“Unbundling the U.S. Electric Power Industry: A Blueprint for Change”

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Executive Summary

This paper considers the issue of restructuring the US electric power industry to unbundle the service components associated with the different stages of electricity supply (from generation to distribution and billing) and thereby make transparent the prices and other attributes pertaining to these service components. Together with open access to each of these components at the unbundled prices, and related financial and risk management practices, unbundling has become a centerpiece of the debate on competition in electric utility services in the United States. This debate has been underway since the framing of the conditions of the Public Utilities Regulatory Policy Act (PURPA) of 1978, but has recently received new impetus after the enactment of the Energy Policy Act (EPAct) of 1992 and the restructuring initiatives set in motion by the California Public Utilities Commission. These moves parallel the worldwide trend to use competitive forces to replace regulation in public utilities facilitated by new technologies in generation, demand side management and information systems.

The privatization and restructuring of the UK power system has demonstrated that a partially unbundled and competitive market -- even with imperfections -- is a viable alternative to the traditional vertically integrated structure that has characterized electric utilities in the United States. In the US, these initiatives have been driven by the recognition that prices are too high, that cost-of-service regulation has been slow and expensive, that new services have been slow in coming from the traditional franchised electric utilities, and that productivity growth and innovation could be significantly enhanced through competition. As a consequence, the old supply-driven electric power industry is slowly giving way to a more vital, customer-oriented demand-driven industry.

The paper examines the similarities and differences between gas and electricity, the lessons learned in the recent restructuring of the US gas industry (especially the implementation of FERC order 436 and FERC order 636), and the lessons learned in the UK and elsewhere to define the market instruments and mechanisms as well as the implementable institutional structures which will maintain reliable and secure delivery of electricity services. In particular, we address the question of how such a market can operate without centralized control.

We have set out a blueprint for change which will encourage the industry to move more quickly to this new reality. Our approach is founded on bilateral transactions between buyers and sellers of the various unbundled service components associated with electricity supply. This approach facilitates competition at all stages along the value chain of electricity supply, in contrast with pool-based approaches where serious competition is feasible only at the generation stage.
There are three conclusions which we reach in this report:

- The electric supply industry in the US will be restructured into a more competitive industry over the next decade. This conclusion is based on evaluation of the pressures on price of electricity in a competitive industrial world. These pressures are being felt strongly in all aspects of the US industrial and commercial sector. The unbundling of the US electric supply industry responds directly to this pressure for a more competitive environment.

Figure ES 1 reflects the unbundled supply industry. It is an industry with significant opportunities for improved competition and efficiency at all points in the supply chain.

**Figure ES 1: Unbundled Electricity Value Chain**

- Restructuring of the electric supply industry in the US based on bilateral contracts between suppliers and customers rather than strict, mandatory pools, which purchase and sell all power, is more efficient and will lead to greater consumer choice and lower costs. This conclusion is based on evidence gained from the restructuring of natural gas and telecommunications as well as from experience in other of the restructured industries; airlines, railroads and trucking.

Within the electric supply industry a range of new functions will provide for an evolution that builds directly upon the today’s wholesale market to provide open access for increased
numbers of players while maintaining the system security and reliability demanded by an industrial society. Figure ES-2 shows the structure of a new electricity supply industry. The physical functions -- security and reliability are provided by NetCoor, the independent system operator. The commercial function of purchase and sale of electric energy within the system are provided by commercial players, some acting within a commercial pool, others acting strictly through bilateral contracts.

Figure ES-2  Structure of a bilateral, unbundled electricity supply market

- The permanent benefits to be gained from restructuring of the US electric supply industry vastly outstrip the transitional costs associated with the restructuring. This conclusion is based on relatively crude, but convincing arguments as to the order of magnitude of both consumer and producer benefits associated with increased direct competition in the industry.
(Consumer Surplus)
$60 Billion
+
(Producer Surplus)
$10 Billion in saved capital expenditures / year
$9-12 Billion net in reduced costs / increased productivity / year
?? Billion net from sales of new electrical services / year

= 

Net Benefits
$80 to $100 Billion / year

We estimate that a competitive and efficient electricity supply system could save consumers $60 billion or more annually. Savings in capital investment could exceed $10 billion annually, savings due to increased productivity in both capital and labor could account for an additional $10 billion or more annually and we have yet to account for benefits that will accrue to both consumers and producers from increased product differentiation -- from new products that enter the market. The conclusion reached is that the benefits -- $80 to $100 billion per year swamp the highest, once only costs of stranded investment in the industry, estimated to be not more than $200 to 300 billion.

Unbundling of the electric supply industry is already well underway. With increased open access such as that proposed in California and in other states, the process of unbundling and with it rebundling of electrical delivery services will occur. The result will be an increasingly flexible, competitive and efficient industry as the industry structure, rules and prices become more transparent to incumbents and potential new entrants.
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1. Background and Introduction

This paper considers the issue of restructuring the US electric supply industry to make the prices and other service attributes associated with the stages (from generation to distribution and billing) of electric power supply more open and transparent to the buyer and seller of electricity. This separation of the value chain of electricity supply into its components is generally referred to as " unbundling". Unbundling has become a centerpiece of the debate on competition in electric utility services in the United States, a debate which has been underway since the framing of the conditions of the Public Utilities Regulatory Policy Act (PURPA) of 1978. The Energy Policy Act (EPAct) of 1992 which mandated open wholesale access to the transmission system, as well as several recent merger cases in which open transmission access was a condition for approval, have further raised the issue of unbundling of services. This movement in the US parallels the worldwide policy trend to use competitive forces to manage former monopoly industries. In particular, the privatization and restructuring of the UK power system has demonstrated that a partially unbundled and competitive market -- even with imperfections -- is a viable alternative to the traditional vertically integrated structure that has, to date, characterized electric utilities in the United States.

Most recently, the bold restructuring initiatives set in motion by the California Public Utility Commission have set the stage for a series of similar measures all around the country. What is driving these initiatives is the recognition that prices are too high, that cost-of-service regulation has been slow and expensive, that new services have been slow in coming from the traditional franchised electric utilities, and that productivity growth and innovation could be significantly enhanced through competition. The old supply-driven electric power industry is slowly giving way to a more vital, customer-oriented demand-driven industry. Our purpose in this paper is to provide a blueprint for change which will encourage the industry to move more quickly to this new reality. In this regard, we argue that various forms of unbundling in the industry are essential in moving to this new reality. Nonetheless, there have a number of concerns expressed about unbundling initiatives. These are discussed in the following paragraphs.

The first concern with unbundling, and with competition more generally, is the possibility that these initiatives will erode the very high levels of reliability which have characterized US electricity supply. Instead of questioning whether these reliability levels are in tune with customer needs and payments, this concern has fueled the argument that because of the real-time operating nature of the electric utility, a strong central control function is necessary. The instantaneous nature of electricity supply is used as an argument that all of these services must be handled centrally in a structure not unlike today's vertically integrated utilities connected horizontally by power pools. The need for high reliability is
reinforced through constant reminders of well publicized power failures such as those in the Northeast in 1965 and New York in 1977.1 Our contention is that the argument here should be decomposed into two fundamental questions:

- What is the appropriate level of reliability for various services and various customer segments?
- What is the most effective market / institutional structure with which to provide services with the desired levels of reliability.

As we argue below, there is every reason to expect that a more market-focused and efficient response to both of these questions will be obtained through an unbundled, competitive industry structure than through a centralized structure. In the past, however, the proclaimed necessity of centralized control has been a significant impediment to addressing other underlying questions concerning how the demands for service will be fulfilled, by whom, under what conditions, and under what market and regulatory structures. The result has been that unbundling of electrical services has occurred only slowly and at the margin, through entry by IPPs and Energy Service Companies (ESCos), while leaving the central operations and control functions of the franchised utilities intact.

A second important issue relates to the regulation of both the incumbent franchised utilities, which still face a universal service obligation, and new entrants. In this context, the fundamental tradeoff which unbundling faces is between promoting the benefits of service and cost innovation resulting from increased competition and the costs which could arise from putting incumbents too much at risk in the transitional phase to the unbundled, competitive market. These costs arise from two areas:

- First, if the economic viability of incumbents is undermined, then universal service, or at least the quality thereof, could be threatened. Thus, regulatory policy during the transition phase must be concerned with moving franchised utilities to a new competitive mind set and to encourage them to view cost reduction and service innovation strategies that will allow them to continue to play an active role in the new marketplace.

- Second, the transition costs resulting from foot dragging to outright legal action which would accompany putting the incumbents at significant risk could result in costly delays. These costs and delays have multiplied in recent years as franchised utilities have challenged the transition to a competitive market at every

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1 During the winter of 1993-1994 the level of reliability, specifically in the PJM power pool, might be questioned as there were days of rolling blackouts caused by severe weather conditions
opportunity, raising issues such as stranded investment, "unfair" competition and
cream-skimming by competitors, to name but a few.  

These considerations have led a number of regulatory authorities to be quite cautious in
their approach to unbundling. While not minimizing the importance of these issues, it is
nonetheless our contention that unbundling, properly structured and coupled with
appropriate risk management and financial services, will promote a rapid and viable path
to sustainable competition. We also contend that such unbundling can provide incentives
for incumbents to become promoters of the move to competition as opposed to very
reluctant participants. The intuition behind our arguments is that unbundling will facilitate
the entry into the electric power market of both new service providers in generation and
transmission as well as intermediaries who can provide information consolidation, risk
management and financial stability for the process. These intermediaries will act as a
fundamental catalyst in creating the new competitive marketplace for electricity services.
The new services will reverse the continuing erosion of revenue in this sector, with clear
benefits for efficient incumbents.

Against the above background and concerns, this paper defines alternatives for
restructuring the electricity service industry in the United States. As in any other active
market, such a market for electric services would consist of both the participants on the
physical side of the business (providing generation and associated supply-side support,
transmission services, and distribution/demand-side management), as well as the financial
side (providing brokering and other intermediation such as financial risk management, and
generally enhancing the liquidity of the paper market). Our focus is on how change can
occur, rather than the questions of why or why not change should occur. The paper
examines the similarities and differences between gas and electricity, the lessons learned in
the recent restructuring of the US gas industry (especially the implementation of FERC
order 436 and FERC order 636), and the lessons learned in the UK and elsewhere to
define the market instruments and mechanisms as well as the implementable institutional
structures which will maintain reliable and secure delivery of electricity services. In
particular, we address the question of how such a market can operate without centralized
control.

While the changes that we envisage are broad and far-reaching, we are at the same time
well aware that from a practical standpoint, the current institutional structure is the
starting point for change, unlike in the UK where government ownership provided the
ability to drastically restructure the system overnight. Thus, an important aspect of this
paper concerns the identification of practical means by which change can occur in a system

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2 For a recent discussion of stranded costs in electric power, see Alfred E. Kahn, "Can Regulation and
Competition Coexist? Solutions to the Stranded Cost Problem and Other Conundras." The Electricity
Journal, October, 1994, pp. 23-35. It should be noted that final treatment of stranded costs significantly
slowed and confused the gas industry transition.
with great diversity of ownership. In particular, the following issues need to be addressed to assure a feasible path to competition:

- First, given the structure of the US supply industry, which market / institutional structure is most likely to be effective in creating an efficient electrical supply system; multilateral (e.g. pool or public hub-based) or bilateral contracts (one to one contracts or private hubs),

- Second, what options are available for addressing stranded investment? This includes evaluation of options for buying back wholesale requirements contracts as well as alternatives for buying out of (or institutionally being released from) the utility's "obligation to serve" as it applies to industrial and large commercial customers,

- Third, how can the electric supply chain be physically, financially and temporally unbundled to provide transparency and to make the conditions under which these services will be transacted as simple as possible.

In the next section, we set out a vision for an unbundled electricity service industry. Thereafter we return to specific issues associated with the unbundling of the industry and discuss how they can be addressed. Next we turn to questions of transition, given the realities of where the industry is today and how fast it can move to a new unbundled structure. Finally, we assess some of the potential impacts of the restructuring and the overall benefits that are likely to accrue as a consequence of it.
2. Industry Structure: Present and Future

In this section, we present a framework for an unbundled electricity sector. We begin with a brief description of the traditional structure of the industry and then indicate the structure of the unbundled industry which we would propose. As we emphasize, the traditional structure of the industry has been characterized by a supply-side perspective, with closely regulated investor owned utilities, which owned both generation and transmission resources, providing most of the energy to customers. Final customers' choices were severely limited in this world, both in respect to the purely physical side of such services as well as pricing and billing options. Small wonder that there has been such an outcry on the part of customers to move toward more competitive conditions.

2.1 The Current US Utility Structure: Issues

Figure 1 shows the traditional structure of electricity provision. Beginning with fuel supply contracts, through generation and transmission to distribution and consumption, this structure has been dominated by vertically integrated, investor owned utilities (IOUs). In 1990 IOUs generated over 80% of the kWh in the United States and accounted for 75% of total kWh sales to customers. The diversity in generation mix in 1990 attests to the fact that we have already begun the movement toward competition. Even more telling is the fact that non-utility generators (NUGs) account for 50% of additions to new generating capacity and are predicted to account for a far higher percentage by the year 2000. This predicted growth is partially the result of the bidding provisions for new capacity instituted in over 2/3 of the states by 1994.

Figure 1: Traditional Value Chain in Electricity Industry
2.1.1 Generation

The present industry structure is summarized in Figure 2, which shows both IOUs and NUGs. IOUs build or acquire capacity based on projections of key variables such as demand, operating costs and buyback rates. Their output is dispatched, and they sell either directly to their native load or wholesale into their pool or, more generally, the network. By contrast, the majority of new generation in the US is being built by independent power producers. In the past these generators sold, most generally, to the IOU in whose service territory they were located. With the advent of the EPAct of 1992, these generators can sell wholesale to any qualified wholesale buyer and receive transmission services, at a fair and comparable price, from the intervening, wheeling IOUs. The conditions of the transactions can be long term contracts or spot contracts, or some combination. In addition they can sell to power marketers or through power brokers within the wholesale market. Clearly, generation in the U.S. electricity market has already moved to the point at which competitive contracting and spot sales are parts of the daily business.

![Diagram of generation and transmission](image)

Figure 2: Schematic of Today’s Integrated Utility Structure

2.1.2 Transmission

Traditionally transmission has been provided as a bundled service to customers, and priced accordingly. Only recently, through the EPAct of 1992 has transmission access been required to be unbundled from other services provided by integrated utilities. Under Section 211 of the Federal Power Act, any Electric Wholesale Generator (EWG) can now
request a price for transmission service from any transmission owning entity. In the traditional model of bundled pricing, the following issues arise:

- There is no clear connection between costs and customer valuations of generation and transmission services. This makes the alignment of investment and operating decisions with net benefits at best difficult and clouds the determination and provision of efficient levels of each of these respective services on the supply side.

- On the demand side, efficiency is clouded with respect to customers' location and operating decisions, to the extent that these depend on the consumption of electricity services. That is, if the only choice the customer has is the bundled service, then his decisions may be considerably different than if he has the opportunity to choose from a larger set of electricity consumption alternatives, possibly altering his own location and operating decisions in the process.

- Bundled prices are anti-competitive for several reasons. Foremost, the resulting lack of transparency prevents NUGs, IPPs, and ESCos from understanding the IOUs' market offering in disaggregated form, thereby clouding the decision that these entrants and potential entrants have with respect to the development of competitive new capacity and with respect to the transmission cost of connecting new generating capacity to customers. There is also significant potential for cross-subsidy between generation and transmission when these functions are bundled, creating barriers for potential competitors in either of these two elements of electricity service. These distortions are difficult to detect by regulators and prevent the development of active markets in unbundled services.

- Bundled prices encourage uniformity and discourage spatially and service differentiated prices for both generation and transmission services. Just taking transmission services, the wide-spread use of "postage stamp" rates at times and at locations where there are significant cost differentials is an example of inefficient uniformity in pricing, since marginal costs of transmission capacity and service depend on both time location parameters. With unbundling and competition, we may expect to see both generation and transmission services begin to reflect the true economic costs of these services, possibly differentiated by location and service quality parameters.

- Pricing flexibility and service innovation would also be enhanced if intermediaries had an opportunity to provide an array of services, covering risk management and

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3 Note that postage stamp rates in combination with a capacity release option would result in appropriate price differentiation.
For a discussion of transmission pricing and the applicability of Postage Stamp, Zonal and Nodal pricing see Tabors and Caramanis Response to FERC NOPR 93-19, November 1993.
physical delivery, for both generation and transmission. These innovations would add value for customers, and they would also enhance the viability and stability of the industry. But to operate effectively, intermediaries need transparency in the offerings of the market place. Absent this transparency, the ability to commit to a 10-20 year fixed-price arrangement for delivering a large amount of power to an end use customer could be managed only through contracting with the vertically integrated IOU who, because they own or control the actual generation resources, control the information flow. The intermediary, on the other hand, would not have sufficient market information to be able to operate in the long term market.

2.1.3 Pooling, Dispatching, Buyback and Settlements

The structure of pooling and dispatch, and the underlying financial arrangements for settlement, are key to the facilitation of market forces and competition in the electric power industry. Even though electricity is quite homogeneous in a physical sense, financially it is far from homogeneous, being characterized by significant cost differences across space, time and generation technologies. The fixed and variable elements of generation costs, coupled with major variations in demand over time, gives rise to the co-existence of generation options with very different cost characteristics. At least from an optimal planning standpoint within individual utilities, the configuration of these generation "portfolios" is well understood. The challenge for transacting arrangements in a new electricity marketplace is to ensure through flexibility in rate structures and institutional arrangements that the goals of economic efficiency are further advanced by exploiting advantageous trading arrangements across industry participants free from asset ownership or other institutional and regulatory barriers.

Even though power pools in the US typically consist of many independent IOUs and other players, they have only recently (with the onset of wholesale wheeling) begun to take on a significant commercial role. However, even in this case, since settlements are largely cost driven or based on long-term contracting arrangements, the participation of these different players in a power pool has not resulted in any significant competition within the pool. Instead, the pool has served more the role of providing insurance through its capability to diversify across its different participants.

The power pool in the restructured UK power system was designed to play a more significant role in facilitating competition but has fallen short of this objective in current practice. Whereas prices paid to individual generators are set in advance in a US power pool (typically based on costs), generators are supposed to compete to supply power to the UK power pool by bidding prices and capacity on a daily basis, thus moving away
from a purely administered cost-based arrangement. However, this scheme suffers from several deficiencies:

- The entire UK is treated as a single power pool, which results in a uniform energy price across the country, despite some significant transmission barriers which effectively divide this power pool into sub-pools.

- Since all generators receive the bid price of the marginal generator (system marginal price), competition effectively occurs only across a subset of generating plants that have a chance of being marginal during the day. The bid prices of base-load generators, in particular, have no effect on the system marginal price.

- All players of a significant size (so called "first-tier") are compelled to join the power pool, even though some may find it more advantageous to themselves and potential customers to transact outside the pool on bilaterally agreed terms.

- Cost differences across the system are only weakly reflected in transmission charges -- hence the compulsory pooling arrangement in the UK has also become a scheme of cross-subsidization.

- The rules that govern the pooling arrangements have given rise to many situations of monopoly behavior in parts of the system that are isolated by transmission constraints.

Given the size and complexity of the US system relative to the UK, a workable scheme for the US unbundling system needs to advance well beyond the level achieved in the UK. The process of thinking through issues of pooling and dispatch should begin by raising the basic question of whether power pools are necessary to meet the goals of unbundling. We argue below that they are not, at least from a commercial standpoint, and may indeed be anti-competitive if foisted on the industry. However, where individual players see mutual benefits of pooling their resources, they should certainly be permitted to do so subject to anti-trust considerations. As illustrated in Figure 3, we see this happening largely at the power market intermediary level, where there will frequently be significant advantages to forming coalitions for coordination purposes. We elaborate on these arrangements later in this section. There may also be some benefits to reliability pools which are brought into action on those rare occasions when security considerations override the commercial ones.
2.1.4 Distribution

Historically, distribution has played a rather passive role in the electric power industry. Distributors who are part of vertically integrated IOUs have served to reinforce the captive nature of their customer base. Distributors who are retail suppliers (municipals or cooperatives that purchase wholesale) have, in the past, maintained only limited functions in the power sector. As the industry has restructured under the Energy Policy Act of 1992, the role of the distribution entity has altered significantly. It is now perceived as the customer of the wholesaler. This role is likely to expand as restructuring removes the present vertical integration of the system. In a competitive system their role, and that of large industrial and commercial customers, will expand to reflect the demand side of the supply/demand equation.

2.2 A Blueprint for an Unbundled Industry

2.2.1 Principles of Unbundling

In this subsection, we present a blueprint for how an unbundled industry might be structured and operate. The following principles underlie the unbundling of the US electric power industry:

- **Promoting competition** through:
  
  transparency of prices;
  open access;
  flexibility for contracting and for price-setting.

- **Value-creation** for the customer through:
  
  the benefits of increased competition;
  reduction of inefficient and distortionary regulation;
  enhanced demand-side service options;
  creation of innovative products and services responding to customer needs;

- **Value-creation** for suppliers by:

  lowering of market barriers;
  enhanced incentives for creativity and efficiency;
  mitigating regulatory constraints.
In general, these principles are all aimed at enhancing the economic efficiency and value associated with electricity supply in the United States.

We see unbundling occurring at two physical levels (see Figure 3 below):

- Between generation, transmission and distribution; and
- Within generation, between the provision of energy and various other ancillary services.

![Figure 3: Unbundled Electricity Value Chain](image)

In addition there is a separation of physical products and financial services as shown in Figure 4.

2.2.2 Unbundling Generation, Transmission and Distribution Services

Figure 4 reflects the structure of an industry in which generation, transmission and distribution services are unbundled. This process is already underway, with the entry of independent generators and the breakaway of customer groups (municipalization) from the vertically integrated structure of the traditional IOU. In our structure, the break-up is facilitated actively by power market intermediaries who will also provide or arrange network coordination and other support services.

In contrast with models of industry restructuring following the UK approach of a mandated common pool, the approach presented here is very much based on bilateral transactions between sellers and buyers of electricity services. As discussed above, while
voluntary pooling is not ruled out, we are not sympathetic with an approach which forces all participants into a pooling arrangement which is then operated based on regulated rules. As the experience in the UK shows, setting *ex ante* rules in this manner is not consistent with "learning by doing" since such rules are often inflexible and changes rarely result in "win-win" outcomes. It is better, in our view, to let industry participants have the freedom to enter and exit pools as they see fit. This provides clear signals to participants of the costs and benefits of their actions, which are obfuscated in pooling arrangements that foster free-riding and cross-subsidization.

From the standpoint of achieving the efficiency gains which are sought through unbundling, separation of generation, transmission and distribution is clearly the primary goal. Unbundling of generation services is also important in order to provide the same competitive and transparency benefits. This disaggregation could take many forms, including the actual divestiture of generation assets by utilities. This sort of disintegration has been championed by some as the best way to clear competitive obstacles in the wholesale power industry. Less extreme measures could include organizational separations such as those required for gas pipelines in FERC Order 497.

![Diagram](image_url)

*Figure 4: The Unbundled System*
2.2.3 Unbundling Generation Services

Generation provides four services that can themselves be unbundled.

- Primary energy supply: Real power which provides energy to end users
- VAR support: Reactive power which maintains the system voltage
- Frequency support: Automatic Generation Control functions which automatically balance energy entering the system so as to maintain frequency at 60 Hz.
- System reserves: A hierarchy of system reserves are provided by generators. At the shortest time these are referred to as spinning reserves, at the longest, system reserve margin.

Today, each of these services is provided as a part of the bundled services of the industry. In addition these services are, in general provided by generators. What is clear is that some, or potentially all of these services could be provided through a competitive market that involves traditional generators, NUGS and, significantly, negative loads.

2.2.4 Service Providers in an Unbundled Industry

As shown on Figure 4, the service providers in an unbundled electricity supply industry consist of both providers of services that are conventional in the current industry structure as well as new provider types. In the former category are the following:

- **Generation** providers -- who will supply generation capacity into the system for:
  
generation of energy;
  providing reserve capacity;
  providing ancillary services.

- **Transmission** providers -- who will supply transmission capacity into the system for:
  
energy transmission;
  complementing reserve generation capacity.
- **Ancillary services providers**\(^4\) -- who will supply ancillary service capacity into the system for:

  - back-up reserves;
  - VAR support;
  - system frequency;
  - system control.

- **Energy service companies** -- who will supply aggregated demand side services for:

  - providing Negawatts in the system;
  - providing other demand management services.

- **Power market intermediaries** will:

  - facilitate physical transactions;
  - facilitate financial transactions;
  - develop liquid secondary markets;
  - provide risk management services;
  - arrange for Network Coordination services.

The role of power market intermediaries is described more fully in the following subsection.

### 2.2.5 The Role of Intermediaries in an Unbundled Industry

In the old vertically integrated structure of the electric utility industry, there was little scope for intermediation, since all transactions along the value chain were internalized within a single company. However, the trends toward emergence of full-fledged intermediation have been evident for some time, paralleling the trends toward greater competition. Power pooling and exchange arrangements across groups of vertically integrated utilities have been a first step in this direction. Whereas these arrangements were originally conceived for reliability reasons, i.e., to spread the physical risk of supply shortfalls or demand spikes across a wider base, they have more recently become a means of economizing electricity supply sources in a given region. Furthermore, facilitated by these power pools and wholesale access, transactions across utility boundaries have

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\(^4\) Ancillary service providers could be either owners of generation or of voltage compensation equipment or owners of large electrical loads that can also supply either the equivalent of spinning reserves or VAR support.
expanded rapidly, accompanied by the emergence of NUGs as significant sources of generation. Some of these transactions have been intermediated by power marketers and brokers.

In the new industry structure which is envisioned in this paper, the role of intermediation is expected to expand quite rapidly. This is consistent with the view that intermediation is the "lubricant" of competitive markets, of which we would expect to see a proliferation in the new industry structure. Intermediaries will perform the following key roles in this structure:

a) **Intermediate physical transactions**

Intermediaries facilitate transactions either by bringing buyers and sellers together in brokerage-type transactions, or by acting as dealers for the unbundled services which will be provided in the industry. For example, in the latter case intermediaries could deal in location and time-specific generation capacity or energy. Alternatively, intermediaries could rebundle unbundled services into specific forms as demanded by the marketplace.

b) **Intermediate financial transactions**

Financial transactions could be intermediated by:

- providing forward contracts on electricity prices -- e.g. a generation company which is exposed to the risk of the spot electricity price may wish to enter into a forward contract to hedge this price risk. An intermediary may "buy" this electricity forward from the generation company and "sell" it to a distribution company which desires to hedge its price risk of spot electricity purchases.

- facilitating the development of more standardized futures-type financial instruments in electricity, possibly based at high volume "hubs" across the country.

- intermediate swap-type arrangements where the delivery of electricity at one point in the system or during a specific time interval will be swapped for delivery at another point or over another time interval.

In broad terms, by engaging in these types of transactions, intermediaries will facilitate the emergence of liquid markets and thereby the strengthening of market forces. We see a hierarchy of forward/futures/options markets developing derived from a series of competitive and liquid hub spot markets across the US.
2.3 The Workings of an Unbundled Electric Power Industry

2.3.1 Overview

The discussion which follows provides a snapshot the physical functions provided by the electric power system and our image of the manner in which the paper actions/instruments will complement and parallel the physical. The Paper over Physicals structure is summarized in Figure 5. We refer to the physical system functions and the paper market instruments as they occur in 4 time frames, Long-Term, Medium-Term, Short-Term and Real-Time.

2.3.2 Long-Term Functions and Instruments

Planning to meet demand at the generation, transmission and distribution levels, developing the financing and constructing the elements of the physical system are the major long-term requirements for the physical system. All of these functions were fulfilled by the centralized utility. In today’s environment, particularly with Integrated Resource Planning (IRP) requirements, most of these functions are being fulfilled on the generation side by NUGs with only limited activities by the IOUs themselves. It seems likely that pricing and service quality for long-term transmission and distribution functions will remain regulated to assure fair and efficient rates and adequate service quality. However, rather than traditional cost-of-service regulation, it seems both desirable and likely that such regulation will be performance-based, e.g. based on a price-cap regime, to provide additional incentives to trade-off between operations costs and investment costs. Such incentive regulation is very consistent with our longer term vision of the unbundled industry as reflected in Figure 3, especially if it simultaneously defines service baskets in a manner which promotes transparency and separability.

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5 It should be noted that considerable discussion is underway concerning the potential for “private” investment in transmission where it is a direct competitor for generation at a point. These proposals frequently focus on DC transmission capabilities or on AC lines in which technologies such as phase shifters can be used to assure both long-term transfer capabilities and system stability.
Within the current structure, the market instruments exist for the capital creation necessary for IOUs to build new plants. Their form and acceptance in the financial community has, however, largely been a function of the regulatory compact which provided a reasonable assurance of earning a specified return on investment. With restructuring, these instruments will need to be significantly altered to match the market risk associated with competition -- a change that financial markets have readily made in transportation, telecommunications and natural gas. On the other hand, the increased role of both IPPs and NUGs in generation has meant that market instruments for private project investments are now relatively well understood. Nonetheless, in the future, the fixed price contracts enjoyed by the IPPs under today's system may well change, leading to changes in long-term financing terms that are appropriate in a more competitive market, i.e. asset-based financing.

In summary, the transition in long-term functions will, we argue, be a smooth one as existing institutions assess risk and return in a market setting of investing in new generation and transmission facilities. Even in a setting where transmission remains a regulated function, it is likely that the potential for competition between transmission and local generation will provide the correct trade-offs and investment signals. Over time, as the regulatory protection of incumbents is gradually phased out (through the reliance on
price-cap type regulatory schemes in the near term and competition in the longer term) financial instruments will develop to both finance new investments and manage new risks.

2.3.3 Medium-Term Functions and Instruments

Scheduling and implementation of system maintenance of generation, transmission and, distribution elements is the primary function that occurs on the physical system in the medium-term. In today’s integrated utility these activities roll forward on a one to two year time frame in which elements are scheduled for maintenance in a coordinated fashion such that system reliability will be maintained and that system operating costs will be minimized. The schedules themselves are, however, frequently modified when forced outages take generation or, less frequently, transmission equipment out of service thus providing both the necessity or the opportunity for moving the schedule ahead.

The medium-term paper market provides, through the forward market mechanism, the economic incentives for increasingly efficient operations. Economic incentives at both the generation and the transmission levels will drive scheduled maintenance and repairs associated with forced outages to more efficient solutions that will include, for instance, three-shift work when significant foregone income or contracted non-performance penalties would result.

As is the case of the long term, the transition from today’s integrated system to a competitive market in generation and a performance based regulatory structure in transmission should occur smoothly. Added economic incentives in operations will provide financial benefits on both the supply and demand sides with little if any losses in efficiency associated with the restructuring away from the vertically integrated utility.

2.3.4 Short-Term Functions and Instruments

Short term functions in today’s integrated system are those that occur in the time frame of a day down to the hour or possibly to 15 minutes. They include the short term load forecasting and scheduling functions and the functions associated with unit commitment and economic dispatch. In today’s utility system, this is largely the domain of the control room where operators make decisions on least cost dispatch of plants that take into consideration their physical constraints such as minimum run time and ramp rates as well as the constraints of the network that require out of merit dispatch. In addition, it is the time frame in which reserve requirements are calculated and, depending on the warning time, reserves are called.
In the complementary paper market, forward contracts are being brought forward to clear in the spot market, ex ante. The paper market requires a point in time -- ahead of actual delivery of the physical units -- at which it can be said that the transaction has been completed subject to final, ex post verification. Given the operation of the physical system, we have suggested that this market function in rolling hourly time steps. As described in Section 3, the forward market will contain the capacity to supply the contracted energy demanded at all points in time and space. The contract quantities, supply and delivery points (but not prices) are nominated in advance as part of the clearing and book keeping operation. The market handles the scheduling of individual capacity resources through the contracting mechanism. As described below, operations in the sense used in today's system, only applies to the real time balancing of the system.

The short term functions and instruments require the greatest evolution from today's utility operations. The functions of the utility or pool operator are changed from responsibility for least cost dispatch and reliability, system security and stability to responsibility only for the latter three, all of whose physical actions -- though clearly not planning and scheduling -- occur in the real-time domain. Within the short term domain a new or modified set of functions will emerge for provision of transparency in information (see below). The nomination and/or posting of transactions will occur ex ante such that the physical and financial transactions can be verified ex post and any over or under delivery/receipt be identified and dealt with in the balancing costs.

Development of a spot market for electricity is the major change in the short term domain. How much change does this actually entail? Looking to other commodities, spot markets develop both rapidly and efficiently. Examples in natural gas indicate that spot market development proceeds with a number of institutions -- exchanges -- providing information and clearing functions. The Henry Hub in Louisiana has become the point of reference for financially based gas transactions with secondary hubs located throughout North America. A potential role is seen for the Malin Substation on the Oregon California boarder as a hub for electricity in the West.

Even with today's integrated electric system we are seeing these institutions developing today with NYMEX, the Chicago Board of Trade, and the Electricity Clearinghouse to

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6 It should be carefully noted that in the vocabulary of today's utility system, hour ahead prices transmitted to larger industrial and commercial customers are referred to, inaccurately, as Real Time Prices or RTP based rates. As originally developed these were referred to as Spot Prices. See Schwepp, Caramanis, Tabors and Bohn, *Spot Pricing of Electricity*, Kluwer Academic Press, Norwood, MA, 1988. Also, Schwepp "Power Systems 2000" *IEEE Spectrum*, August 1978, and Schwepp, Tabors, Kirtley, Outhred, Pickel and Cox, "Homeostatic Utility Control" *IEEE PAS*, 1980.

7 Prices in the bilateral gas markets are generally highly transparent. In competitive bidding situations prices quoted are generally separated by less than $0.01 in transactions of $2.00 per million BTU's. This is analogous to a .1 mil differential out of 20 mil dispatch cost in an economy energy interchange characteristic of most centralized pools in the electricity market.
name only three. While immature or still in the development stage, these institutions are structured to provide the basic spot market clearing functions. The key element in participation in the forward and spot markets for each of these institutions is the financial and physical legitimacy (ability to deliver and/or pay) of the market participants. The institutions provide the mechanisms for transparency in transaction information.

2.3.5 Real-Time Functions and Instruments

Real-time functions of the electricity system, which we refer to as Network Coordination (NetCoor) rather than today’s System Control, are those that provide for system reliability, security and stability. These functions can be provided using market instruments but are unlikely to be satisfactorily managed using market forces. System reliability refers to the ability of the system to provide energy when and where demanded. The forward and spot markets will fulfill this function through contracts based on expected unit availability and forecasted load up to the final hour of delivery. Generating units are forced off unexpectedly and demands vary on a more rapid basis. Today’s system provides this balancing through two mechanisms. In the time frame in which a unit might fail or, less likely, a large demand might enter or leave the system, reliability is provided through spinning reserves; in the shorter time frame through Automatic Generation Control (AGC) functions. Today these reserves are provided for within pooling agreements and/or under NERC requirements. Some level of capacity is held “hot” and “spinning” (additional capacity on thermal plants that are on line -- the last 10 MW of a 250 MW unit, for instance). This capacity and its energy can be added to the system in a matter of a minute or two. Additional capacity is held as “fast start” with a time to synchronous operations of less than 5 minutes (gas turbine capacity, for instance). Not all of this capacity need reside on a single system as interchange agreements can provide some or all of particularly the longer time based reserves. The rule of thumb is that there needs to be sufficient spinning reserves to cover the loss of the largest unit on line at any time.

We argue that these functions can be easily maintained through a new / modified set of market instruments that can be exercised by Network Coordination. As an independent, performance based, regulated entity, Network Coordination purchases contracts for reserves -- call contracts -- with specific performance characteristics based on expected needs that provide for MW and MWh. These contracts will include megawatt as well as megawatt resources. Contracts would be called to cover unplanned outages and increased demands. The cost of operation of this aspect of Network Coordination would be covered through ex ante contracts with ex post verification -- plus a management fee -- to the responsible participants. Within a prespecified range these hourly costs could be traded off between participants before the actual transactions came due. The result of these ex post trades is the creation of a secondary market in capacity and/or energy.
directly analogous to the market that has emerged in natural gas with a longer clearing time.

The second function to be fulfilled by Network Coordination even closer to real-time is that of maintaining system frequency. In today’s system, frequency is maintained by Automatic Generation Control devices that are installed and operating on many, but not all, generating units. While the physics are more complex, these devices are best thought of as monitors that automatically sense deviations away from nominal 60 Hz frequency. When frequency is low, additional primary energy (steam) is introduced into the unit thus providing more rotating energy in the system. When frequency is high the reverse is true. Both the AGC device and its operation have a cost to the generating unit owner/operator. This function is readily provided through long-term contracting between the unit owner and Network Coordination, which would provide contractual incentives for system efficiency.8

Two final functions must be fulfilled by Network Coordination for stability and security to be maintained. The first is the requirement for VAR support (seconds to minutes) and the second the need to respond to rapid changes in system configuration that will induce transience -- i.e. manage transience such that the system automatically returns to acceptable operating conditions rather than becoming unstable (in a time frame of cycles to seconds). VAR support today is provided by generators capable of “lagging or leading” in phase angle of generation, through capacitor banks or through static VAR compensation or so called “FACTS” devices, (Flexible AC Transmission Systems). This capability provides the trade-off between real and reactive (VAR) generation at any unit. As with AGC, this function has a capacity cost -- the capability -- and an operating cost that needs to be contracted for, usually as a call contract.9 VAR contracts will be long term with performance based on monitored unit output -- parallel to that employed today.

Transient stability issues are probably the most complex to solve in the transition from today’s market to one in which the market is dominated by bilateral transactions rather than central control. At one level it is possible to argue that today’s handling of transients phenomena will be directly transferable to a competitive market. The time domain is so short that all operating rules and knowledge must be captured in automatic control signals that are embedded in computer algorithms. Transients are handled automatically and will,

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8 Starting in October of 1994 the National Grid Company of the UK advertised in the London Financial Times (October 13, 1994) for “Frequency Control Services” and “Reserve and Constraint Services” in advertisements headlined “Have you got the power to make money?” Their bid is to purchase on either the supply or the demand side services that will respond rapidly to frequency change or services that can respond to needs for system reserves or constraints. Both services were called to bid by December 2, 1994.

9 It should be noted that contracting for VARs was one of the earliest modifications introduced into the UK Pooling system.
of necessity, continue to be. Today’s rules assume, however, a very full knowledge of the condition of the system based on positive information about generation and demand, which is currently telemetered to systems control. While this is clearly not a problem that will stop or even slow a transition, there are two interrelated questions to be addressed.

The first question is whether network coordination can operate from monitored data on the system rather than monitored data at the unit. If the answer is yes, then the information required for transient stability can be generated and delivered to network coordination without requiring intrusive knowledge about unit operations. If the answer is no, it will be necessary to develop new algorithms and logics by which to provide this coordination.

The second question is whether Network Coordination can maintain stability with control over only a small number of units (megawatts) and load reduction (negawatts) or whether the current control logics require positive control on all units. If the answer is that limited resources are all that is required, then access for control for transient stability can be contracted for in the same manner as other coordination services. If this is not the case, then a regulatory ruling will be necessary that provides unit control capability on all resources for this function only.

The final issue in terms of the real-time domain is how the services of Network Coordination would be paid for. As discussed under reserves above, some services required by the system are directly attributable to individual participants in the system. This is specifically true of both shortfalls in supply or excesses in demand relative to contracted levels. Network Coordination can attribute and bill for these services given known contracted capabilities. The balancing and bookkeeping can occur ex post as part of an established accounting routine as occurs with the “uplift” function of the UK Poolings and Settlements. The other functions to be fulfilled in real-time by Network Coordination are truly systems based and not attributable. These functions need be paid for by, in essence, a performance-based contract between the users of the system (end consumers) and Network Coordination. As a regulated entity, Network Coordination will perform as close to a competitive entity as possible if its earnings are a function of the difference between a price cap and its costs. This drives its costs of operating the system to a minimum for provision of a predefined and regulated level of service.

2.3.6 The bilateral model (NetCoor) versus a pool-based model (PoolCo) of electricity industry restructuring

10 Note that the ex post balancing function in the UK does not differentiate between sources of problems and spreads these costs evenly to all consumers.
In broad terms, restructuring based on horizontal industry unbundling with bilateral transactions ("NetCoor") and restructuring based on horizontal industry unbundling with a compulsory common pool (the "UK model" or "PoolCo") are the two main alternatives to the current vertically integrated industry structure. In the table below we have summarized the operating and economic consequences by time frame associated with each of these institutional structures, in contrast with the current structure.

Even though it may be possible for individual consumers at the wholesale and retail levels to "shop around" for their power supplies in the UK PoolCo model, this competition only creates incentives for individual distribution companies to operate efficiently, and does not apply any pressure for upstream efficiency improvements. For example, in the UK to this date, the costs of system losses are simply passed through to customers!

It is important to note that the scope for increased efficiency through intermediation in a UK PoolCo model is very limited. This, in itself, speaks to the fact that a highly structured PoolCo-type model is not a significant advance over the current regulated industry model, and could well create as many problems as it solves by imposing rules *ex ante* (which are difficult to change *ex post*) to control a new industry which nobody yet fully understands.
<table>
<thead>
<tr>
<th>Overall System Efficiency (see figure 6)</th>
<th>Current Regulated G&amp; T System</th>
<th>UK PoolCo with Independent Generation</th>
<th>Bilateral Contracting with NetCoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Term</td>
<td>Forecast uncertainty borne by all; excess capacity costs or shortfalls allocated in political process.</td>
<td>No potential for each buyer to seek own supply. Hedging of risk through contracts-for-differences possible.</td>
<td>Each buyer seeks own supply and reliability of supply, facilitated by intermediaries</td>
</tr>
<tr>
<td>Short Term</td>
<td>Scheduling handled internally (unit commitment).</td>
<td>Supply is provided through the pool, little potential for each buyer to seek own supply. Centrally administered spot market. Difficult to reflect cost of reliability accurately.</td>
<td>Spot market clears between parties. Gas market indicates this can be as close as that achieved by central control. Cost of reliability is accurately reflected in bilateral transaction terms.</td>
</tr>
<tr>
<td>Real Time</td>
<td>Internal response (security and stability).</td>
<td>Institutional control through PoolCo.</td>
<td>Contracted controls available through NetCoor.</td>
</tr>
<tr>
<td>Example</td>
<td>Most of US Electric Power Sector.</td>
<td>UK privatized power system and NEPOOL at the wholesale level.</td>
<td>WSPP at wholesale level.</td>
</tr>
<tr>
<td>Ability to respond to change</td>
<td>Highly limited</td>
<td>Determined by the regulatory process that establishes PoolCo. In practice highly limited due to winners/losers problem.</td>
<td>Adaptive with limits set in the regulatory process.</td>
</tr>
</tbody>
</table>

Table 1: Comparison of Alternative Structures
3. Key Issues Associated with the Transition to an Unbundled Industry

In our introductory section, we raised several key issues which need to be addressed in the transition to an new unbundled electric supply industry structure for the US. Here, we return to these issues and discuss in turn how we see these issues being addressed in the new industry structure.11

3.1 How can reliable supply be ensured?

As we noted above, reliability of supply has been a primary issue in the ongoing debate on restructuring the US electric power industry. This issue is best addressed in two stages:

- Do customers in the industry have a mechanism to communicate their preferences for reliability through responses to reliability-differentiated pricing menus, time-varying prices and other means?

- Does the industry have the capability to respond to these expressed preferences?

In the current structure of the industry, the answer to the first question for the vast majority of customers is no. Prices are, for the most part, independent of service reliability and time, even though the cost of providing the service varies considerably with these factors. Hence, prices do not currently reflect costs. While many utilities have used real time, time-of-day or reliability-differentiated pricing schemes, these have for the most part been confined to a small group of industrial consumers.

As a consequence, the resource planning process in the electric power industry has been divorced from customer preferences for quality of service. The long-standing practice of setting reliability levels on various engineering criteria continues. While this has certainly resulted in a very high level of service reliability, it has also resulted in high costs due to underutilized capacity which may often exceed the value that customers receive from it. In other words, setting reliability based only on engineering standards without concern to both its cost and value is a luxury we no longer want nor can afford. Competition will

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11 A comparative evaluation of the process of transition from regulated to market based industries may be found in Timothy P. Gardner and Lawrence D. Gilson "Predictable Patterns: Navigating the Continuum from Protected Monopoly to Market Competition". Venture Associates. Arthur Anderson. December, 1993.
bring to customers the level of reliability that their production, service needs or lifestyle require.

Our contention is that an unbundled demand-oriented industry would be much better placed to understand the reliability preferences of a diverse customer base and respond to these preferences through a wide variety of service options. Prices to individual customers in such a setting will more correctly reflect the level of reliability they receive. Spot pricing and interruptible service schemes will work as they are supposed to. If people want uninterrupted service at times when this is very expensive to provide, they will have to pay for it.

Some of the arguments against unbundling have implied that unbundling would reduce the capability of the industry to respond to extreme situations which stretch the industry's resources. There is very little evidence of this in other industries, such as road and air transportation, telecommunication or natural gas. Indeed, when the North East experienced extreme winter weather conditions in February 1994, natural gas delivery in the region continued without disruption, whereas many extensive disruptions of electric power supply were experienced, shutting down Washington DC and other urban centers in the region.

The UK experience with restructuring its electric power industry provides significant insight into how unbundled generation would ensure reliable supply. In the UK, provision of generation capacity spanning the entire long-term to real-time spectrum is entirely decentralized and market-driven. The British electricity market pays generators for both capacity and energy, with the level of these payments varying (through market clearing) with the level of reserve capacity in the system. If a generator decides to drop out, payments to the remaining generators increase, resulting in (a) increased prices, thereby dampening demand; and (b) greater incentives for other generators to increase their supply. This market-equilibrating mechanism has very effectively taken the place of centralized planning and control, and has already resulted in the replacement of inefficient oil and coal-fired stations by new gas-fired plants.

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12 Currently, these schemes are widely perceived as means of providing hidden discounts to retain large customers (e.g. interruptible customers that are never interrupt) rather than as schemes that enhance supply-side efficiency. For a discussion, see Michael Crew and Chitru Fernando, "Implementing Priority Service: Some Theoretical and Practical Issues", forthcoming in the book series Topics in Regulatory Economics and Policy edited by Michael Crew (1994).
3.2 Centralized versus decentralized control, dispatch and transactions?

Closely related to issues of reliability and how to best provide it is the question of who instructs generators to start and stop operations, and how much to produce. In the past, the industry has been comfortable with centralized controllers dispatching pools of generation according to a merit order. The premise that centralized control and dispatch is essential for ensuring reliable and efficient (merit-order) operations has been widely prevalent in the industry.

As the industry begins its transition to a more unbundled and market-oriented structure, this premise has been widely questioned since it is antithetical to an otherwise decentralized operation. As we have argued above, it is reasonable to assert at least from a theoretical standpoint that markets can assure, through the actions of self-interested parties, efficient merit-order operations and customer-sensitive reliability levels. If generators are not called in order of merit, overall costs will increase above least-cost levels, resulting in an opportunity for a market participant to exploit. Indeed, much of the pressure for change to the current industry structure is coming from those who could benefit by seeking out such lower-cost opportunities.

In practice, however, the provision of low-cost reliable power supply by decentralized markets may be obscured by information barriers, capacity lumpiness and anti-competitive behavior. However, the use of an old solution in the form of administered mandated pools will not cure these problems. As noted in the previous section, we place greater reliance on active market intermediaries to alleviate some of these problems. These intermediaries would be active in both the physical and the financial markets, clearing markets, transforming service characteristics and providing risk management and other financial services. Where it is beneficial to do so, they would be free to operate cooperatively through power market cooperatives or strategic alliances, where such alliances promote system integrity and efficient operation through economies of scale or information sharing. In other situations, intermediaries may choose to operate alone.

We believe that the functions traditionally attributed to a pool can be realized through a combination of straight market functions and through the development of the NetCoor, or Network Coordination functions. As is the case in natural gas, it is argued above that the NetCoor would have the ability through market contracts to balance all normal operating variability. Emergency conditions will, on occasion, occur through severe weather or other extremes. Under these conditions, again as has been shown to be true in the gas industry, the NetCoor could call on individual generators to supply emergency power or energy. It is clear that it is to no player's advantage to have the system collapse as all make money through transactions that are completed between supplier and buyer.
Penalties for failure to perform have proven to be powerful incentives to maintain reliable performance.

3.3 What criteria for transmission regulation and pricing?

Open access to the electricity transmission networks that criss-cross the country is an essential prerequisite to the operation of a competitive unbundled market in electric power. While EPAct encouraged the opening of access to transmission through mandated wholesale wheeling, several issues surrounding the price regulation of transmission services remain. These need to be resolved before transmission can become fully established as the cornerstone of a competitive electric power market in the US.

As we see it, the key issues in pricing transmission to enable effective competition are the following:

- Transparency of prices (unbundled transmission service)
- Non-discriminatory access and pricing (comparability between native load and third parties)
- Efficiency of operation that is reflective of the cost of operations

The right of access to a utility’s transmission network by a third-party generator or distributor provides value to such a generator or distributor, due to the opportunity this provides for each, respectively, to sell at a higher price or purchase at a lower price than would otherwise be possible. In an unrestricted marketplace, this value would provide the basis for pricing the service. If the differential between the resulting price and the corresponding cost was excessive, it would normally be eliminated through competition or regulation. Under competition, and assuming that economies of scale are exhausted, prices would be driven down to marginal cost levels. This is a state which regulation would attempt (imperfectly) to emulate. Even under economies of scale, as might be argued to obtain in transmission, marginal cost together with appropriate demand charges to collect fixed costs, serves as the efficient and equitable basis for price differentiation across consumers. In particular, transmission constraints at certain points in the system will be reflected by higher marginal costs of serving those points. So too will time-of-day differentiation of transmission prices reflect the differing marginal costs of serving particular demand points with transmission services as a function of the pattern of supplies and demands on the system at various points of time. Masking these marginal cost differences by uniform (postage stamp) rates, even if differentiated between firm and non-
capacities can then be traded with the assurance that when they are called on, they can be delivered with a high degree of reliability. As long as the property rights for these firm allocations are clear, they can be traded in a competitive market.

Following our scenario further, interruptible or non-firm service offerings will also be offered competitively, and from two sources: first through longer-term contractual agreements by companies which have firm transmission and/or generation capacity which they wish to offer on non-firm terms (e.g., by pooling non-coincident demands in an efficient manner); second through medium-term and short-term spot markets which will act further to price the value of interruptible capacity at various points and various times along the transmission grid. In the resulting competitive market among market intermediaries, generators and transmission companies, the combination of long-term bilateral contracting markets and shorter term contracting and spot markets will act interdependently to provide appropriate price-cost-value links between suppliers and customers.

This scenario requires a cooperative organizational compact or regulatory structure (e.g., a Regional Transmission Group) to determine rated system paths and to act as an information or market coordination point for property rights for these paths. For these reasons and to assue continuing stable evolution toward a fully competitive market in transmission services, some form of regulation will be required to provide transmission companies with the incentives for efficient operation and investment. In this regard, requirements for low regulatory transactions costs, high transparency of the pricing structures, and flexibility to compete all argue for a regulatory structure which is performance or price-cap based rather than rate-of-return based. Price-cap regulation provides incentives both for operating cost minimization as well as for growing revenues through development of customer-responsive services.

3.4 Can loop-flow problems in transmission be satisfactorily addressed in an unbundled industry?

One of the issues that is perceived and described by many within in the utility industry as the reason that open access will be difficult and tight central control will continue to be a necessity is the phenomenon of loop flows or parallel paths that occur within tightly integrated electric power transmission networks. These flows are a function of the physics of the system -- specifically the resistance and impedance of individual components.

Production Costing: A Key to Pricing Transmission Access", Public Utilities Fortnightly, February 1, 1993, pp. 52-55.
relative to the amount of power flowing on the system. It is frequently argued that the phenomena of loop flows blocks our ability to describe the path(s) over which a transaction will flow and thereby blocks our ability to cost and price transactions as they occur on the transmission network.

Loop flow or parallel path flows occur within electrical transmission networks as a function of the amount of energy being transmitted in the network, the location of the injections (generation) and the withdrawals (demand). In a network that does not contain phase shifting devices these flows are entirely a function of Kirchhoff's law in physics which state, simply, that energy will flow over the path of least resistance. The implication is that for any specific contract between generator and buyer the "flow" of electrons may follow any (or all) of a number of paths through the network. The concept of a "contract path" exists, not as a physical reality but only as a point of convenience in contracting.

3.4.1 Why Loop Flows Are an Issue: Identification of Rights and Costs

Under the circumstances in which the transmission network is only lightly loaded and therefore not constrained, it is relatively simple to state the path over which power will flow -- that of least resistance, or shortest electrical distance. Under these circumstances there are no loop flows. As increasing quantities of energy are injected and withdrawn from a network, our ability to define paths becomes increasingly difficult. Power flows on parallel paths, still as a function of Kirchhoff's laws but with higher costs to the flows since losses due to transmission increase with increases in flow. Losses must be made up from increased generation. As the system begins to reach its limits i.e. be constrained because of either voltage or current limitations, the costs of transmission increase even more dramatically as it is necessary for generation to be "redistributed" to operate closer to the loads thus increasing higher cost generation when lower economic cost generation is available but the network can not carry it securely. The progression of increased costs leads to interruptions in loads and emergency purchases (megawatts or negawatts) before the network reaches its physical limits. Figure 5 provides a graphical representation of the costs associated with increased flows in a transmission network. These changes in cost occur both in time and space as transmission conditions change. The question of whose

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16 For a discussion of transmission systems operations see that provides increased detail as it applies to the evaluation of costs see Schweppe, Caramanis, Tabors and Bohn Spot Pricing of Electricity (Boston, Kluwer Academic Press, 1988) and/or Caramanis and Tabors November, 1993, response to FERC 93-19-000 "Inquiry Concerning the Commission's Pricing Policy for Transmission Services Provided by Public Utilities Under the Federal Power Act", June 30, 1993.
lines power is flowing on and how costs can be recovered is basic to the operation of a transparent pricing system for transmission.

![Diagram of SRMC $/MWh vs System Network Loading]

**Figure 6: Costs of Transmission**

There are two critical issues associated with the loop flow problem:

Can transmission rights be identified?

Can transmission costs be identified?

These issues are, at a first level, separable. They have distinct geographic differences within the US as a function of the topology of the transmission system.

**3.4.2 Transmission Rights**

**The West**

In the WSCC, as already described, rights to use of the backbone transmission system are well defined and the ability to update those rights are well established. The initial
establishment of the Western Regional Transmission Agreement (WRTA) is based in part on these existing transmission relationships, and on the long standing working relations of the utilities involved which have established accepted rules.\textsuperscript{17}

At the WSICC level, the ground work is in place for present and future allocation of transmission rights. Given a transaction between a buyer and a seller, there now exist accepted practices for determining the ability of the system to carry the transaction as a function of points of entry and exit and the timing of the transaction. While this is still based on expected typical transmission conditions the fact of the existence of procedures for allocation of rights provides both a logical and an implementable point of departure.

The Rest

The majority of the remainder of the US has transmission facilities that are highly intermingled\textsuperscript{18}. At the most extreme, in New England and New York as well as portions of the PJM pool, lines and substations are either jointly owned (percentage basis) or even split owned (e.g., the first 10 miles as opposed to the last 12 miles of a line). At the other extreme, all of the transmission facilities in Georgia are jointly owned with equal rights of access by all of the major players in the state which includes an IOU (Georgia Power), a Regional wholesaler (Oglethorpe Power Co.) and a group of municipals (Municipal Electric Association of Georgia). Both the NEPOOL region and the PJM pool region represent the most difficult areas in the US in which to define ownership rights. The linkages were intended to be tight and overlapping. These systems have succeeded in being effectively integrated with, in New England, central dispatch of all units.

Dealing with the ownership question is not intractable, however, and independent of all other issues it will need to be solved. While there is no electrically or economically correct answer to the question of how to allocate ownership and with it rights, there have been a number of proposals placed on the table. These have ranged from creation of a stock company that owns all of the assets of the regional grid, to separating the elements of the grid by current companies' investments and geographic inputs\textsuperscript{19}. While we can (and

\textsuperscript{17} In October 1994 the FERC approved the WRTA subject to the establishment of a joint planning procedure and the establishment of comparable (within each utility) tariffs for users of the transmission network.

\textsuperscript{18} It is important to note that the issue is ownership not access. Access to the grid in New England and New York is very easy -- it is a right associated with membership in NEPOOL or NYPP.

\textsuperscript{19} David Moskowitz and Douglas Foy ("Looking for Peace in the Middle of a Nervous Breakdown", Electricity Journal, November 1994, pp. 22-33) have proposed a series of actions which would provide for sale of the transmission assets to an independent entity at close to replacement value as one means of recovering some of the stranded asset value of the utilities. Their proposal also includes a significant
have\(^{20}\) argued in favor of a specific approach, the point that is clear is that the allocation of the ownership rights is largely independent of the question of cost and price. Ownership significantly influences the complexity of the pricing system and the number of steps or layers that may be required in developing a transparent pricing scheme for transactions in specific subregions.

3.4.3 Summary

The issue of transmission rights is one that has, for many years, been subject to operating rules in the WSCC, region. Based on the logic and the topology of the system, this situation is likely to hold well into the future. The solution to the ownership rights problem in the rest of the country is a step that will and is being taken in each of the existing pool regions. The manner in which the allocation of ownership takes place will, as is argued in the section below, affect with whom transactions are negotiated and the relative complexity, of any bilateral transaction, but given FERC's current position, they should not affect either the method of calculation of cost or the price posted for transmission service. As is discussed in Chapter 4, this is in large part because Network Coordination is not necessarily the same as transmission and transmission ownership rights, per se need not play any part in the contract costs associated with the coordination function. Further, it is the reason that the NetCoor structure as proposed functions effectively -- it can provide the payments needed to reimburse individual owners for loop flow.

\(^{20}\) See Tabors and Caramanis response to FERC NOPR 93-19.
4. Achieving the Transition

4.1 Overview: Principles not Rules

Defining what can be the outcome of the process of unbundling and restructuring of the US electric power system represents the critical first step in an iterative process toward implementation of restructuring. In sections 2 and 3 we discussed how the unbundled industry might operate from a physical and functional standpoint, and how the critical issues associated with unbundling can be addressed within the structure that we have proposed.

In this section we discuss some principles that can be guides to the transition of the industry. These may be summarized as follows:

- Allow the market and market instruments to evolve over time. The setting of firm rules only provides opportunities for anti-competitive behavior on the part of existing players and the stifling of the introduction of new tools and instruments which experience in other related industries has show us emerge when markets are allowed to evolve.

- Begin the process with the separation of the functions of generation, transmission and distribution of today’s vertically integrated IOUs. Separating generation -- an inherently competitive component of the industry -- from transmission and distribution provides the critical first step in establishment of the market for electricity. Ancillary services represent a market that can be developed over time. Even in the UK, these services were seen as critical to provide but not necessary through a full market in the first stage. Again, provision of ancillary services as part of an evolutionary process offers a means both of learning which financial instruments are the most effective under particular conditions and of reducing the initial risks perceived to be present in the early phases of industry restructuring.

- Identify and separate those issues that are inherent in the transition from those of competitive equilibrium. We argue in this document that there are inherently different issues associated with the operation of the stable market and those associated with the transition from the today’s structure to that market. Separating the transition from the issues of stability will allow for the development of institutions that are needed by the stable market, while continuing to maintain the institutions -- the regulatory control -- necessary to move from where we are to where we want to be.
• Use regulation as a stop-gap until full competition arrives. Regulation can be a critical part of the evolution but should be neither the driver nor the brake. To achieve the potential, regulators will need to provide the environment that will allow for equal access to the physical system, i.e. guarantee equal access to the paper / financial market structure and assure that information is transparent and readily available to all players.

4.2 The Institutional Challenges

4.2.1 Overview of the issues

There are a series of institutional challenges that need to be met in the transition. The most difficult of these challenges is the need to restructure the implicit agreement between the existing utility and consumers of electricity -- the so called “regulatory compact”. These challenges fall into three broad areas:

• Moving current utilities into a competitive environment;

• Dealing with stranded investment both in capital and contracts;

• Minimizing the losses and sharing the pain between stockholders and ratepayers.

We argue that addressing and dealing with each of these issues is necessary to the final restructuring of the electric industry. As discussed below, the issues are separable, though interrelated; but are best handled independently. Each can be handled as part of an evolutionary process. None represent processes that are “show stoppers” in either the very short or long-run, i.e. contracting activities could begin nearly immediately and proceed along with the physical and financial restructuring of the existing system provided

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21 This has been guaranteed by both the 1992 EPAct and by the recent FERC rulings related to AEP and required to gain approvals for mergers (e.g. Central and South West / El Paso merger) and to gain certification as an electric power marketer (Heartland) as well as FERC’s most recent ruling on Comparability as stated in its response to both WRTA and SWRTA applications as Regional Transmission Groups (October 26, 1994). This principle is now referred to as the “Golden Rule of Transmission”, or “do unto others as you do unto yourself”.

36
there is sufficient oversight to guarantee market power is not exercised by the existing utility participants.

During the transition there will be a role for regulation in balancing of the forces for market development with the potential for the abuse of market power that potentially could be employed by current players. While the key themes are clear, one of the issues that we feel does require additional discussion is the role of the regulator in promoting the transition. Two points appear to be particularly critical to achieving the transition:

- The importance of performance-based regulation (for example, price caps) as a regulatory framework congenial to competition.
- The importance of information regulation. The idea is not just that prices and services are unbundled, but that the information on these is transparent and readily available.

These issues are critical to the process of the transition and will be covered in the sections which follow.

4.2.2 Moving Electric Utilities into the Competitive Market

There are two actions needed to move existing utilities into a competitive market. The first of these is the need to restructure the utilities themselves into units that can operate in a competitive environment. This is critical in both generation and distribution. The second is to modify the regulatory process such that incentives are provided for efficient operations of transmission and provision of network coordination in a manner that can mimic the market-based responses.

Separation of Functions

The current vertically integrated utility structure was established to provide least cost service at a time when economies of scale in generation and transmission argued for a single provider. “Real-time” operational considerations combined with vertical ownership provided the assumed rationale for highly centralized control. Both assumptions have been demonstrated to be no longer valid through the experience in generation in the US and in the operation of the power system in the UK.\(^{22}\)

\(^{22}\) The financial success of NUGs, which compete directly with utility owned facilities, demonstrates the first point and major innovations in both communications and computation currently implemented for
There appears to be a growing consensus that the process of industry restructuring must separate the functions of generation, transmission (and network coordination) and distribution. This separation can be accomplished through “Chinese walls” separating the operations and management teams of the individual components or through their direct organizational and financial separation, but it is hard to justify holding the companies together institutionally while separating them in management and finance. There are too many potential benefits in corporate freedom to be gained from full separation. Generation assets which are largely geographically limited in today’s system are likely to be, for instance, more efficiently operated and managed when allocated by technology -- large coal, intermediate oil, gas turbine combined cycle, etc. By the same token, one company might choose to operate urban or suburban distribution systems because it was better able to contract for supplies and manage distribution O&M services in these areas than a more heterogeneous geographic region.

Transmission and network coordination fulfill a different role that again argues for these functions to be separate from either generation or distribution. Network coordination provides the common functions needed to maintain system balance. These functions require disinterest in either generation or distribution and require, at present at least, direct regulatory oversight. Because these functions are highly interrelated, they can be implemented within the same institutional structure.

The separation can occur over time or very quickly, with existing utility functions being established initially as independent functions under a common corporate structure and, over time, spun off in separate corporate identities. In the US economy such actions are routine. In energy, Northeast Utilities spun off Yankee Energy in 1989 with new stock issued and distributed to all existing owners. In much the same process, Union Carbide shed their industrial gas activities operating under the name Linde to a new independent corporation, PraxAir -- a routine process in today’s markets.

Redirect the Incentives

Under today’s regulatory structure, utilities operate against a societal objective of minimization of total cost. For investor-owned utilities (IOUs), however, financial success
is a function of regulated rate of return on non-depreciated capital. While the effect has never been convincingly proven, the argument of Averch-Johnson is that this form of regulation provides incentive for over building and “gold plating” of capital systems thus favoring capital investment over improvements in operating efficiency.  

In the process of restructuring it is desirable to move even the regulated components of the system closer to market incentives in which there are both risks and rewards associated with ownership and operation of system components. Performance-based regulation (e.g. price cap regulation) is being increasingly accepted as a means of encouraging efficient operations of regulated industries and, it is argued, is a critical element in providing incentives that encourage efficient trade-offs between operating costs and capital investment by regulated elements of the industry such as transmission, network coordination and distribution. 

As with the arguments surrounding the separation of utility functions, development of more market-based incentive systems in the regulated portion of the industry can, and in all likelihood will, continue at a pace independent of the overall restructuring of the industry. It is important for efficient operation of the restructured industry and may slow, but not stop the process.

4.2.3 Stranded Investment

Easily the most hotly debated issue in the restructuring debate is that of stranded investment and the likely handling of the costs associated with it. The objective of this section is to identify and classify/separate what can or will be stranded both in terms of capital assets and in terms of contracts. It is critical to note that the existing electric utilities are not the only participants even in today’s market that are subject to having investment stranded. Non-utility generators with high cost plant subject to fixed term contracts face a financial cliff when their contracts come for renegotiation, potentially leaving them with non-productive assets. The same is true for providers of interruptible power or other forms of load reduction. In these cases if there were investments made for

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25 The UK has instituted and implemented price cap regulation also referred to as performance based regulation or, in the UK, RPI-x. This regulatory structure is a part of the process of privatization of telecommunications, natural gas, water and electricity. The recent ruling in favor of performance based regulation at San Diego Gas and Electric (see Electricity Daily August 5, 1994) represents the identical approach.
response, and the cost of supply exceeds the market price, these investments will be stranded. Utility investment remains, however, the largest pool to be dealt with.

4.2.4 What is being Stranded?

Existing Capital

Stranded investment in the electric utility sector is generally considered a capital amortization issue. When capital investments were made in anticipation of rapid demand growth that did not materialize, these investments can not be paid off as quickly as anticipated. In a restructured industry these investments would be stranded, i.e. in the absence of regulated returns, they will not earn back their costs. In the same manner, capital investments made in technologies which showed high promise when the investment was made but whose promise has waned -- nuclear technologies, for instances are also likely to be stranded. Capital investments made in non-generating technologies that have not achieved their expected return are still a third issue. In each of these cases the utility is carrying on its books investments which will not be recoverable at market prices.

These capital investments are not, however, useless, nor are they (or necessarily any other facility) going to be mothballed as “stranded”. Stranded investment in the electric utility industry will be approached as in any other industry. Independent of the capital cost of the technology, the economically rational decision as to which plant to operate is the one with the lowest marginal cost. This could mean that the most valuable operating asset in the new competitive market will be the plant that represented the poorest capital investment. The investment is made -- sunk -- the question is now one of operating the existing capital stock as efficiently as possible.

From the perspective of the utility industry, the issue of stranded investment will be one of identifying the amount of investment (in total) that has been made that can not be expected to be earned back in a reasonable amount of time by sales of energy and capacity in a competitive market. A competitive market will drive the commodity value to the marginal cost forcing the owner of the facility to earn back its capital costs as the difference between any unit’s or the total system’s average operating cost and the system’s marginal cost. The amount stranded is the difference between the capital required to pay for the facilities and the amount earned above marginal operating costs.

It is quickly seen that some facilities will have a high earning value (independent of their costs), others will have a low earning value even if they are fully depreciated. If the assets are being sold in the market they will bring a price that is based upon their value in the market, not their cost to the original buyer. Additionally, the impact of stranded
investment will differ between utilities -- many may have little or no stranded investment by virtue of low operating costs or other factors while others will have a significant amount.

The electric utilities are not the only ones who will find some or all of their assets stranded. Non-utility generators whose economic position is justified only in terms of a regulated "avoided costs", such as California's Standard Offer #4, will face the same issue of value and cost when they reach the end of the initial fixed price term in their contract -- assuming that the contracts are held in place to their maturity. This includes, for instance, many waste-fired and biomass projects but does not include most fossil fired units.

Others who will find capital investment stranded include Energy Service Companies (ESCO's), firms whose income is again tied to the current "avoided cost" of existing utilities. If and when these contracts are renegotiated, they will be referent to the value of market based electricity rather than regulated electricity -- a difference likely to change the value of the ESCO's service to their clients.

Existing Contracts

The second category of stranded asset will exist in contracts for power supply. At present, there are a breadth of contracts at the wholesale level that are priced at levels well in excess of what are likely to be market prices. Many of these contracts have come into existence because municipal or cooperative utilities have been requirements customers of a single IOU or other state or federal utility. The contracts have been set for long periods of time -- in excess of 10 years in many cases -- and have been based on expectation of regulated rates. The change in the market will provide here, as it did in the opening up of the gas market, a significant number of stranded contracts -- contracts whose buyer will try very hard to invalidate. The process of renegotiation of the contracts will, in all likelihood, lead to a reduction in the value of the contract and its earnings to the supplying utility if the supplier is even able to keep them as customers.

As described in the paragraphs above, the same issue will arise with NUG contracts. These will be renegotiated at market rates or under regulatory supervision. When this occurs, the contracts will be pulled toward today's lower market levels.

One of the most interesting questions as yet to be addressed is the likely outcome of international contracts, those specifically with Canadian utilities. For the past decade these contracts have been moving rapidly toward favoring the selling utility in terms of "avoided cost" type of pricing. With increased market pricing within the US, it is likely that pressure will be brought to bear on the international contracts as well. It is difficult to
know what impact federal and/or state regulation may have on the structure and cost of these contracts in the transition to a full market structure.

4.3 Sharing the Pain

The question which arises in the electric industry in the same manner in which it arose in the gas industry and in telecommunications is “who will bear the costs?” There are basically three answers to the question; stockholders, ratepayers and increased efficiency through advances in technology that provide high value (relative to cost) services.

Stockholders: Stockholders have been protected from much of the market risk through the regulatory process. In recent years they have, however, been subject to disallowance on investments judged by the regulatory process to have been imprudent. While there are arguments in favor of stockholder losses, it is unlikely that the financial markets will tolerate stockholders being held hostage to the process of restructuring.

Ratepayers: Ratepayers have been paying the bill for utility investments for decades, it is argued. The process of restructuring in the US, as was the case in the UK, is based in large part on the ability of the ratepayer to see lower costs and greater flexibility and options in supply. This means that the ultimate beneficiary should be the ratepayer and therefore, this group should bear part -- though not all-- of the pain of the transition. We learned in the restructuring of natural gas in the US that it is possible to share the pain between ratepayers and stockholders.26

Advances in productivity and technology: An area that is often overlooked in the debate over who will bear the cost of stranded investment is the fact that there is, we would argue, significant room for increased productivity on the part of the IOUs and larger federal state and municipal utilities. This increased productivity means that net revenues can increase (to pay for stranded assets) even if total revenues are flat or declining.

Experience in the UK has shown that with market incentives there has been marked improvement in labor productivity in generation and in transmission and distribution. This increase in productivity can arise from a number of sources, most notably market incentives to have generation facilities on line at times of high spot prices, as in the case of the UK. In the US these same forces for increased productivity have been noted in nearly

26 A notion which has been discussed in several states is to give the IOU a “trade”. The IOU temporarily gets more pricing flexibility and protection from retail wheeling. In return, the IOU accepts price cap regulation with a larger X factor and a reasonable ceiling on ROI, and agrees to write off uneconomic plant (stranded investment) at a certain rate over the transition period (say over 5 years, the normal period for a price-cap review in the UK).
all of the industries that have gone through the process of restructuring. Whether labeled as “cost cutting” or incentive based operations, the impact has been the same; fewer employees to accomplish the same tasks with higher levels of responsibility and reliability. Decreases in operating costs have left additional revenues to cover stranded investment costs.

The second area that is often overlooked is the potential for increased revenue resulting from new services made possible by advances in technology. The telephone industry has benefited dramatically from new services that have been made possible by rapid growth in local digital switching technology. New switching technologies have made possible “call waiting” services that are attractively priced for the consumer and have virtually no incremental cost to the supplier. This has greatly assisted in paying for the replacement of outdated analog switching equipment (stranded investment in the break-up) with digital equipment. In much the same way, central digital answering services are replacing the line by line tape driven answering machine. They are more reliable and more cost effective for the customer and are another example of increases in flexibility and productivity brought about by new technologies in a competitive telecommunications industry. It is argued that with increased competition and avenues for technologic development, new end use technologies and control technologies will emerge in the electric supply industry as well.

It has not been our objective to answer the question of how stranded investment should be handled, but rather to point out that there are a set of issues on how it is defined and a further set on how the cost can be spread among the players. It will clearly be up to the individual State Regulatory Commissions to strike the appropriate bargain between the speed of introduction of competition and the stranded investment issue.
5. Assessing the Impacts and Overall Benefits

"The permanent social welfare gains potentially available from a transition to a fully competitive electricity market dwarf even the highest estimates of the one-time costs of the transition. A post transition electricity market has the potential to perform at least as efficiently as the post transition gas market."^{27}

The objective of this section is to identify the benefits that are likely to be generated through the implementation of an efficient market for electricity. It is an effort to present a range of values generated in a logical fashion. It is critical to note that the benefit calculations represent a "back of the envelope" approach and should be interpreted accordingly. Our effort is to provide a starting point for the discussion not to provide the definitive answer.

The benefits that accrue come from three principal sources, improvements in efficiency of operations, improvements in efficiency of capital utilization, and improvements in the decision making associated with capital investment. The market will ensure that everyone who operates efficiently stands to be a winner in the long run. At the same time, the discipline of competition will ensure that inefficient providers, whether they are current incumbents or not, will lose out.

5.1 Assessment of Net Benefits

The traditional net benefit measure used in economics (since Willig's classic article rehabilitated it) is^{28}:

\[ \text{NET BENEFITS} = \]

\[ \text{Consumer Surplus} + \text{Producer Surplus} \]

\[ (\text{Total Revenue - Total Costs}) \]


Taking each of these terms individually:

5.1.1 Consumer Surplus

Consumer surplus represents the value to consumers from reduction in prices and improvement in services available within the competitive market relative to the present offerings. In terms of costs and prices, we can see clearly in today’s wholesale market the pressures on price reduction being introduced both by the technology shifts that have brought the gas turbine combined cycle technology into the forefront (cost reduction) as well as in the downward pressure on prices brought about by intense competition to sell the excess capacity available in the wholesale market.

Taking the evidence that we have from the wholesale electricity market, in early 1994 the transaction price for wholesale power contracts ranged from $35 to $40 per megawatt hour. By the end of the summer the price had dropped to $22 to $28 per megawatt hour. This reflects an average drop of $12.5 per megawatt hour. Over the past two years the average wholesale market in the US has seen a drop of roughly $20 per megawatt hour from $55 to $35.

To achieve a rough estimate of the impact of this reduction in wholesale costs if passed on to the consumer, there are 3 trillion \(10^{15}\) kilowatt hours sold annually in the US. A savings of 2 cents per kWh represents an annual savings to consumers of $60 billion accounting only for the price change. This amount would be increased by the quantity of additional electricity sold based on the elasticity of demand with respect to price.

Looking at reductions in costs, the same pattern appears. Costs of generation, given new technology, have been reduced such that the cost of electricity, including amortized capital and maintenance, produced by today’s NUGs (dominated by gas fired Gas Turbine Combined Cycle (GTCC) units) is roughly 2 cents less than the cost of electricity produced by utility owned generating stations. This reduction in production costs has

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29 Information on pricing taken from McGraw-Hill Power Markets Week, for the period from Spring 1994 though the late fall of 1994. These values represent rough averages only.
30 This value should be juxtaposed against the estimates of the cost of transition from the regulated to a restructured industry generally placed in the range of $200 to $300 billion though values as low as $20 billion have also appeared. As pointed out by Pierce, op cit., “To put these estimates in context, the aggregate industry book value of equity is approximately $175 billion and market value of equity is approximately $300 billion.” p. 18.
provided significant pressure on wholesale prices and thereby the creation of the consumer surplus described above.

There is a second element to consumer surplus which is also of significance but less quantifiable -- availability of additional services. These services arise in two ways, financial and technological. As we have seen in the telecommunications industry, unbundled services have been rebundled into packages that provide a mix of options in risk management. This has arisen from the ability for market intermediaries to provide services in fixed vs. variable costs which match more nearly the needs of any individual consumer. In the electricity market we are already beginning to see the repackaging of electricity contracts to provide risk management tailored to individual needs.

On the technological side, the telecommunications industry was, and continues to be, able to expand its services through technological changes that bring significant added value to customers. When the original restructuring occurred there was a dramatic increase in consumer electronics available for interfacing with the phone system. With increased time, the local companies have introduced a breadth of services that compete with these products -- voice mail is the most obvious example -- as well as a range of packaged services in highly flexible commercial and industrial phone systems. Would these services, now considered invaluable by consumers, have developed in a hierarchically structured industry? It seems unlikely. At the same time it is difficult to provide any single number to add to consumer surplus to reflect the added value of the increases in services provided.

The winter of 1993/94 provided an additional indicator of the benefits to be achieved through increased operating efficiency, though again difficult to directly quantify. During the extreme cold snap of January, 1994, the electric utility industry in the east central and northeast faced a series of conditions that required major power exchanges to institute rotating blackouts in order to maintain the security of the system. These blackouts had a very significant cost to the consumers of the region, as did the emergency purchases that flowed through all of the southeast, east and east central regions of the US. This situation is directly analogous to that which occurred in the cold winter of 1976/77 with respect to the natural gas industry. At that time the gas market was heavily distorted by regulation. Gas did not flow to areas of demand. Over 4000 manufacturing facilities and thousands of schools closed causing over a million layoffs. The comparison with the winter of 1993/94 is startling. There were no shortages of gas that caused disruption in supplies. The market structure provided gas to all demands, the pipeline system carried the required supplies and delivered them against extreme demand variability brought on by dramatically cold temperatures in all of the east. The benefits to consumers were dramatic. No

31 Pierce, op cit., p.2.
interruptions, no loss of work time, no loss of jobs. When compared with the response of
the regulated electric utility industry acknowledged to have dramatic excess capacity in
this same geographic region, the results are clear -- the market worked far better at time of
crisis than the regulated structure!

A participant in a competitive market knows that its inability to provide service in all
reasonably foreseeable conditions will cost it millions of dollars in
immediately foregone revenues and many millions more in foregone future
revenues attributable to the diminution of its reputation for reliability. A
monopolist subject to cost-of-service regulation has more attenuated
incentives to operate efficiently and reliably. Politicians and regulators are
far more forgiving of errors than are markets. 32

5.1.2 Producer Surplus

The producer surplus is measured as the improvement in profits that can be achieved by
increased operational efficiency on the production side and increased revenues through
new services. In both the long and the short run, prices and costs will be realigned to a
point of increased operating efficiency. As described above, the impact of changes in
technology in generation has had a significant impact on potential for producer surplus in
the industry -- the efficient operators are achieving revenues well in excess of those
perceived to be less efficient. The current players are being seen as positioned well or less
well in the competitive environment, even in the popular press. 33 Utilities like Central
Maine Power, Philadelphia Electric (PECO Energy), and Southern California Edison are
seen to have many challenges" relative to the well positioned" Kentucky Utilities,
Louisville Gas & Electric and Northern States Power, to select a few from The Times
listing. We would tend to extend the Times listing of well positioned companies to include
companies like PacifiCorp based on their regional reach, ownership and/or access to
transmission facilities and low cost energy. Increases in operating productivity in the UK
have, informally, been claimed to be as high as 40%. 34 To be conservative, if one assumed
only a 10% decrease in cost (or increase in productivity) across the US industry and
assuming a cost per kWh of $0.03 to $0.04, this would amount to an annual savings to the
producers of $9 to $12 billion.

32 Pierce, op cit., p.3
34 Based on informal discussions held by the authors while working with National Grid Company, Ltd in the UK.
Looking at the existing and capital stock of the industry of roughly $175 billion in book and $300 billion in market value, and assuming that one third to one half of this is reflected in generation, the remainder in transmission and distribution assets, then the average book value per kW in the US is between $80 and $120 and the market value between $140 and $210. Compare this with the cost per unit of new capacity which ranges from a low per kW of $400 for gas turbines to $800 for gas turbine combined cycle (GTCC) to $1200 to $1500 for coal and $2000 to $3000 for nuclear units. If we assume that the rate of replacement plus incremental growth in the capital stock is very low, only 2% per year, this implies a demand for 15,000 MW per year in new capacity. The past history of the industry has been to add new coal and nuclear units while the pattern of additions for NUGs has been GTCCs. The difference in capital cost between these options is $400 to $700 per kW. On an annual basis this reflects a benefit of between $6 and $10 billion that the market is already beginning to appreciate as the marginal facilities shift from existing electric utilities to NUGs (or utilities who use GTCCs to remain cost-competitive).

As with the telephone industry, the electric sector is now seeking and achieving success in development of revenues from sources outside of the US. Utility subsidiaries such as Southern Electric International (the Southern Company) and Pacific Enterprises (PG&E) appear increasingly well positioned for developing power projects in new markets such as China where forecasts for new power developments are at the rate of a 1000 MW generation unit per week at the turn of the next century. These new services will bring significant new opportunities for revenues into the industry and with them the opportunity for expansion in producer surplus within the industry.

The remainder of the story with regard to producer surplus is that it will be gained by the companies -- within and outside of the current electric utility structure -- that are well positioned with regard to their assets in generation, transmission and distribution and who are able to move ahead of, or at a minimum along with the restructuring of the industry. Those companies who fight the transition and/or spend the majority of their resources in delaying the process through legal or regulatory activities will bear the brunt of the cost of the transition as they will be poorly positioned to restructure themselves and even less well positioned to take advantage of either technological change or market expansion.

5.1.3 Net Benefits

The net benefits from restructuring will be the sum of the benefits on the consumer and the producer side. An estimate of consumer benefits -- albeit crude -- is of the order of $60 billion annually from price reductions brought about by increasing competition for supply.
The benefits on the producer side are far more difficult to estimate yet even here it is possible to see that there will be significant savings. Modest decreases in costs or increases in productivity could easily net a 10% improvement or between $9 and $12 billion annually. A conservative estimate of the benefits from improvements in capital stock through change in market based technology alone indicate benefits on the order of $6 to $10 billion per year in capital investments saved. When one considers the additional consumer benefits associated with increased market options and with increased reliability, the net benefits increase as they do with producer capability to enter new traditional and expanded markets. These factors could easily expand the quantifiable benefits to exceed $100 billion annually.

How does this balance against stranded investment? If all of the investment in the industry were considered to be stranded -- $ 300 billion in market value -- the benefits would pay for the costs, in simple terms, in 3 years!

\[
\begin{align*}
(\text{Consumer Surplus}) & \quad \text{\$60 Billion} \\
+ & \\
(\text{Producer Surplus}) & \quad \text{\$10 Billion in saved capital expenditures / year} \\
& \quad \text{\$9-12 Billion net in reduced costs / increased productivity / year} \\
& \quad \text{?? Billion net from sales of new electrical services / year} \\
= & \\
\text{Net Benefits} & \quad \text{\$80 to \$100 Billion / year}
\end{align*}
\]

5.2 Benefits of Deregulation: Comparison with other Industries

"Economic Deregulation is one of the most important experiments in economic policy of our time. In 1977, 17 percent of US GNP was produced by fully regulated industries. By 1988, following ten years of partial and complete economic deregulation of large parts of transportation, communications,
The electric utility industry is certainly not the first, and is unlikely to be the last of the regulated industries to be restructured. Regulated reform activities have dramatically affected airlines, trucking, railroads, telecommunications, cable, brokerage, banking, petroleum and natural gas. The question that has been asked of all of these activities is whether the process has, in fact, resulted in aggregate savings -- have the net benefits been positive when all factors are taken into consideration?

In a major effort undertaken by Clifford Winston of Brookings Institute provides an overview of the economic value associated with the process of deregulation. While admitting that the jury is still out on some of the steps taken in the 9 industries that have preceded electricity through the deregulation morass, the overwhelming conclusion is that the impacts have been positive: "...the prevalence and importance of natural monopoly is vastly overstated. Technological change has frequently lessened the presence of large scale economies (e.g., airlines, railroads). In addition, competing technologies challenge the notion that any particular technology forces an industry to be characterized as a natural monopoly (e.g., telecommunications) and that society should be denied the benefits of multiple services that arise from competition."  

The work of Winston is significant to the discussion of benefits presented in this paper. The absolute levels of the benefits are not easy to forecast. They are highly dependent on who and how the forecasts are made and upon the assumptions involved. In each case, there were detractors -- generally not the microeconomists -- who felt that the industry was running as efficiently as possible in its regulated mode. The evidence is to the contrary, the benefits of deregulation have and continue to be significant with the changes in prices the most significant benefit as seen by the market.

The most relevant industry to use as a comparison for the restructuring of the electric industry is natural gas -- a comparison frequently made, though equally frequently used as an example of the dramatic differences between gas and electricity. As we have discussed in sections 2 and 3, natural gas and electricity are more alike than they are different. In

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36 Winston, op cit., pp. 1267. It is interesting to note as well, pp. 1274 and 1275 that the forecast of the benefit and the benefit achieved were frequently at variance. In some cases the assessed values ranged from the negative to the positive -- always skewed toward the positive, however. For some industries such as natural gas the assessed value of deregulation was merely listed as "substantial".
1985 as the movement for restructuring of the gas industry began, one heard arguments like:

“Given its capital intensive nature, oligopolistic producing sector, monopolistic and vertically integrated transmission sector, and the exclusive nature of ...franchises,... the industry is a textbook example of an industry that does not lend itself to the discipline of the free market.”

These same arguments are being heard (in nearly the same vocabulary) in today’s debate in electricity. Yet in the intervening years the gas industry has been almost completely deregulated at its extremities. Prices for gas at the city gate have declined or remained even in 47 of the lower 48 states. The average decrease in gas costs has been 18 percent since 1984 for a savings over the past decade of nearly $84 billion, this in an industry that is roughly one fifth the size of the electric power industry. Interestingly, the electric power industry has been one of the major beneficiaries of lower gas prices in all but two states and yet costs of electricity have remained the same or increased in real terms in all by 5 of the 50 states.

Natural gas is the relevant comparison. It was vertically integrated (though not to the extent of the electric utility industry), it was highly dependent on a monopolistic transport system, it did face both state and federal regulation, and it was perceived to be a natural monopoly both in terms of its economic and its physical characteristics. As we have attempted to show in our discussion, it not a natural monopoly in either economic or physical terms. The issues faced in the gas industry will be dealt with in the electricity industry. There are additional operating issues that need to be faced through the creation of new or modified institutions for physical and economic clearing of the market, but these issues are no more difficult nor troubling than those that have been resolved by the natural gas industry. The results were clear. Significant benefits in price reduction and service choice for all consumers in the market. Similar benefits from deregulation can clearly be expected in electric power.

6. Concluding Remarks

This paper has examined the issues associated with restructuring the US electricity supply industry from its current vertically integrated regulated structure to one that is more unbundled and market-oriented. We have proposed a structure which is based on bilateral contracting arrangements between sellers and buyers, in contrast to a pool-based structure following the UK model, in which the chain between buyer and seller is disrupted by an intervening power pool. As we have argued in the paper, the model that we have proposed here will address all the concerns associated with the restructuring of the industry, specifically those related to providing reliable supply and achieving a transition to a viable and competitive industry, while going much further than the PoolCo model in its reliance on market forces. Thus, we have described what we believe to be an economically and technically viable structure for operation of a market-based electric utility industry.

In contrast to the PoolCo approach, the scheme proposed here depends vitally on intermediaries rather than "pool rules" to deploy market forces. This is consistent with the way in which virtually all markets operate in the US and in particular, parallels the approach that has evolved in the US gas industry. We have suggested the development of a NetCoor from a limited set of the current functions fulfilled by today's electric utility control center. As shown in Figure 4, all of the functions of the utility can be fulfilled within such a market structure. More importantly, by allowing room for markets to develop in virtually every segment of the industry, economic efficiency is guaranteed in a way that is consistent with the organization of every other industry in the United States.