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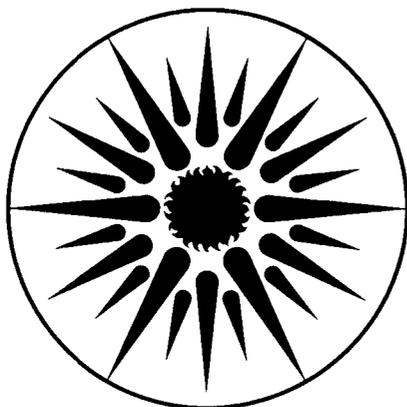
Structural Evolution of the Electric Utility Industry

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October 1988

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STRUCTURAL EVOLUTION OF THE ELECTRIC UTILITY INDUSTRY

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EXECUTIVE SUMMARY

The electric utility industry is presently dominated by companies which are vertically-integrated regulated monopolies that generate electricity, own and operate the transmission system, and provide distribution services to end users. However, the success of privately-owned generation plants that have developed as a result of the Public Utilities Regulatory Policy Act (PURPA) provides strong evidence that competition is both possible and desirable. The viability and efficiency of PURPA producers means that natural monopoly conditions in generation are no longer operative. FERC's recent Notices of Proposed Rulemaking (NOPR) aims to encourage competition by easing the entry of additional players into electricity supply markets (i.e., independent power producers). Competitive processes are fundamentally decentralizing. More decision-makers will be involved than under a regime of vertically-integrated regulated monopolies.

FERC's proposals will surely have an affect on current industry structure; implicit in the proposals is the view that the rationale for the vertically-integrated firm is no longer compelling. Although vertical integration may diminish in importance, the role of centralized coordination will remain critical. The technical characteristics of electric power systems require real-time coordination and the centralized control of power plants is necessary to assure economic and reliable system operations. This study explores the organizational consequences of the end of vertical integration, and specifically looks at a future electric power industry which includes a competitive generation segment (made up of GENCOs) and regulated distribution companies (DISCOs). Three major topics are discussed: 1) the bulk power transmission system and implications of DISCO versus GENCO ownership and control, 2) the planning and operating environment in a decentralized industry structure, and 3) the dynamics of asset reallocation.

Critical role of the bulk power transmission system

In a decentralized utility industry, the bulk power transmission system will link the transactions of a competitive generation segment with existing distribution systems that will be fully regulated. The ownership and functioning of the transmission system are critical. Any ownership arrangement must address three problems: 1) assurance of the security of the interconnected network in the event of physical disturbances, 2) efficient pricing of short-run economic transactions, and 3) economic incentives for minimizing the joint cost of new transmission and generation facilities.

In the near term, one probable scenario involves the gradual disintegration of the vertically-integrated firm, which evolves into a DISCO. The DISCO will own and operate generation resources, but will obtain new generating capacity through contractual arrangements with GENCOs. DISCOs will retain control of the *existing* transmission network, although different ownership arrangements may be established with GENCOs for additional transmission capacity. Another likely near-term organizational structure is the fully-integrated power pool in which

member DISCOs obtain the benefits of joint control of a large transmission network.

More extreme cases that involve exclusive control of the transmission system by GENCOs or DISCOs were also considered because they highlight long-term choices. GENCO ownership of the transmission system raises fundamental contradictions in the areas of system security and efficient short-run transactions pricing. System security is a public good and it is unlikely that privately-controlled GENCOs will have sufficient incentives to act in the public interest. It would be preferable to have DISCOs responsible for system security questions, provided they are at the appropriate technical level. In addition, DISCO ownership of the transmission system is more likely to assure efficient *short-run* transmission pricing than GENCO ownership. GENCO ownership of the transmission system could create a potential conflict of interest with other sellers that wanted access to a particular buyer. In the worst case, a GENCO might be able to use its market power to force inefficient transactions on buyers. However, the GENCO has much more motivation than the DISCO to invest in additional transmission capacity that may be required because access could be critical to a project's economic viability. DISCOs lack the same incentive to invest in new transmission capacity. Irrespective of the ownership arrangement, the long-run evolution of the transmission system will probably be sub-optimal because transmission and generation expansion will no longer be planned jointly as in the current vertically-integrated industry structure. However, the net result of competitive generation should be lower consumer costs because generation is a larger component of the delivered price of electricity than transmission.

The planning and operating environment in a decentralized industry structure

Under a decentralized industry structure, a variety of planning and operating services associated with bulk power generation will be accomplished by "arms-length" contracting instead of the hierarchical administrative procedures which are typically utilized by the vertically-integrated firm. Based on experiences with Qualified Facilities (QFs), scheduling and even dispatch of individual units owned by GENCOs will not pose major operational barriers, although it will be necessary to develop more explicit contractual language.

The DISCO will still retain the planning problem of providing some appropriate aggregate reliability level. In the formative stages of a decentralized market structure, a DISCO's reliability problem will involve determining the amount of GENCO supply to contract for in order to meet its aggregate supply objective. At later stages of evolution when the installed base of DISCO-owned generation has diminished, the problem will be transformed into an explicit consideration of DISCO investment in resources to meet the supplier of last resort obligation. The DISCO will have many investment options to meet this obligation including the use of storage technologies. Under a decentralized industry structure, storage will perform the functions of short-term price arbitrage and load-balancing as well as an increased role in meeting reliability needs (based on our assumption that bulk power reliability will decline overall). In addition, the

expansion of storage services can play an efficiency role out of proportion to the increase in the fraction of customer load that it serves because it offers the possibility for professional intermediaries and speculators to enter the power markets and bear some of the risk.

Asset reallocation mechanisms

Two asset reallocation mechanisms are examined in detail: 1) the “spinoff” or divestiture of assets to unregulated GENCOs, and 2) the mergers and acquisitions option. Assets that are potential candidates for divestiture include retired power stations (because the site and facilities may have residual economic value) and trouble baseload plants. Mergers and consolidations are also a likely response to competitive pressures.

Consolidation will produce clear benefits in cases where small distribution companies or partially-integrated firms aggregate into larger entities, particularly given the fractionated structure of the current industry. Consolidation of firms might produce negative effects if the trend appears “excessive”. An “excessive” consolidation trend may well be interpreted as an indicator of the failure of competition. One way to assess the potential danger from excessive consolidation in the electric generation market is to analyze the risks and threat to competition posed by types of firms that could potentially acquire new and existing resources. For example, the entry of fuel suppliers, equipment vendors or engineering firms, and independent private power producers into the power generation market is likely to be interpreted as a sign of competition more than its failure. In contrast, future scenarios in which utility affiliates or incumbent private producers improve their already dominant position may well suggest excessive concentration. The dominance of these firms would indicate the presence of barriers to entry (i.e., incumbents have an advantage over potential entrants to the point that the entry of outsiders can be prevented).

Key issues for public policy

Increasing competition will reshape the organization of firms in the electric power industry, while public policies pursued by regulatory agencies will play a key role in managing competition. Three major public policy areas can be identified which will require some government intervention to achieve a smooth transition from the current structure of vertically-integrated firms to a less regulated and more decentralized industry.

First, because of its critical role, the ownership structure and functioning of the bulk power transmission system must be resolved in a fashion that assures protection against major system disruption, efficient pricing of short-run transactions, and long-run additions to transmission capacity. Second, with deregulation of generation, the regulated distribution company (DISCO) will face new challenges in its reliability planning responsibilities. Regulators will surely be involved in the process of redefining the utility’s role as “supplier of last resort”. The DISCO will have many investment options to meet this obligation, of which storage facilities and services may play a particularly prominent role.

Finally, competitive forces will be stifled if there is an excessive asymmetry in market power and financial resources between buyer and seller. Roughly 76% of the nation's electric generating capacity are owned by several hundred investor-owned utilities, while 3,000 relatively small public utilities and rural electric cooperatives account for the remaining 20% of total sales. These small utilities, most of which are part of the public power sector, that are currently protected by regulation will function better in a more competitive market place if they merge with other firms. The existence of thousands of small entities may ultimately pose political barriers to increasing competition, if consolidation does not occur in the public power sector.

1. INTRODUCTION

The Federal Energy Regulatory Commission (FERC) has initiated a series of changes in the structure of regulation in wholesale electricity markets that promise to alter the ways in which the firms in the utility industry are organized. The traditional rationale for the vertically integrated firm hinges on the notion that coordination economies reinforced natural monopoly conditions that were dominant in all segments of the power production process. The benefits of these economies to consumers could best be captured by granting a regulated monopoly franchise to one firm that integrated generation with the transmission and distribution functions. The FERC Notice of Proposed Rulemaking (NOPR) on Independent Power Producers (IPPs) is based on the proposition that wholesale markets for generation are, by and large, "workably competitive." The main evidence for the viability of competition is the success of privately-owned generation plants that have developed as a result of the Public Utilities Regulatory Policy Act (PURPA). It is argued that these competitive forces in power generation have resulted in lower production costs, the dominant factor in the delivered cost of electricity. This means that natural monopoly conditions no longer exist in that sector; therefore, the need for regulation of bulk power generation has effectively disappeared. The logical consequence of this state of affairs is that the compelling quality of the rationale for the integrated and fully regulated firm has also vanished.

The changes in bulk power regulation represented by the FERC initiatives embody the larger tension between forces of centralization and decentralization in the organization of electricity markets (Kahn, 1988a). Competitive forces are fundamentally decentralizing in that more decision-makers are involved in competitive processes than under a regime of vertically-integrated regulated monopolies. The multiplicity of actors in a decentralized market, however, increases the problems of coordination. In electricity, coordination is a real-time requirement for which some centralization of market-making authority is essential. Neither of these forces will completely dominate the organization of electricity markets. Rather, the organization of functions within firms will change in response to the decentralizing pressures of competition. Although vertical integration will diminish in importance, the role of centralized coordination will remain critical in many functions.

This study examines the organizational consequences of the changing balance of forces and discusses three major topics: 1) the critical role of the bulk power transmission system, 2) the planning and operating environment in a decentralized industry structure, and 3) the dynamics of asset reallocation.

In a decentralized utility industry, the bulk power transmission system will link the transactions of a competitive generation segment with existing distribution systems that will be fully regulated. The ownership and functioning of the transmission system must be organized so as to maintain system security in the face of disruption, facilitate economic transactions in the near term, and allow for efficient capacity expansion over the long term.

Second, the planning and operating environment of the various industry segments under a decentralized market structure is reviewed. Historically, the vertically integrated firm has been responsible for coordinating investment decisions and operating procedures in a centralized manner. Under a decentralized industry structure, a variety of planning and operating services associated with bulk power generation will be accomplished by "arms-length" contracting instead of the hierarchical administrative procedures which are typically utilized by the vertically-integrated firm. For example, this could lead to changes in the operational definition of "firm power" and "economic dispatch". It is likely that the utility's traditional role as "supplier of last resort" will also be redefined in a new industry structure. Finally, storage systems and the storage function will assume an increasingly important and expanded role. As coordination costs increase, storage systems will balance some of the supply and demand fluctuations that previously were smoothed out administratively.

Finally, the dynamics of asset reallocation are discussed. Competitive markets always involve the movement of assets from lower-valued uses to higher-valued uses. This can occur either through utility decisions to spin off particular assets or through a series of mergers and acquisitions. The possibilities for significant economic gains and losses will increase, principally because technical innovation will play a more important role in competitive generation markets. The accumulation of such gains and losses will likely lead to consolidation among firms. Consolidation of firms that perform the distribution function may have the beneficial effect of reducing the transactions costs associated with acquiring supply resources. However, the consolidation of existing generation suppliers may have the net effect of reducing competition.¹

2. CENTRAL ROLE OF THE BULK POWER TRANSMISSION SYSTEM

Power generating stations are typically located at some distance from load centers, although, in many cases, major load centers are partially served by "local" generation. The key factors in power plant siting are economic access to fuel supply, the costs of environmental mitigation, and access to cooling water. Typically, new power plants are sited in locations remote from load centers as a result of economic analysis (coupled with political constraints) that balances the costs of land, fuel transport and handling, and pollution control. Because of the prevalence of relatively remote siting, it is necessary to transmit power. The technology for power transmission has evolved to a point where a large network of high-voltage lines creates electrical linkages over substantial geographic regions.

Typically, the power plant siting and transmission investment decisions are a joint process in vertically-integrated utility companies. This would not necessarily remain the case under a

¹ A similar dynamic in the airline industry is a suggestive analogy.

regime of competitive generation investment. The key issue involves the ownership and "mission" of the existing transmission network. Two polar cases illustrate the choices that can be made on this issue. At one extreme, the transmission system can be construed as belonging properly to the distribution function. As such, its function is to facilitate the acquisition of low cost resources for the consumers of the distribution companies (DISCOs). This is the model outlined in the British Government's proposal for the privatization and restructuring of its power industry. Public Service Company of New Mexico's (PNM) recent restructuring proposal is an example of the opposite approach. PNM proposed that its existing assets would be broken up so that the existing transmission network would be part of a new de-regulated generation company. In this case, the function of the transmission system is to facilitate the profit-maximization (or other objective function) of the generating company (or GENCO).

These extreme cases highlight long-term evolutionary trends; in the near term, other configurations are more likely to develop. For example, one probable scenario involves the gradual disintegration of the vertically-integrated firm, which evolves into a DISCO. Initially, the DISCO will still own and operate generation resources. The DISCO will obtain its new generating capacity through contractual arrangements with GENCOs and over time, private producers will supply an ever-increasing share of the DISCOs power. In this intermediate configuration, it is likely that the DISCO will retain control of the existing transmission network. Different ownership arrangements may be established with GENCOs for the new transmission capacity that will be required. Another likely near-term organizational structure is the fully-integrated power pool in which member DISCOs obtain the benefits of joint control of a large transmission network. Thus, in the near-term, the likely cases represent intermediate cases compared to our two possible long-term scenarios. Conceptually, it is useful to examine the more extreme models, which involve exclusive control of the transmission system by the DISCO or GENCO, in some detail to help highlight long-term choices. Three major problems that any arrangement must satisfy are discussed: 1) assurance of the security of the interconnected network in the event of physical disturbances, 2) pricing of economic transactions in the short-run, and 3) economic incentives for minimizing the joint cost of new transmission and generation facilities.

2.1 System Security

Disturbances in power systems are propagated over the transmission network. A large generator or line outage can spread to entire regions in very brief periods of time. In such circumstances it is necessary for the restoration of control to proceed in an organized, cooperative manner that is essentially under centralized direction. In fact, several analysts maintain that the role of regional control centers in short-term load balancing represents a natural monopoly (Jurewitz, 1988). When system security is endangered, a few major control centers will have the responsibility for managing disruptions and directing the activities of load and supply points.

It is generally agreed that the current technical and institutional arrangements for handling system security problems need improvement (Wu and Montecelli, 1988). This problem will become more pressing as the transmission network is run increasingly close to its capacity limits. It is reasonable to expect that restructuring of the utility industry will tend to push operation of the transmission network closer to its limits. Therefore, the system security issue will become more rather than less important.

It is unlikely that technical problems associated with system security will be particularly intractable. In fact, the problems may be as much institutional as technical. System security is a public good. It cannot be left to the privately controlled GENCOs to bear responsibility for providing this good. GENCOs will not have sufficient incentive to act in the public interest, because the pursuit of private profits is the principal rationale for their creation. Therefore, responsibility for security questions ought to devolve upon DISCOs.

The main issues that arise with DISCO control over system security are scale economies and technical expertise. The two issues are interrelated. Natural control areas in power systems are relatively large geographically. The operational economies of centrally dispatched power pools indicate that the natural control areas can exceed the service territories of relatively large integrated firms. To achieve these economies under scenarios of vertical disintegration and deregulation, it has been argued that some aggregation of DISCOs will be desirable, if not actually necessary (Joskow and Schmalensee, 1983). If DISCOs are too small, they may be unable to afford and manage the technical expertise that will be necessary to achieve coordinated system security. Even if the monetary and management costs can be borne, an excessive number of DISCO control centers will be redundant and uneconomic.

Alternatively, the organizational problem can be characterized as the challenge of finding institutional arrangements that are intermediate between the fully-integrated power pool and situations in which a large-scale DISCO's service territory exactly coincides with a control area. It is worth noting that the level of coordination between entities required for security purposes is much less than that which is typically implied by centralized dispatch. Individual scheduling of transactions occupies an intermediate position in terms of the level of coordination. It is unclear how the institutional/organization barriers that hinder creation of cooperative arrangements among small DISCOs (relative to the size of natural control areas) will be resolved. Industry structure problems that are especially relevant to small DISCOs will be discussed again in the context of mergers and acquisitions (Section 4).

2.2 Short-Run Transactions Pricing

The economic theory of efficient pricing as applied to transmission services is based on marginal cost principles. This theory has been discussed at length in the difficult case in which power is transmitted over lines owned by several parties, some of whom are only intermediaries in a particular transaction (Kelly et al., 1987). The conclusion reached in this and similar

analyses is that the correct short-run transmission price is essentially the cost of line losses from the point of production to the point of purchase (Bohn et al., 1984). This price only applies in the case where transmission capacity is not constrained. Where capacity is limited, a congestion charge must be applied to ration demand.

Few problems would arise in implementing short-run transmission pricing if DISCOs owned the transmission facilities. All DISCOs could compete with each other for the competitively priced supplies offered by all GENCOs. There is little incentive to distort short-run transmission pricing as long as all DISCOs have access to the transmission network and can compete on the basis of price in situations in which capacity is rationed through a congestion charge. In situations in which capacity is limited, it is expected that only those transactions that had the greatest gains from trade would be completed (i.e., where the buyer's and seller's cost differed by the largest amount).

GENCO ownership of transmission facilities could raise more serious problems in terms of assuring efficient pricing of short-run transmission transactions. For example, the GENCO would have a potential conflict of interest with other sellers that wanted access to a particular buyer. The GENCO might well be able to use its market power derived from the ownership of scarce transmission capacity to force inefficient transactions on buyers. Contracts with DISCOs that included inflexible take-or-pay provisions might be a prominent mechanism by which this would occur. Such contracts would limit the ability of regulatory or competitive pressures to minimize short-run production costs. The GENCO can not be expected to offer transmission access to lower priced competitors because of the pecuniary advantage that it would accrue from selling its own output under take-or-pay arrangements. This appears to be a particularly difficult problem, although, it may be possible to constrain the GENCO from such behavior under given circumstances.

2.3 Transmission Capacity Additions

From a societal perspective, the relative incentives for DISCOs and GENCOs are reversed with respect to the efficient development of new transmission capacity. In the short run, it is desirable to have DISCOs own the transmission network; however, DISCOs may not be the best entity to ensure optimal development of new transmission capacity additions. We foresee problems over the long term because the DISCO would lack an incentive to invest, to the degree that regulation has induced a bias against investment. This problem may not be absolute; DISCOs might build transmission to relieve internal bottlenecks in their service territory.

Compared to the DISCO, the GENCO would have much more motivation to invest in new transmission capacity. For example, the incentive to invest lies with the seller, not the buyer, in a situation in which new transmission capacity is needed to bring new generation to load centers. Typically, a particular new generation source is only one of several alternatives for the buyer. For the seller, either he can reach market for his generation, or he cannot. Therefore, the cost of

transmission linkages is essentially just another cost of doing business for the GENCO. If a project is sufficiently economic that it can compete with the added burden of transmission investment, then there is no inherent obstacle.

There are a number of cases in the PURPA market where private suppliers have made significant investments in transmission in order to reach attractive markets. The most striking example is a 200-mile line built by central Nevada geothermal developers to interconnect with the bulk power network of Southern California Edison. Many of the land-use and permitting questions that would arise in the general situation of private transmission investment are absent in this case since the bulk of the right-of-way involves desert land owned by the federal government (Oxbow Geothermal, 1986). A second example involves a group of QFs that bore the capital costs of a dedicated transmission line that connected their projects to the Pacific Gas and Electric grid. In this situation, the utility constructed the transmission line, primarily because the utility could exercise its eminent domain power to acquire the right of way.

The preceding example may offer a reasonable model that can be used to solve problems that typically arise in transmission capacity expansions. The construction of new transmission facilities would be a shared responsibility between DISCO and GENCO. Construction and operational responsibility would rest with the DISCO, or some suitable regional association of DISCOs. The GENCO will assume the principal cost burden for dedicated transmission because it is the primary beneficiary of the transmission system expansion.

This approach of shared responsibility will undoubtedly encounter numerous implementation problems. For example, it will be necessary to develop mechanisms to accommodate economies of scale and network externality problems. Scale economies are ubiquitous. The capacity of transmission lines increases with voltage rating, however the cost of the higher voltage lines goes up less than proportionally. The problem of network externalities is somewhat less obvious. The problem arises from the non-linear electrical interactions due to changing patterns of loads and generation as the network is reconfigured for whatever reason. Thus, a new transmission line will affect the future transmission cost opportunities for other generation projects. Problems of this kind exist in other network systems such as communications (Rohlf, 1974; Oren and Smith, 1981). Optimal expansion of capacity in such situations is a complex engineering problem.

It may be desirable from a total system perspective to construct new transmission facilities with capacity in excess of the requirements of the project that is expected to fund them. Under vertical integration, the long-run evolution of regional transmission systems was accommodated by building in advance of capacity needs. It will not be easy to develop the required coordination mechanisms in order to achieve a similar outcome with decentralized GENCOs and DISCOs. Either GENCOs or DISCOs must speculate on future transmission capacity needs in the hope that investment today will be recovered in the future from projects that do not exist at present. Even if such risky investment were undertaken, it would require costly compensation.

It is likely that the long-run evolution of the transmission network will be sub-optimal, because the scale economy and network externality problems are not easily resolved. It is difficult to estimate the magnitude of this problem, although it will vary to some extent by region. For example, the impact may be larger in the Western region of the United States than the East. In the West, power plants are typically located at greater distances from load centers and the transmission grid is less dense compared to the East. As a result of these two factors, incremental transmission lines will be more costly and the problem of quantifying the interactive effects of the cost of multiple new transmission lines will be of greater importance.

It is important to examine the transmission planning problem in its larger economic context: the joint optimization of generation and transmission expansion. Under the current vertically-integrated industry structure, coordination among firms has resulted in relatively efficient transmission expansion (i.e., realized scale economies), given the generation expansion plan. Unfortunately, the generation expansion plan was often inefficient. Plants were often constructed at a cost that was too high. In a dis-integrated scenario, more efficiency in generation investment could be expected. Competition should lower costs. Some inefficiency in transmission planning is likely to accompany these economies in the cost of generation. However, the net result should be lower consumer costs because generation is a larger component of the delivered price of electricity than transmission.

Long-run transmission planning may represent the most important coordination economy achieved by vertical integration. However, coordination economies also arise with regard to several short-term operational issues, which is our next topic of discussion.

3. PLANNING AND OPERATIONS UNDER DECENTRALIZATION

The vertically-integrated firm coordinates investment and operational activities administratively. A decentralized market structure for electricity will require market mechanisms to achieve coordination. Under a decentralized market structure, it is likely that bidding and auction mechanisms will assume an increasingly important role in the planning and selection of new generation projects. The relationship of power purchase auctions and bidding mechanisms in the resource planning process have been discussed elsewhere (Rothkopf, et. al, 1987, Kahn, 1988b). In this section operational issues are discussed, such as unit commitment and economic dispatch, and the planning responsibilities for supply and demand imbalances. The focus is on the utility's planning responsibilities in this context because it highlights issues related to the utility's redefinition of the "supplier of last resort" function as well as the enhanced economic role of storage technologies.

3.1 Unit Commitment and Economic Dispatch

Generation resources are matched to real-time loads by centralized control centers. Unit commitment optimization programs are used to schedule individual units for short-term planning purposes. The actual dispatch accounts for deviations from the schedule caused by unforeseen events, such as changes in load or generation availability. This procedure depends upon the ability of the control center to determine operating schedules with minimal transaction costs. However, short-term negotiations are often conducted by a utility that wants to purchase non-firm economy energy from other utilities. Moreover, some of these purchases may be outside the utility's control area.

It is not necessary for generation resources to be owned by the vertically-integrated firm that operates the control center in order to assure effective scheduling. For example, many Qualifying Facilities (QFs) operate under long-term contracts and typically coordinate their maintenance schedules with the control center. From the utility's perspective, this ensures their availability for short-term commitment purposes. Similarly, generation resources that are jointly owned by two or more utilities operate under contractual terms that allow for short-term scheduling.

It will be necessary to develop more explicit contractual language with regard to scheduling and dispatch under an industry structure based on GENCOs selling to DISCOs. Particular attention to these issues is necessary in the case of QFs, because of PURPA's provisions that obligate utilities to purchase QF power. Current practice allows for some limited curtailment of these projects. For example, Pacific Gas and Electric Company's (PG&E) experience with QF curtailment has been mixed. PG&E has offered substantially reduced purchase prices for 600 or 1000 hours per year, and relied upon the supplier to adjust output accordingly. In many cases, the producers will simply accept the reduced prices rather than actually curtail physically. Only when PG&E reduced QF payments to zero did QFs significantly curtail their actual output (PG&E, 1987).

Dispatchability may be defined as a broader type of operating flexibility than the kind of curtailment scheduling options currently available under PURPA. Dispatchability extends to actual control of the output of privately-owned facilities, up to and including the ability to turn plants on and off at the dispatcher's discretion. Even in these cases, the facilities remain subject to operating constraints that involve minimum running times, minimum downtimes, and whether they will follow instantaneous load fluctuations. PG&E has recently negotiated agreements with some of these features for three 100-200 MW projects in Northern California. A complete unbundling of all the factors involved in centralized unit commitment, such as ramping and voltage support, has yet to be approached through contracting.

Under a decentralized industry structure, GENCOs may wish to sell bundled services that include capacity features such as dispatchability or firm power that are produced by a system of generating units, rather than individual plants. The availability of such services depends in part

upon the consolidation of resources within a given GENCO. In this situation, some of the supply/demand balancing function nominally under DISCO control can be contracted out to the GENCO. However, the viability of this option rests on the assumption that the GENCO segment of the industry will exhibit some concentration of ownership (i.e., one firm owning several plants which can be operated together). The concentration of plant ownership was not anticipated by PURPA in which the implicit model was atomistic and decentralized ownership. Other industries have exhibited a similar pattern in which many firms entered the market, but ownership was later concentrated. The airline industry showed such a dynamic under deregulation (A. Kahn, 1988); it might also be expected to some degree in the electric utility industry.

At this time, it is unclear how the operational functions currently performed by centralized commitment and dispatch will ultimately be divided between DISCOs and GENCOs. One way to characterize the problem involves defining the utility's role as "supplier of last resort." This focuses attention on the mechanisms for dealing with situations in which the market fails to clear.

3.2 The Utility's Role as "Supplier of Last Resort"

Public policy differs concerning which markets are allowed to ration demand, how this is done, and under what circumstances it is deemed tolerable. Traditionally, electric utilities have had an obligation to serve which has translated, in practice, to highly reliable bulk power service. As regulation of bulk power supply diminishes, it is likely that some reduction in service quality will also occur. The experience of the airline industry under deregulation is instructive in this regard. Since deregulation, the monetary cost of air travel has declined significantly, however, consumers have had to bear increased congestion and delay costs (A. Kahn, 1988).

The electric utility industry has not developed much in the way of rationing methods or procedures because of its historic obligation to serve. Many utilities offer some type of interruptible service primarily to large industrial customers. In some cases, the utilities also promote load management programs for other customer classes. Recently, it has been argued that there would be substantial welfare benefits from a more systematic differentiation of service reliability through various pricing, priority and insurance schemes (Chao and Wilson, 1987). The Electric Power Research Institute (EPRI) has initiated an investigation into these ideas. Perhaps the most difficult aspect of this problem is the endogenous determination of the reliability level that consumers are willing to pay for. The deregulation of electricity generation is likely to make this a more proximate than an academic question.

One approach that has been suggested involves defining the DISCO's reliability obligations in terms of segmenting consumers into core and noncore classifications (Joskow, 1987). This approach mimics recent trends in the natural gas industry, where the obligation to serve is expected to be retained only for core customers. In some states, a gas utility's noncore customers are free to shop around for commodity supplies and to acquire their own transmission

services. Such schemes require that issues of transmission access and pricing be solved, which even in the case of natural gas remain unsettled (Smith, et. al., 1988). In electricity, these problems may be even more difficult to resolve (Jurewitz, 1988).

Even if customers are segmented into core and noncore classes, the DISCO will still retain the planning problem of providing some appropriate aggregate reliability level, at least for core customers. This issue will probably not be that important in the near-term because the entity we have been calling a DISCO will often be just the self-liquidating descendant of the vertically-integrated firm. Thus, initially, the regulated DISCO will still own (or operate) the vast majority of generation resources that it requires to meet its load. Over time, the DISCO will only be able to serve a reduced fraction of its load requirements from the generation plants that it owns. The GENCOs will serve incremental loads, including loads previously served by DISCO-owned units that are retired from service. However, the reliability planning problem for the DISCO will still be qualitatively different from the corresponding problem in natural gas, because the local electricity distributor (DISCO) will have the option of supplying part of its total requirement internally; i.e. *not* through contracts.

In the formative stages of a decentralized market structure, a DISCO's reliability problem will involve determining the amount of GENCO supply to contract for in order to meet its aggregate supply objective. At later stages of evolution when the installed base of DISCO-owned generation has diminished, the problem will be transformed into an explicit consideration of DISCO investment in resources to meet the supplier of last resort obligation. Some analysts have argued that DISCOs will have to deal with the needs of potentially-returning core customers if electricity prices rise rapidly in unregulated, competitive electricity markets. These customers will seek protection under the DISCO obligation to serve (Pace, 1987). Such a situation could also arise if the bulk power market proved to be less than "workably competitive." In these cases, the demands placed on the supplier of last resort function could be severe, and the potential for cross-subsidy to the returning noncore customer could be significant. Concerns of this kind argue for restraint in opening up transmission access to end-users.

The root concern involves questions of fact about the ease of entry for new power suppliers. Will noncore customers and private producers easily and viably contract, or will these markets fail and thereby create large residual demands on the DISCO? This question will take time to resolve. In the interim period, it will be important to distinguish between transient and chronic reliability and shortage problems. Chronic problems should not arise if the electricity generation market is truly competitive. The existence of such problems would argue for a return to the vertically-integrated, regulated firm. Transient supply/demand mismatches are a different matter. In this situation, the DISCO's supplier of last resort function should be more manageable.

The DISCO will have many investment options to meet its supplier of last resort obligation, including the use of storage technologies. While storage is also used by natural gas distribution

companies for seasonal peak problems, the situation in electricity is considerably different than in gas because of the importance of random generation outages. Special attention is necessary to the market consequences of electricity storage in a vertically-disintegrated industry.

3.3 The Role of Storage

At present, only hydroelectric facilities allow for bulk electricity storage. However, during normal operation of hydro reservoirs, the storage function is only one of many objectives for such systems. Because of these multiple objectives, the ability to use the storage function of these reservoirs is limited. Some utilities have constructed specially dedicated facilities for bulk power storage using large pumps coupled to a dual reservoir system. Although, pump storage systems can store significant amounts of electric power, these systems seldom store more than 1-2% of the annual electricity requirements of customers.

Currently, the function of storage in electric power systems is confined primarily to price arbitrage over short time periods. Low-cost, off-peak energy is used for input to pumped storage systems, and it is discharged during periods when opportunity costs are high. For these systems the time cycle seldom exceeds a month. Multi-purpose reservoirs can often achieve some seasonal storage, holding water in months of abundance and discharging in months of relative scarcity.

In addition to price arbitrage, storage can also be used to meet reliability requirements. It is difficult to ascertain how often pumped storage systems are used to ensure adequate reliability, in part because it is not easy to separate such cases from the normal operation of storage facilities. However, we expect that the role of storage in meeting reliability needs will increase in the future as vertically-integrated firms become less dominant in the utility industry. This view hinges on the notion that bulk power reliability will decline overall under a decentralized industry structure. Storage resources will be one of the more economic means available to serve potentially unmet needs because marginal improvements will still have value, although the average level of reliability will diminish.

The value of storage, however, goes beyond its load-balancing function; it may be even more important for its role in the potential expansion of risk-bearing. One of the challenges of a decentralized power industry is to develop a better alignment of risk-bearing, responsibility and profitability. Many of the arrangements between GENCOs and DISCOs will inevitably involve risk-shifting from the supplier to the buyer through contractual obligations. This arrangement may not be qualitatively different from vertical integration, which had the same risk-shifting effect. Storage offers the possibility for professional intermediaries and speculators to enter the power markets and bear some of the risk. This is a standard function in other commodity markets. The speculators play their role principally through futures markets, which cannot be formed without certain preconditions. These conditions include 1) the development of predictable transport costs and 2) the development of inventory services. Storage is inventory. Therefore, the

expansion of storage services can play an efficiency role out of proportion to the increase in the fraction of customer load that it serves.

Assuming the storage function increases in importance, who and how will storage services be provided. If only existing technologies are considered, then it is clear that those DISCOs with hydro storage capability (in particular, pumped storage) will have the opportunity to enter the reliability market to other DISCOs not so favorably endowed. We define this as the "external" reliability market to connote that the service provided is outside the domain of DISCO obligation to serve. It is possible that conflicts of interest may arise for a DISCO between the obligation to its own customers, and the profit opportunities in the "external" market. Presumably, during peak periods, the DISCO would refrain from diverting its own storage resources to this market. But there may well be opportunities for entry in other periods.

New storage technologies may allow the entry of private suppliers into the external reliability market (i.e., GENCOs). Large-scale batteries are currently being tested for utility application, and compressed air systems are thought to have commercial potential. However, it is difficult for us to imagine how unregulated GENCOs would be able to acquire federal licenses to construct new pumped storage facilities. It may well be that only DISCOs will be able to develop new pumped storage facilities.

Despite the opportunities for a market in storage services, there are substantial impediments as well. The main problems stem from the constraints on transmission which may limit transactions. It is these constraints, which are as much technical as institutional, that limit the "commoditization" of bulk power. Buying and selling are impeded if transactions are not standardized. For example, gas utilities are currently grappling with this problem, because transmission services are still so transaction-specific that secondary and other derivative markets have yet to develop (Smith et al., 1988). The prospects for further commoditization are good in the gas industry. For example, a true national spot market appears to be developing in the Houston area, which relies on extensive pipeline interconnections. If transmission contracts can be standardized, then a futures market may also develop. Without predictable transport costs, a spot market cannot induce the development of a futures market (Stein, 1986). The prospects for this developing in electricity are more remote than in gas. Standardization of transmission pricing may depend on new communication and control technology. Political issues involving access by retail customers also will need to be resolved. Thus the expansion of storage services will be one of the important means available to smooth market fluctuations, but it will be an opportunity with limits.

4. ASSET REALLOCATION

It is likely that firms will shift the ownership of particular assets as part of their response to a changed industry structure. As profit opportunities change, the productivity of assets in a particular organization will also change. The logical consequence of this will be a redrawing of the

boundaries of firms. In previous sections, we have discussed some of the value changes that are likely to occur for different kinds of assets. In this section, mechanisms for the reallocation of assets are outlined. The discussion focuses on the fate of the existing assets of the vertically-integrated and regulated firm. Two asset reallocation mechanisms are examined in detail: 1) the "spinoff" or divestiture of assets to unregulated GENCOs, and 2) the mergers and acquisitions option.

4.1 Divestiture

We assume that some GENCOs will prosper in a deregulated electricity generation market as they provide incremental capacity additions. Further, it is conceivable that GENCOs will use some of their profits to acquire assets of previously regulated and integrated firms. In one possible scenario, the entity that we have been calling a DISCO is just the self-liquidating vertically-integrated firm. Either through gradual evolution, or deliberate policy, the DISCO will own fewer and fewer generating plants as private producers supply an ever-increasing share of the DISCOs power. If the DISCO pursues a conscious policy of divesting existing generating assets, then some GENCO will purchase these facilities.

There are several types of plants for which such transactions may occur. One class of assets that may be sold is retired power stations. When a generating plant reaches the end of its economic life, the site and facilities have residual economic value. The site and facility is likely to have the highest value to a future builder of generating capacity. The site is likely to be well-situated with respect to fuel delivery, some of the existing equipment may continue to have value, and the site may have a favorable location in the transmission network. Unless the DISCO seeks to upgrade these sites as investments in its supplier of last resort function, they are likely to be sold off to GENCOs.

Troubled baseload power plants are another class of assets that are potential candidates for divestiture. Typically, these plants have failed to generate rates adequate to cover their accounting costs, or if incomplete, are unlikely to generate revenue sufficient for this purpose. They often represent a substantial economic burden to their owners. The financial strength of firms holding such assets would be improved if these units could be divested. One prerequisite for divestiture of operating plants is some guaranteed revenue formula. These assets can only be independently valued if the revenues of individual assets are separated from those of the firm as a whole. Several utilities are attempting to develop explicit revenue mechanisms for troubled baseload plants.

These two classes of assets are obvious candidates for divestiture because they are "excess capacity" even from the viewpoint of the traditional regulated and integrated firm. It is also possible that a utility company without excess capacity might choose to divest its generating resources, simply as a profit-maximization strategy. In this case, the remaining DISCO would have to convince its regulators that power costs for customers would not increase as the result of

divestiture. At first glance, these arguments may be difficult to make. If GENCO profits from the divested assets were greater than under regulation, it would have to be because either revenues were higher or costs were lower. If GENCO revenues were higher than under regulation, then DISCO costs would probably go up as well. Alternatively, if GENCO costs were lower, it might be asked why the regulated firm could not capture such economies. The recent history of regulation and deregulation in other industries suggests that cost economies are likely to result from competition (Bailey, 1986). Whether this would occur in the power industry without divestiture is uncertain. On balance, however, operating cost economies would appear to offer the only rationale for the divestiture of assets that are not excess.

Finally, some assets would probably not be spun off under almost any scenario. For example, hydroelectric resources are highly-valued and unique: 1) the operating costs of hydro plants are negligible, 2) hydro resources are licensed to users under federal law that would not allow an easy or uncontested transfer, and 3) hydroelectric facilities often provide crucial storage and load balancing services that will be particularly valuable to DISCOs. Substitutes for these storage and load balancing services are likely to be costly and are part of the supplier of last resort function that DISCOs must perform for their customers. Other assets such as peaking turbines, and perhaps some intermediate load plants also fall into this category. For this reason, DISCOs are not likely to divest themselves of these type of facilities, and may even choose to invest in additional or replacement facilities of this kind.

4.2 Mergers and Acquisitions

Mergers are one industry response to competitive pressures. Consolidation at many organizational levels is a likely outcome of industry restructuring. The electric power industry can expect a significant amount of reshuffling in its ownership structure. Some firms will disappear; other will grow larger; new entrants will appear. Some of this expected consolidation will be unambiguously beneficial; in other cases, the benefits are more uncertain. In some situations consolidation would be beneficial, but may not occur.

The aggregation of small distribution companies or small partially integrated firms into larger entities is the major case where consolidation will result in clear benefits. For competition to work successfully, there can not be an excessive asymmetry in market power and financial resources between buyer and seller. Small utilities that are currently protected by regulation will function better in a more competitive market place if they merge with other firms. A number of utility analysts have argued that the current structure of the industry is excessively fractionated (Gilbert, 1988).

Table 1 presents recent data on the number of firms and their share of total sales to ultimate customers for various industry segments (EIA, 1988). A relatively few investor-owned utilities dominate the industry in terms of electric sales, with 282 private companies accounting for about 77% of total sales to ultimate customers. In contrast, about 3,000 publicly-owned utilities and

rural electric cooperatives account for the remaining 20% of total sales. This data suggests that consolidation, if desirable, is a more pressing issue for public utilities and rural cooperatives than privately-owned electric utilities. However, based on publicly-reported information, most utility consolidation efforts have involved merger activity among investor-owned firms. There are also several examples of investor-owned firms that have acquired, or attempted to acquire, municipal or cooperative systems.² In the public sector, federal power marketing agencies provide some of the market aggregation services that increasing competition seems to require.

Table 1

**Electricity Sales and Size of Utilities
by Type of Ownership**

| Type of Electric Utility | Number of Companies | Number of Companies (%) | Electricity Sales to Ultimate Customers (%) |
|-----------------------------------|---------------------------|----------------------------------|---|
| Private | 282 | 9% | 77% |
| Public/State | 1,991 | 61% | 15% |
| Cooperative | 965 | 30% | 7% |
| Federal | 11 | - | 2% |
| Total | 3,249 | 100% | 100% |

Source: Energy Information Administration, "Financial Statistics of Selected Electric Utilities, 1986" DOE/EIA-0437(86), February 1988, Table 1, p. 4.

The settlement of claims arising out of troubled generation projects is one mechanism that might produce some consolidation in the public power sector. Public power agencies have been involved in a number of these projects (e.g., Washington Public Power Supply System, Wabash Valley Public Power Association, and Massachusetts Municipal Wholesale Electric

² For example, Pacific Gas and Electric has offered to acquire the troubled Sacramento Municipal Utility District (SMUD).

Corporation). Determining and allocating the economic losses in these situations may provide an opportunity for rationalizing the power supply activities of the members of these joint action power agencies. Thus far, there are few examples of institutional mechanisms that have been created that will facilitate this process. The existence of thousands of small entities may ultimately pose political barriers to increasing competition, if consolidation does not occur in the public power sector. In this situation, the potential for abuse of market power would exist, which would tend to increase FERC's regulatory burden. A continuation of the current institutional setting in public power may well create unstable markets that have a negative effect on the political viability of increased competition.

The evolution of the public power sector is strongly influenced by the fact that many public power entities purchase wholesale electricity from federal power marketing authorities or investor-owned utilities. FERC regulates the price of these wholesale transactions. As competition increases, it is conceivable that the purchasing entity may choose to shop around for wholesale power, thereby altering its traditional supply arrangements. This situation resembles the noncore customer planning problem described in our discussion of possible changes in the utility's "supplier of last resort" obligation. It is unclear to what extent the traditional supplier would retain any residual obligation to the "shopping" public entity (Bouknight and Raskin, 1987). Regardless of legal arguments, wholesale public power customers may be able to exert political power disproportionate to their economic strength. The FERC would be under political pressure to protect the interests of publicly-owned DISCOs that were economically damaged by poor bargaining or otherwise in the competitive marketplace. Political concessions of this kind would weaken competition because it would inevitably involve breaking contracts. Thus public interest regulation would raise the risks faced by private suppliers. To the degree that aggregation could be achieved in the public power sector, there should be less chance of poor bargaining, more strength through supply diversity, and smoother functioning of the market.

Consolidation of firms might produce negative effects if the trend appears "excessive". An "excessive" consolidation trend may well be interpreted as an indicator of the failure of competition. This phenomenon is only a risk in the generation segment, because effective regulation should be able to capture the benefits of consolidation in transmission and distribution. One way to assess the potential danger from excessive consolidation in the electric generation market is to analyze the risks and threat to competition posed by firms that could potentially acquire new and existing resources. In thinking about this problem, it is useful to classify these firms by their core business activities. Four possible cases are considered in which the acquiring firms are: 1) fuel suppliers, 2) equipment vendors or engineering firms, 3) independent private power producers, or 4) utility affiliates operating as unregulated GENCOs.

Fuel suppliers, particularly in the natural gas industry, have already entered the private power market through QF affiliates. As the private power market expands, these firms will probably make additional efforts to enter the market. It is unlikely that fuel suppliers could

exercise monopoly power without attracting rivalry from competitors, because fuel markets are workably competitive. However, there may be less competition in particular fuel markets. For example, scale economies are substantial in the Western U.S. coal market and transport alternatives are limited. The result has been something close to vertical integration between coal producers and power plants (Joskow, 1985). The potential for monopoly power exists in this situation. Ironically, those railroads that have captive shipping routes have probably benefited the most from these conditions.³ It is unlikely that Western coal producers will be able to dominate the region's private power production in the future. The efforts of coal producers to gain a competitive advantage are constrained by the fact that they have no particular expertise in building and operating the associated generating plants.

Equipment vendors and engineering firms are also likely to play an active role in the private power market. Often, these firms will be equity investors in particular projects and perhaps in GENCOs. The firms in these industries are also by and large competitive. Competitive pressures are probably greater among engineering firms compared to equipment vendors, because there is an oversupply of engineering construction firms (a legacy of the utility industry's large nuclear- and coal-fired plant construction program). Equipment vendors may be able to exert monopoly power in cases where a particular technology has a cost advantage. For example, General Electric (GE) turbines have played a dominant role among gas-fired producers in the QF market. The company's presence in this market has also been significantly aided by the financial resources of its credit arm. However, GE's dominant position does not necessarily imply monopoly power. Other turbine manufacturers, both foreign and domestic, are capable of entry. The ability of other potential entrants to contest the market is often sufficient to discipline the behavior of incumbents.

Vendors of a proprietary technology with a distinct cost advantage could also gain a favorable competitive position in particular market segments. For example, clean coal technologies that rely on fluidized bed combustion may represent a potential case of this type. Such vendors may be able to capture technological rents. It is doubtful that the relative advantage of these firms is so overwhelming that it would enable them to obtain monopoly power by acquiring competitor firms. First, it is unlikely that any proprietary technology would be sufficiently exclusive in nature that some imitation would not be possible. Moreover, a firm's dominant position in a particular segment of the private power market would not necessarily imply a failure of competition in the market as a whole.

Thus, the entry of fuel suppliers and equipment vendors/engineering firms into the power generation market is likely to be interpreted as a sign of competition more than its failure. However, future scenarios in which the existing actors in the private power market, either utility

³ The policies of the Interstate Commerce Commission in this area have also aided the railroads.

affiliates or incumbent private producers, improve their dominant position may well be used as evidence of the negative implications of consolidation. The dominance of these firms would indicate the presence of barriers to entry. That is, incumbents have an advantage over potential entrants to the point that the entry of outsiders can be prevented. Incumbents can acquire weaker firms in the industry and achieve some degree of monopoly power by exploiting these advantages.

It is difficult to speculate on the sources of entry barriers. In an industry as subject to local political forces as electricity, it is possible that local political power could become a source of market power. Both incumbent QF firms and utility affiliated GENCOs could exercise such power. One of these type of firms would have to be dominant (rather than both) for the monopolization scenario to occur. Of the two candidates, utility affiliated GENCOs are the more plausible emergent monopolist. This scenario would evolve either through the collusion of the affiliated DISCO or through the capture of the regulatory apparatus. Undoubtedly, the financial strength of any incumbent/potential monopolist would be an essential element in an anti-competitive consolidation. In terms of financial strength, the utility-affiliated GENCO is a more likely candidate than the incumbent QF firm.

It is more productive to explore the public policy response to demonstrated failures of competition, rather than speculating on the sources of entry barriers. The likely outcome would be a revitalization of utility regulation. However, it is unclear that a "re-regulation" scenario stemming from monopoly abuses in an unregulated generation market would involve a return to the traditional vertically-integrated firm. For example, a return to vertical integration would be unlikely if the entry barrier were collusion between the utility-affiliated GENCO and the associated DISCO. In this case, the expected regulatory response would involve sufficient oversight to eliminate collusion and encourage entry. If the nature of the market failure had more to do with the difficulty of any potential supplier developing projects (i.e., a shortage scenario), regulators might respond by offering additional producer incentives. This scenario might favor a return to the traditional vertically-integrated firm, but with more favorable treatment of investments.

It is difficult to predict whether anti-competitive consolidation will occur. The supplier response to PURPA indicates that barriers to entry are not particularly great. However, the QF industry is still too young to prove that QFs are sustainable over the long-term. In a more competitive environment, market segments may emerge in which competition is difficult to sustain. For example, the public power sector may experience such problems if small publicly-owned DISCOs do not achieve some level of aggregation.

5. CONCLUSION

Increasing competition will reshape the organization of firms in the electric power industry. While there is considerable evidence that a competitive generation segment can be "workable," regulatory agencies and public policy will play a key role in sustaining this market. Our analysis

also suggests that the key public policy areas will be 1) the structure of the bulk power transmission system, 2) planning for reliability in a more decentralized manner, and 3) achieving aggregation of the distribution function, particularly in the public power sector. Each of these areas will require some government intervention to achieve a smooth transition from the current structure of vertically-integrated firms to a less regulated and more decentralized industry.

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