *European Wholesale* Electricity Market Structures

Key:
D Day
W Week
E Weekend
M Month
Q Quarter
S Season
Y Year
B Baseload
P Peak

	Exchange	Bilateral market							Futures
	Spot market	Day ahead	Week block	Weekend block	Month block	Quarter block	Season block **	Year block	Futures market
Austria	×	1D BP	1W BP	1E B	3M BP	.	.	.	×
Germany	Hourly Day A/H	1D BP	1W BP	1E B	6M BP	4Q BP	-	3Y BP	✓
Netherlands	Hourly Day A/H	1D BP	1W BP	-	2M BP	4Q BP	.	2Y* BP	×
Nordic Area	Hourly Day A/H	.	-	.	-	.	5S B	3Y B	✓
Spain	Hourly Day A/H	-	1W BP	-	2M* BP	2Q BP	.	Rem of yr	×
Switzerland	×	1D BP	1W BP	1E B	3M BP	.	.	.	×
England & Wales	30 Mins Within day	1D BP	1W BP	-	3M BP	2Q BP	2S BP	1Y	✓

* 2 full years plus balance of current year . ** There are three seasons in the year in the Nordic area (winter 1, summer and winter 2) but only two in England and Wales (winter and summer) * 2 full months plus balance of current month
Source: Caminus

5. CONCLUSION

Markets are generally very good at allocating resources and directing investment, but when the costs of running a market become too onerous, internal decisions by a vertically integrated company or a set of enlightened rules can often be preferable. On paper, operating a market for real-time energy is very appealing. A well-designed auction, with multiple firms bidding should result in efficient pricing. However, this idealized scenario ignores the transactions costs involved in running such a market, and these costs have proven extensive both in California and in the U.K. Moreover, the geographically segmented structure of the grid (zones in California and nodes in PJM) has reduced the number of sellers in any particular area. Instead of facing a multitude of sellers, congestion problems may result in the grid operator dealing with several monopoly or oligopoly suppliers. Facing such high transactions costs and uncertainty, upstream vertical integration by the grid operator is surely more efficient than trying to operate an inherently flawed market.

If anything has been learned from the California experiment it should be that there are often unexpected costs involved in radical restructuring. To a large extent, the California market was over-designed. It was the product of a federal and state regulatory process that attempted to balance a host of conflicting special interests. In contrast, other successful markets have evolved and matured over long periods of time with modest of experimentation and adaptation. It took the WSPP over a decade to develop an efficient market with reliable and transparent electricity pricing. It took California regulators only a few days to dismantle it.

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