

A Market-Based Model for ISO-Sponsored Demand Response Programs

A White Paper Prepared for the Multi-Client Study:
A Critical Examination of Demand Response Programs
at the ISO Level: End Goals, Implementation and Equity

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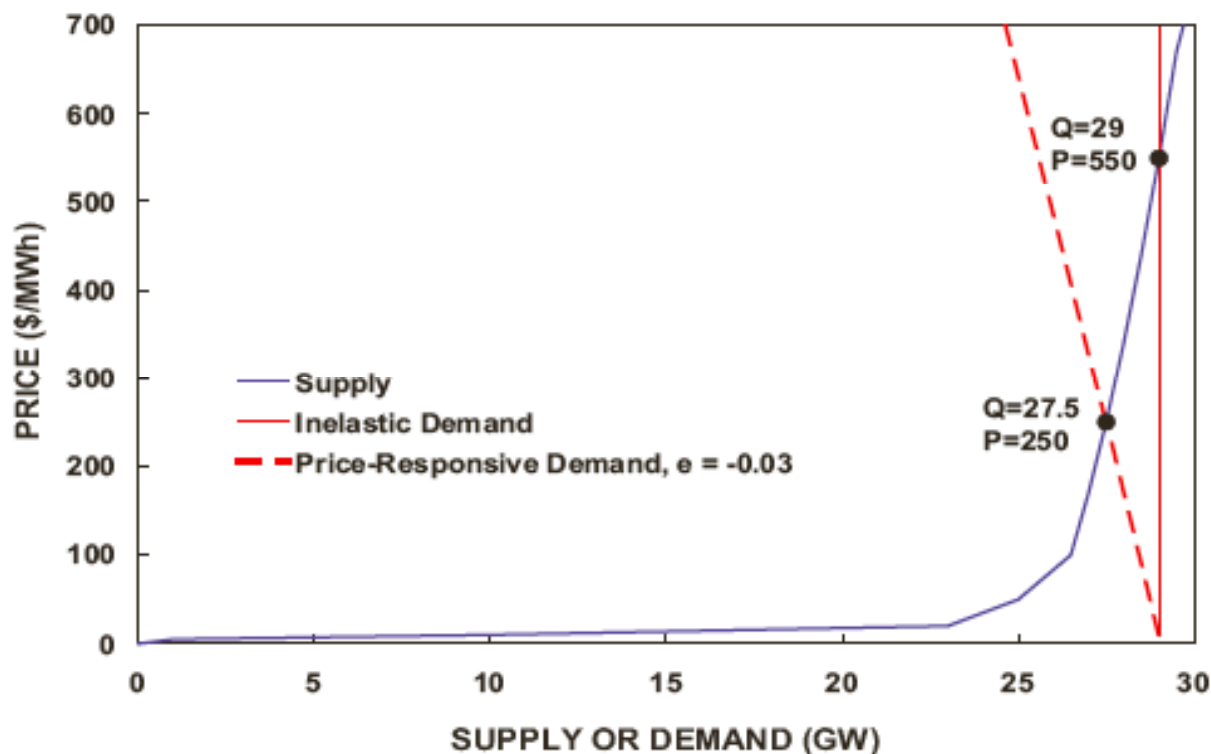
I. Introduction and Executive Summary

This paper lays out a general model of active double-sided markets in the electric power industry. The model focuses on the crucial integration of wholesale and retail markets, and on the role that prices play in transmitting information across those markets and across time, via forward markets. Market institutions and prices provide platforms through which buyers can discover their preferences in the face of potentially every-changing technology and service offerings from competing retail providers, taking into account other changes (like the personal computer) that can affect their demand for particular electric services; sellers can discover their opportunity costs, their comparative advantage, and the potential value of new business models and new technologies. The Independent System Operator (ISO) can play a crucial role in this nexus of institutions because of the perpetual need for system balancing and coordination; however, our model contrasts with the implementation of top-down demand-response programs at ISOs by articulating a vision of double-sided markets with active demand.

Simply put, a double-sided market is an institution that enables buyers and sellers to find each other and to consummate transactions for mutual benefit. Think, for example, of Ebay, a market platform that simultaneously accommodates multiple supplier listings and buyer bids. Details of double-sided market designs can vary – in most retail transactions, for example, double-sided markets take the form of retailers posting prices for goods and potential buyers looking at those prices as “take it or leave it” offers. In financial markets, multiple buyers and sellers make simultaneous bids and offers, using a set of pre-determined rules to govern the consummation of transactions.

This market institution is in direct contrast with the supply-oriented, single-sided market that is typical in electric power. In wholesale power markets we have become familiar with generators submitting offer curves, or a schedule of offers for different portions of their generation capacity, but without active bidding on the demand side it is still only a single-sided market. Figure 1 shows how a single-sided market with passive, inelastic demand, tends to have higher prices than a market with active demand and supply – a double-sided market.

Figure 1
The Price-Reducing Benefits of Double-Sided Markets



Source: Hirst & Kirby (2001), p. v.

The double-sided market we envision in this model is one in which economic agents on the supply side submit offers, economic agents on the demand side submit bids, and a computer algorithm coordinates the bids and offers to determine the market-clearing price and the amount sold. The most important detail in this model that is substantially missing from existing electricity markets is active demand. Active demand means customers in retail markets making bids, in which they essentially state a set of prices above which they do not wish to purchase any more power. Their load-serving entities (LSEs) take those active bids into the wholesale market, and bid on behalf of the bids their customers have submitted. Note the crucial difference here between active demand and LSEs bidding in the wholesale market on the basis of load shaping and average profiles. Active bidding communicates more precise information about the preferences of consumers into both retail and wholesale markets, integrating them and consequently leading to better decisions and more efficient resource allocation.

A recent study estimated the prospective benefits of active demand response at \$7.5 billion by 2010 (ICF 2002). Other studies, described in GAO (2004), give further details of the benefits that have already been generated because of demand response and active retail choice.

Electric loads follow patterns that vary over the day and the season. The daily variation is generally low (off-peak) demand overnight, a rise in demand in the morning to a shoulder period through the day, a high-demand period in the late afternoon and early evening (exacerbated by

air conditioning on hot days), and a return to a lower, shoulder demand in the evening. In the absence of any price variation over the course of the day, this pattern repeats daily. The seasonal dimension depends on whether the area uses electricity for heat or cooling, and the extremity of the climate variance.

Electricity demand's general pattern is its average price elasticity of demand in a particular hour in response to the fixed, average retail price that most customers pay. For a given customer, demand elasticity does vary according to this demand pattern. Furthermore, customers are heterogeneous and have different, subjective demand patterns and elasticities. The traditional grouping of customers into residential, commercial and industrial classes provides a very rough approximation of the difference in demand elasticity patterns across users. For example, the small commercial customer class includes businesses that operate only during the day as well as 24-hour groceries; these different businesses have diverse needs and load shapes, yet they receive the same, fixed, value proposition.

The electricity industry in the U.S. has not evolved using business models that take advantage of customer heterogeneity, either to provide customized value propositions to consumers or to use different demand patterns to decrease risk and enhance system reliability. Indeed, the evolution has been quite the opposite. The regulated utility's obligation to serve has led to a requirement that the utility serve all customers at any time of day, but without the use of any other tools to manage the shape of load over the course of the day or season. Utilities have accordingly had to invest in the generation, transmission and distribution infrastructure to do so, investments they typically welcome due to their enhancement of the return to shareholders on a larger rate base.

Fixed retail rates mean that the prices individual consumers pay bear little or no relation to the marginal cost of providing power in any given hour. Moreover, because retail prices do not fluctuate, consumers are given no incentive to change their consumption as the marginal cost of producing electricity changes. The consequence of this disconnect goes beyond inefficient energy consumption and also causes inappropriate investment in generation and transmission capacity. *It has also suppressed the implementation of technologies that engage customers in making active consumption choices, even though communication technologies have become increasingly affordable and user-friendly.*

This argument against regulated, fixed retail rates evaluates two different types of efficiency – static efficiency and dynamic efficiency. Static efficiency measures the extent to which resources are allocated, produced and consumed efficiently (that is, in ways that maximize total well-being or total surplus) in a short-run snapshot of the transaction. Dynamic efficiency measures the extent to which investment, innovation, and technological change occur that optimizes resource allocation, production and consumption over time.

The negative consequences of fixing retail rates were hidden for decades by other aspects of regulation, such as the control of wholesale prices and excess supply in generation, but the problems arising from fixed retail rates have become more obvious in the era of restructuring. In particular, the liberalization of wholesale prices has disconnected the wholesale and retail markets, with unintended negative effects for customers and firms.

“Deregulation” of wholesale power markets without contemporaneous retail competition has proven to be a flawed model. Without retail pricing reform electricity restructuring will fail to deliver efficiency and value to consumers. Under rate-of-return regulation, the utility’s profit motive and business model all arise from the cost-recovery-based “sell more power, make more profit” incentive. Under cost recovery with a regulated rate of return, utilities make money by increasing load. The “one size fits all” of regulated and fixed rates is becoming increasingly obsolete because of technological, institutional, regulatory, and cultural changes that acknowledge and exploit the diversity of products that the electricity industry can profitably sell to consumers. Retail reform is necessary to maximize the value of other market reforms and is in and of itself a valuable step in producing efficient and fair electricity markets.

Allowing for the legal and regulatory separation of energy commodity sales from the wires business is a related, crucial step. Technologically, it is no longer necessary to impose the traditional regulatory assumption that energy must constitute a tie-in sale with the rental of the wires. Just as the rent you pay for a rental car is separate from your purchase of the energy required to operate it, so should your purchase of electrical energy be separate from the entity that charges you for using the wires. Reversing this retail regulatory lock-in would recognize the potential for and enhance the development of competitive electric energy markets.

The absence of retail competition means that, every day, customers are losing value. They are losing the opportunity to receive novel, innovative, value propositions from retail service providers. In both their system operator and wholesale market platform roles, ISOs can facilitate this move to retail choice by implementing double-sided markets with active demand.

II. Economic and Historical Perspective

A. A History of Supply-Focused Regulation

Since the beginning of commercial electric power in the 1880s, electricity has been sold to end-use customers as a bundled good – energy and wires – through vertically integrated firms. It also has been regulated as a bundled good, both by regulatory fiat and, up to a point, by technological necessity. That regulation has largely taken place at the state level, starting with New York and Wisconsin in 1907 (Hirsh 1999, p. 21).

Under regulation, utilities received exclusive franchises for specific service territories. This franchise generally carries with it an obligation to serve all present and future customers in the service territory at a reasonable cost. This obligation to serve all customers in a territory persists to this day as a fundamental characteristic of the monopoly franchise and has served to eliminate possible competition for utilities, including competition from new technologies for distributed generation. Basing the rates that customers pay on cost recovery is one of the consequences of the obligation to serve (in combination with rate-of-return regulation). This focus on cost recovery in rates often provides an obstacle to the evolution of market-based retail electric pricing, because instead of considering the value created for customers it emphasizes only the cost of providing customers with a particular type and level of service.

Technology has changed over the century since the inception of state regulation of utilities. The clearest example of technological change applied in the electric power industry is the import of the jet engine to create the combined-cycle gas turbine in the 1980s; however, other than that, the prevailing technologies in the electric power industry come from the first half of the century. At the commencement of state-level regulation in 1907, the only way to measure and record the flow was with a human being, an induction coil, and a pen and paper. Thus monitoring current flow was very labor intensive, and therefore prohibitively costly. Installing induction coils along a utility's transmission and distribution network would also mean incurring a high fixed cost, much of which would be sunk, in addition to the high variable costs of gathering and recording the data regarding the current flow. Moreover, until the 1930s, much generation took place on-site, which decreased the need for metering. The growth of large-scale central generation increased the demand for meters, and in the pre-digital era, the metering technology was the analog watt-hour meter.

By the 1950s, paper tape and then magnetic tape could record the magnetic field measurements and the current flow, eliminating the need for real-time human data recording. This dramatic change technically enables the unbundling of energy from wires, meaning that the existence of separate markets for energy and for wires became possible 50 years ago where it was not before.

But these tapes were cumbersome and the data were not always easy to interpret and use. Furthermore, the large scale and cost of computing in the 1950s and 1960s made the metering of specific current flows both low priority and costly. Thus although this technological change made the existence of separate markets feasible, the costs of the technology were still high relative to the benefits. The invention of analog-to-digital converters, and the increasing power and decreasing scale and cost of semiconductors, reduced those costs and made current flow monitoring less expensive and easier to accomplish. The information technology revolution of the past two decades has decreased the transaction costs that hindered the formation of separate energy commodity markets in electricity. It has also increased the dimensions of the energy product that can be metered, including power quality and reactive power.

The other technology that plays a role in this dynamic is the end-use meter. The typical watt-hour meter that most utilities use predates the increased power and sophistication of semiconductor technologies, and it also predates the development of tape recording technologies in the 1950s. The core of the watt-hour meter technology became standard in the 1890s with the development of the induction-motor watt-hour meter that could measure electricity use on alternating current systems (Dahle 2003). The utility uses this meter to measure the amount of energy that a consumer uses, but the meter is not sophisticated enough to provide time-specific information about current flow, even though semiconductor technologies make such metering feasible and inexpensive. To this day, the watt-hour meter still requires a meter reader, adding substantially to the variable costs of its use. Utilities have a large installed base of end-use meters in homes, offices and businesses, and the total energy use information from these meters is used to determine the utility's "revenue requirement", or the amount of revenue they are allowed to keep to ensure that they earn the regulated rate of return.

Further technological change has increased the efficiency of small-scale electricity generation, creating contestability in electric energy markets. By 1992, the potential for competitive

electricity commodity markets encouraged the passage of the Energy Policy Act. This legislation opened wholesale electricity markets, which are under the regulatory jurisdiction of the federal government instead of the states, to competition. Dynamic changes in the generation of power provide further technological arguments for the regulatory unbundling of energy from wires, yet to this day the regulation of energy and wires as a bundled good persists. Although the Energy Policy Act deregulated wholesale electricity transactions, wholesale markets and regulatory policies remain supply-focused.

Even regulators have long acknowledged that the regulated world is at best a second best environment. While initially established to approximate the static efficiency with which markets enable economic actors to allocate resources, the regulated system does not capture the rich and complex web of information that would lead to “efficient” pricing and supply of electricity. In reality, determining capital costs and implementing rate-of-return regulation is complicated, and does not necessarily generate an efficient outcome. Electric utilities provide multiple products and services, so the simple “decreasing long-run average cost/economies of scale” designation as the basis for electricity regulation is likely to lead to inefficient outcomes. Furthermore, regulator decisions regarding what to include or exclude in the allowable costs for determining rates are subject to manipulation.

The traditional regulatory model is also obsolete because of its barriers to achieving dynamic efficiency. Technological and economic change have changed the environment in which we buy, sell, and use electric power, but regulatory inertia and the continued focus on cost recovery limit our ability to implement technological changes and innovate within the industry. Bid-based, double-sided markets provide an efficient, and fair, alternative.

B. Benefits of Double-Sided Markets¹

The economic efficiency benefits of market-based pricing, active demand, and double-sided markets also incorporate reliability and environmental quality. A properly structured set of double-sided markets will include a market for reliability, and suppliers of reliability will interact with consumers of reliability (and third parties) to achieve an economically efficient outcome. Further, with appropriately internalized environmental costs (trading; emissions regulation), the market for environmental quality should become economically efficient. Markets help achieve that outcome by promoting conservation in response to price changes.

Dynamic retail pricing through double-sided markets enables customers to shift demand away from peak periods with high prices, and/or to reduce their overall use. This economizing incentive, aligning benefits to consumers and costs to producers, is the source of the conservation benefits of double-sided markets. Market-based conservation reduces energy costs and increases energy efficiency (Taylor and Schwartz, 1990). Conservation typically takes two forms – curtailing consumption (reducing overall use) and shifting use to non-peak hours. The primary effects are felt directly by the consumers who choose to curtail or shift use, and about 20 percent of the value of market-based pricing comes from this direct effect (McKinsey 2001, p. 5). But an indirect effect creates even more value – the reduction in peak demand lowers wholesale prices

¹ For an extended discussion of the benefits of market-based retail pricing in particular and more extensive references to related literature, see Kiesling (2005).

for all other consumers of all power in that hour. So even if customers cannot shift away from peak, their prices can be lower and more stable because of the decisions of others to shift. Double-sided markets encourage customers to manage their own energy costs, and help bring market supply and market demand into balance at lower and less volatile prices.

Heterogeneous demand patterns across time and across customers create an opportunity to enhance overall efficiency of the electric power system, particularly through increased infrastructure capacity utilization. High and consistent capacity utilization is the hallmark of a dynamically efficient network. However, the obligation to serve requirement in conjunction with fixed rates means that the electric power infrastructure must be built to meet the highest possible peak demand. Those peak generation, transmission and distribution resources lie idle for most of the year. This capacity underutilization is grossly inefficient, and the opportunity cost of the investment in those underutilized assets is high.

A double-sided market that enabled customers to choose prices that reflect the real cost of providing them with power in that hour would lead to less underutilized peak-specific infrastructure, and the capital would be better used elsewhere. Market pricing would lead some customers to shift their demand to cheaper hours away from peak, thereby improving load factors and capacity utilization of existing infrastructure. Through this process double-sided markets also elongate the time between required infrastructure investments and upgrades. Overall resource use would fall as generation and transmission capacity utilization and load factors rose, allowing us to meet both efficiency and environmental objectives simultaneously.

Market-based pricing also increases competitiveness of electricity markets and reduces the severity of price spikes. Customers modifying their use when they see price volatility help reduce the magnitude of price spikes. When consumers can receive price signals and can respond to them, some consumers will shift their demand to cheaper hours when they face high prices. Shifting demand from an expensive hour to a cheaper hour lowers equilibrium price in the expensive hour and may increase it in the cheaper hour.² “Marginal cost real-time pricing also opens the door to conservation and load management to all customer classes. Customers will ‘discover’ avenues to manage load that make economic sense. In most cases conservation and load response will be implemented before taking on the larger capital investments for on-site generation.” (Winters 2001, p. 77)

The active demand feature of double-sided markets provides consumers with a direct tool for disciplining wholesale prices. Double-sided markets integrate wholesale and retail markets, by transmitting information that causes retail prices to reflect costs more accurately. That integration means that customers bear wholesale electricity prices more directly, and therefore will be more likely to shift demand away from hours with high wholesale prices. During peak demand hours, if prices are fixed and demand is inelastic, market manipulators can increase profit by withholding. If active demand decreased during price spikes, however, the opportunity for manipulation would decline. Therefore, enabling active demand disciplines firms that could exercise market power in a supply-focused market. In markets that have only one-sided supplier

² Price might not rise in the less expensive hour because generators are often willing to accept lower prices to avoid having to shut off generators in that hour.

bidding, suppliers are more able to manipulate prices than in double-sided markets where consumers can express their preferences. Market-based pricing reduces the exercise of market power by changing the shape and size of load curves and load duration.

Market-based pricing through double-sided markets also rectifies some of the inequity and unfair outcomes created through regulatory institutions. Consider, for example, the unintended effects of a fixed, average rate structure. The efficiency loss from the distortion of resource allocation that arises from using average prices and not marginal prices is clear. What is often overlooked, though, is that the unwillingness to price peak resources in peak hours also means that off-peak users are subsidizing the increased resource use by peak users during expensive peak hours.

Fixed rates place all wholesale price risk on the utility, but enabling customers to choose how much price risk to bear would both be more efficient and fairer. Double-sided markets enable customers to choose how much of that price risk they are willing to bear, and how much they are willing to pay to avoid. Regulated rates do not fully communicate the cost of insuring different types of consumers against different types of price risks, largely because as part of the political bargain, regulated rates (particularly for residential customers) are discounted and do not reflect insurance against price risk. Customer heterogeneity means that they have, among other things, different risk preferences, and different willingness to pay to avoid price risk. Double-sided markets allow the electricity commodity price and the financial insurance premium components of the price to be unbundled, and to be offered separately to customers. This unbundling would enable more efficient pricing of the financial risk, leading to optimal risk allocation among customers and suppliers.

Retail competition would facilitate better risk management, contributing to both static and dynamic efficiency. Currently, many jurisdictions use fuel clauses to pass fuel price risk to retail customers, but in many cases they do not enable end-use customers to employ risk management instruments to hedge the fuel price risk. Utilities do not face strong incentives to hedge fuel price risk, because they face the risk of being second-guessed in their hedging strategies by regulators. Consequently, risk management either does not occur or is done poorly. Retail competition creates an environment in which competing retailers have incentives to quantify these risks and take them on, at the level and price that individual customers want.

In addition to the resource allocation (static efficiency) and equity benefits of double-sided markets, they provide dynamic efficiency benefits. The interaction of supply and demand through market processes transmits information about what services and resources are more or less valuable, and market processes allow investors to act on that information over time. That process leads to further innovation, taking the form of new technologies, new value propositions, and new ways of organizing transactions. Indeed, the lack of such innovation in electric power suggests the sterility of the current regulatory regime. The major innovations in electric power have come from outside the industry, and most have not been implemented. For example, two-way digital metering could cost \$100 per meter if installed in volume (500,000 premises), and if the installation is coupled with flexible pricing customers could actually save money and earn a return on the \$100 quickly. Yet we have not seen the implementation of such innovations, and the creation of complementary innovations, even though dynamism of this sort infuses the rest of society.

GAO (2004) provides further treatment of the value of demand response and double-sided markets. The GAO report is a very useful summary of the issues and the existing literature in the role of consumers, retail choice, and the demand side in the electric power industry. In analyzing existing demand response programs they broke them into two categories: market-based pricing (such as real-time pricing, time-of-use pricing, and bidding for demand reduction) and reliability programs (such as interruptible contracts, demand control contracts with the system operator, and compensation for voluntary demand reduction). By doing this, the report makes it crystal-clear that active demand participation in electric power markets is a crucial tool for enhancing the reliability of the network, as well as for improving the efficiency and effectiveness of electric power markets.

One particularly striking point that the report makes is that wholesale and retail markets are inextricably intertwined, even though their regulation is jurisdictionally separated. Thus regulatory inefficiencies and distortions present in one portion of the value chain affect other portions. The report cites widespread agreement among those interviewed that the lack of retail customer choice hampers the evolution of robust wholesale markets and contributes to higher and more volatile wholesale prices.

The report also points out that fixed retail rates create an environment in which end-use customers inadvertently harm both the efficient operation of markets and reliability of the network. Discussion of this concept has been circulating for years, but thinking of the inadvertent overall harm that customers unknowingly produce because of the incentives facing us is a powerful way to communicate the inefficiencies and the unfairness of the existing regulatory environment.

III. Design Considerations and Best Practices

A. A Model Double-Sided Market Design

Consider a wholesale electric power market environment in which several integrated markets coexist. Real power (the actual energy flow) markets, both spot and forward, would enable buyers and sellers to transact over sales of electric power in the short run, in long-term contracts, and in financial instruments to hedge price risk. Reserve markets for reserve availability at various time intervals would also provide the necessary reliability of supply to ensure system balancing. Such reserve markets would range from 10-minute to day ahead, and could accommodate long-term contracts in which generators supply reserves in conjunction with real power sales for which they have entered into long-term contracts. Similarly, markets for ancillary services would enable buyers and sellers to transact over the provision of voltage support through reactive power or other services that complement the sale of real power. In other words, the market design would not restrict the creativity of market participants if they come up with a mutually beneficial transaction innovation in either real, reserve or ancillary power markets.

In this set of integrated markets, the supply participants would not be restricted to generators providing power, but would also include demand reduction, voltage management, and load

control technologies. Such technologies provide reduction that can be measured in megawatt-hour equivalents, and can thus be sold directly into real, reserve, and ancillary markets that are denominated in megawatt hours. This portfolio of market platforms would be technology neutral, meaning that no particular way of providing a megawatt-hour equivalent would have an advantage bidding into these markets.

The demand side in this portfolio of markets would be the load-serving entities (LSEs). In some cases, such as states in which retail competition is healthy (such as Texas), LSEs may sell power on to retail service providers; however, in the current environment most LSEs engage in both the physical delivery to and the retail relationship with end users.

The spot market institution is a uniform-price double-sided market. In a double-sided market, suppliers offer their capacity into the market in each period, and can change their offer curves each period. If they have entered into bilateral contracts then the capacity they have available to offer into the spot market is the difference between their total capacity and their contracted amount. The demand side in the double-sided market – the LSEs – submits purchase bids, which they can also change every period. A “smart market” computer algorithm ranks the offers from lowest to highest, ranks the bids from highest to lowest, and determines the market-clearing price as the point where the supply (offer) curve and the demand (bid) curve intersect. In a uniform-price market, all buyers pay the market-clearing price, even though all except the marginal buyer were willing to pay more, and all sellers receive the market-clearing price, even though all except the marginal seller were willing to accept less.

The forward markets, reserve markets and ancillary markets could have similar designs, although market designs perform best when they are customized to local conditions and trading customs. It may also prove valuable to choose to run some markets together, in a combinatorial fashion. For example, the bid to purchase a MWH of real power for a given hour would have to occur in conjunction with a bid for a particular amount of reserves for that hour and a particular amount of reactive power supply to accompany the real power transaction. In addition, voltage control technologies and other innovations increase the feasibility of decentralized day-of reserve markets, so the market design should not rule out the development of such markets. Combinatorial and day-of reserve market designs are complicated and are the subject of further research.

In addition to the market institution, the legal institutions in which this market model operates matter a great deal. The LSEs on the demand side, either by contract with retail service providers or by their obligation to serve, should have the legal obligation to meet end-user demand. In a Coasian sense, this assignment of legal liability is a definition of property rights, which provides robust incentives and reduces the transaction costs that can hamper trade (Coase 1960). In the presence of transaction costs, the best place to put legal liability is on the least-cost avoider – which party is the one that can avoid harms to the other party most cheaply? In the sale of power from LSEs to end users, if reliability is a good that has value that LSEs provide to end users, the LSEs are the least-cost avoiders. The relevant property right that integrates the retail market with the wholesale market is the contractual right to a particular level of reliability.

This definition of property rights seems to contradict the legal reality that utilities do not guarantee service to customers. For this reason, the idea of legal liability for reliability resting with LSEs should accompany contracts that enable customers to purchase the quality of service that they desire. In other words, LSEs should be free to sell reliability as a differentiated product to customers with different preferences, through an instrument like reliability insurance. Technology increasingly enables us to privatize many aspects of reliability, opening up the opportunity to create value by selling reliability-differentiated electric power retail service.

While creating an environment in which participants can transact freely, these legal institutions impose commensurate obligations on market participants. On the demand side, LSEs must also treat the bids they make to buy in the wholesale market and financial and legal obligations. This legal rights assignment reduces the incentive facing LSEs to underschedule their bids, as seen in the Power Exchange market in California in the late 1990s. The suppliers face similar legal obligations to meet the terms of their transactions, implying legal liability if they fail to deliver as agreed to in a transaction. The ISO has a legal obligation to provide a transparent and technology neutral market platform and operating environment for the facilitation of these transactions.

In this market model the ISO could serve two crucial roles: a market platform for each of several markets, and the system operations and coordination to maintain system balance. Bilateral contracting and the use of other market platforms should not be prohibited, as such a prohibition would essentially create a monopoly market platform in the ISO. This concern is most pressing for the transactions least associated with the ISO's real-time balancing operations, in other words, for the real power markets and day-ahead reserve markets. However, the ISO's system operation function requires ISO knowledge of transactions and commitments that will occur in the system, so the ISO should implement, and the participants should agree to, a scheduling reporting requirement that covers all bilateral and non-ISO transactions. This requirement would be implemented in a transparent manner but would have to protect the privacy of the participants, so the requirement should not be to reveal, for example, prices.

Implementing integrated double-sided markets could have several possible effects. The static efficiency, or resource allocation, benefits include transparent price signals from end users through LSEs to wholesale market, increased efficiency by better aggregation of more information from both sellers and buyers participation, and better discipline of the ability of suppliers to exercise market power (Rassenti, Smith, Wilson 2003). The dynamic efficiency benefits could include the application and development of new technologies, such as demand voltage control, direct load control, thermal storage, building controls, and grid-friendly appliance technologies.

Note that two valuable benefits arise in this model: capacity planning and forecasting through energy markets, and network/critical infrastructure security. As discussed above, the double-sided market model promotes more efficient capacity utilization, but it also provides a platform of spot and forward energy markets through which capacity price signals would flow. In addition, the distributed nature of customers and sellers, differential preferences over reliability, and the technology to perform controlled individual interruption enhances critical infrastructure security while maintaining overall system reliability.

B. ISO Market Practices

Several utilities have implemented some limited market-based pricing programs. Although small and exploratory, these have generated positive results that will be useful as more utilities move to market-based pricing. GAO (2004) surveys the extensive literature on the costs and benefits of double-sided markets and an active demand side. For example, it highlights the \$1.5 million in savings to consumers under the New York ISO's demand bidding program in the summer of 2001 alone, as well as savings of \$38-58 million to both customers and utilities in 2001 due to other NYISO demand-based reliability programs. Such calculations include benefits to customers who do not themselves participate in demand response programs, and those benefits are of two types: decreased prices because of the decreased cost of producing power, and increased reliability through decreased probabilities of outages.

NYISO has provided demand response programs aimed at large industrial and commercial customers since 2001, to help manage peak load during summer months. NYISO's programs feature both price-responsive demand and interruption contracts. Their price-responsive demand program, Day-Ahead Demand Reduction Program (DADRP), enables customers to bid into the day-ahead market for load reductions they would make on the following day. Through this bidding process they discover the price they would be paid to commit to a specific scheduled load reduction on the following day; once the time period for which they scheduled the reduction is complete, the customer is paid for the reduction. The interruption program, Emergency Demand Reduction Program (EDRP), is a reliability-specific day-of interruptibility contract that is available for hours when there is a shortfall in reliability reserves. Customers can choose to allow the NYISO to interrupt their service, for which the customer is paid a price determined through a bidding process.

Both programs prevented outages in summer 2001 and contributed to lower and less volatile electricity prices (Neenan *et. al.*). Furthermore, a little demand response goes a long way to creating lower, stable prices; a small percentage of responsive and interruptible load creates a reliable network with lower and more stable prices for all customers. Boisvert, Cappers, and Neenan (2002) also emphasize that one reason for the success of these programs is the integration of the demand response computer systems with the ISO's pricing, scheduling, and balancing operations.

Neenan, Boisvert, and Cappers (2002) analyze the customers who chose to participate in the EDRP reliability programs in 2001, focusing on the risk tradeoffs that these customers were willing to make. For example, during three particularly hot days in August 2001, almost 300 EDRP customers curtailed 420 megawatt hours, on average. During these three days NYISO's demand hit its all-time high, but there were no forced outages.

Their logit analysis of whether a customer chose to interrupt or not in a particular hour, given the prices facing them, suggests an average implicit price elasticity of demand of -0.09 . When customers could choose interruption, EDRP participants chose 38 percent load curtailment. They also found that the most responsive customers, those who were most willing to curtail or

shift load, were the larger users. These results suggest that the demand for electricity is relatively price inelastic in general, but that consumers are willing to shift load over time. It also reinforces the point that selective interruption among large users with relatively higher price elasticities of demand reduces and stabilizes prices while maintaining system reliability.

None of these ISO demand-response programs implements true market-based pricing, though; instead they are “demand response” programs that use time-of-day price changes to give customers incentives to shift load. That said, they do indicate how powerful price incentives can be for consumers, and how market-based pricing contributes to a reliable, efficient electricity system.

The Midwest ISO’s recently implemented market design has some features of double-sided markets. On the demand side of the day-ahead market, buyers can submit bids that reflect different degrees of price sensitivity. On the supply side, generation and demand reduction can offer into the market. These Demand Response Resource offers represent prices at which the “seller” would reduce withdrawals from the grid, and they are bid directly into the day-ahead market. Importantly, this design does not treat the demand side as an ancillary service, or relegate it to a program. This market design could provide a precursor to and a model for ISO implementation of double-sided markets, although as a single day-ahead auction it is only one step in that direction.

ISOs should not become regional monopoly market platforms. As currently constituted these organizations are franchised monopolies, notwithstanding the fact that the franchise monopoly characterized many of the problems of the existing regulatory regime. ISOs are simultaneously acting as transmission managers, market makers, and regional regulators. These roles frequently cut against each other and may be fundamentally incompatible. These incompatibilities reinforce the argument for clarifying the ISO role as a market platform, but not a monopoly, and a system operator to meet reliability and security requirements.

The truly double-sided model allows buyers and sellers to figure out *how* they want to transact with each other. Under existing ISO models, including the incorporation of demand response as a program instead of as active participants, ISOs are going down the road of defining how the participants will interact, not defining a platform that enables participants to determine the best contract for them. In contrast, a double-sided market model empowers market participants with greater tools to figure out how they want to interact themselves.

C. Unbundling of Energy and Wires Transactions

This double-sided market model is most viable in an environment in which the sale of the energy commodity takes place separate from the rental of the transmission and distribution wires. In other words, an important complementary institutional innovation would be the unbundling of energy and wires transactions.

Many foreign countries – United Kingdom, Australia, New Zealand – have managed successfully to liberalize their electricity systems. When they liberalized, these countries severed that tie-in: wires and energy were separated into two distinct businesses. From the beginning

these countries saw that restructuring must honor the competitive differences between the wires business and the energy business. Although there may be just one set of wires, energy can be supplied by independent companies that compete for retail accounts and bill end users for the energy delivered to them on the common set of wires.

By way of clarifying industry differences, the state also long ago granted a franchised local monopoly to the telephone company, but technology flooded out that monopoly power despite Bell Telephone's attempt to hold back the sea. Switching technology allowed messages to be routed onto any long distance line and this brought competition in long distance rates. Then cell phone technology allowed the local phone wires to be bypassed, bringing competition to all levels. Thank heaven for the entrepreneurs and innovators. But nothing comparable to these developments is technically possible in electric networks yet; a smart, digitally-enabled grid and distributed generation may change the economics of wires and make them contestable.

The only state that has moved to separate electricity from the wires monopoly to allow competition in energy sales is Texas. Texas law requires a separation between generation, transmission and distribution, and retail sales. Texas has also recognized a separation between the wires company and the "competitive energy services" market, to help insure that electric distribution utilities could not enter the retail market with appliance sales, lease and repair; reliability services, on-site generation, etc. This provision was initially introduced in the state's integrated resource planning rules, and later adopted as an unbundling rule and a distinct section in the statute.

One state has separated the commodity sales from the transportation leasing in natural gas. The state of Georgia ingeniously voted to separate the local pipes business from the sale of the gas that comes through the pipes. The monthly rental rate for the pipes continues to be regulated as a monopoly, but there are now a dozen or more competing companies that supply the end use customer with gas. The same model applied to electricity could yield great benefits because over half of total retail cost is the energy component.

Since peaking energy is much more costly to produce than baseload off-peak energy, competitive energy sales would lower off-peak prices and raise peak energy prices. This effect occurs because the fixed hourly price charged by your utility loses money on high peak consumption (a subsidy) and profits from off-peak consumption (a tax). Profit hungry competitors would lower off-peak prices forcing peak prices to be raised.

But this is only part of the story. The capacity of the grid – the wires, local and long distance – is determined entirely by peak energy demand. Reduce peak consumption and you relieve transmission congestion and increase reliability and infrastructure security. Hence, regulatory reform must address how we price the wires infrastructure. Since capacity is determined by peak consumption, capacity cost should be born by the peak users. Suppose half the wires capacity cost is due to only six hours of peak demand. Then those consuming power during one quarter of the day should be charged for one half of the capital. Such pricing is not only "fair," it conveys the right incentives for capital utilization. This is why hotel room rates are so much higher at seasonal peaks—the peak renters have required all the extra room capacity to be built. The off-

season renters are not the ones that are pushing room capacity. The competitive process “knows” this and determines who pays how much for what.

This argument can also be applied to unbundling reliability. If the capacity cost is half to get the energy delivered at a low level of reliability, and half to ensure a high level of reliability, then it makes sense to further separate who pays – between those who want energy whenever, and those who demand high levels of reliability. A competitive process would “know” what to charge for reliability.

A properly restructured electricity industry with appropriate pricing of capacity will do likewise. For example, it could pay a high-rise building owner to install a gas micro turbine for peaking energy, or install motion sensitive light switches in all the offices, if in addition to the energy savings the owner could get a wires charge rebate due to his reduced dependence on the grid. The fact that he cannot get such a rebate tells you how regulation blocks innovation at the margin.

Also, consumers who reduce their peak demand reduce the need for security reserves and improve grid reliability. But regulation spreads the cost of security and reliability over all customers, and fails to give a fair break to those who help to solve the problem by giving them a discount for their valuable services.

At the state level, regulation provides a barrier to the free entry of alternative energy providers to serve the energy needs of end use customers; these energy providers would have the incentive to introduce demand response technologies – metering, switching and monitoring devices – designed to fit the preferences and budgets of customers, and enable them to take advantage of the low cost of off-peak energy.

Across the board, however, both state and federal regulation has accepted the unexamined assumption that energy sales must be tied to the rental of the wires. We propose some options to consider for implementing the unbundling of the energy and wires transactions.

Option 1. Set a future date by which time all of the local utility’s customers are to be served by an alternative competing retail energy merchant who bills customers for their energy consumed. Allow free entry. As of the target date all customers not signed up with an alternative provider will be prorated among all the providers in proportion to the number of customer accounts they have successfully solicited. The state of Georgia did this for natural gas, as did the province of Victoria in Australia for electricity. Customers are now served by a local regulated pipe or wire company, and some dozen or more different competing retail gas or electric supply companies. This model has the advantage that it defines an endpoint for achieving the restructuring.

Option 2. Require the local utility to separate its energy customers into an independent merchant company. Then allow free entry into the merchant energy business for alternative providers. The wires company then serves all of the various energy merchants. Instead of a rush of some 30 entrants, as in the Georgia gas business, followed by attrition to half that many, this scenario would build competition by chipping away at a single initial firm subjected to contestable entry. There need not be many entrants, as potential entry alone will force the incumbent to price low

enough to prevent a flood of entrants. This model stretches the restructuring process in a manner that provides a bridge between the current and future framework.

Option 3. Allow several companies to bid for shares of the local utility. The winning bidders jointly share the distribution wires entity and its operating costs, under a competitive joint venture or cotenancy agreement, but they compete to supply the down stream retail customers their energy. FERC has used this model to increase competition in gas pipelines networks, but it has not been tried anywhere, to our knowledge, in retail electricity markets. In this application each cotenant has the right to sell, rent or lease his share of customer hook ups to any outsider or to any of the other cotenants subject perhaps to antitrust considerations; also each cotenant, any consortium of cotenants, or any outsider has the right to expand capacity and acquire title to all new capacity. That freedom of entry makes the cotenancy competitive by removing the ability of an infrastructure incumbent to block competitive entry. Each cotenant's surplus capacity of customer hook ups can be used to solicit customers anywhere in the local network. Wires regulation would be unnecessary, beyond some oversight function, as each cotenant would have an incentive to minimize the operating cost of the wires joint venture.

Under all three options, competing energy suppliers would be free to bypass both the distribution and transmission system wires by locating small distributed generation sources near the end use customers. These options give free rein for the development of new technologies motivated by the savings that could be attained and turned into potential profit for the innovators. Existing technologies may or may not be the most cost efficient for the power future, and consumers are long overdue to benefit from technological competition.

Any reform that separates the market for wires from the market for energy will be vigorously resisted by the local franchised monopoly. From the beginning of state regulation nearly 100 years ago, these monopolies have had the right to tie in the sale of energy with the rental of the wires network. This *de facto* right is jealously guarded and protected. Yet in other areas of the economy, antitrust laws prohibit tie-in sales.³ Many regulators will also resist these changes because it means that energy prices will be regulated by competition, rather than by regulators applying average cost of service formulas.

Many citizens will be wary of such changes because they see the California debacle as a consequence of “deregulation,” not understanding that California did nothing to deregulate retail energy. Yet this was the crux of California's failure: wholesale markets were deregulated without first moving to deregulate the key retail sector as indicated in these options. This precipitated a crunch with unresponsive demand impinging on limited supplies causing highly volatile wholesale prices that drained the local monopolies of their financial resources.

IV. Barriers and Issues

Obstacles to double-sided markets include metering and billing technology, existing state-level regulations, regulatory uncertainty at both the state and federal levels, and 75 years of embedded culture that is resistant to change.

³ For an overview of the antitrust issues in tying, see Tirole (2005).

Double-sided markets require infrastructure for communicating prices clearly to customers, enabling the supplier to meter, record and store actual usage by time period that corresponds to the time period over which prices change. Conventional watt-hour metering only allows average pricing, and does not present the energy consumer with any incentives to reduce peak use, or to shift from peak to non-peak use (peak shaving).

Sophisticated metering, billing, and response technologies are widely available and can be implemented cost-effectively, especially for large energy consumers. All of the technology to implement market-based pricing does exist, but the industry has not yet coordinated on an industry standard. This lack of real-time metering lowers both average and marginal demand elasticity, and customers have never developed the habit of thinking about how much their electricity costs and different ways of using it and paying for it. This lack of information severs the link between consumer choices and wholesale prices. Average watt-hour metering prevents the distribution utility and the retail provider (if they are separate) from observing the customer's actual consumption patterns during the day, so utilities assign customers a statistical load profile that is an average of similar consumers. These load profiles do not reflect the customer's actual usage, and unless consumers and producers can observe that actual usage, consumers cannot benefit from demand shifting, voluntary interruption, or use curtailment.

The investment incentives facing utilities, which currently own the simple watt-hour meters installed in most buildings, are heavily dependent on the rules that regulators devise for billing and access to meter data. Utilities do not have strong incentives to install sophisticated meters if they either will not own them, or will not reap the profits that could come from using them. However, in most states utilities can also block customer access to their own consumption data that would give competing retailers an incentive to offer smart meters and other technologies that tap customer demand, such as grid-friendly appliances. In addition to the issue of data ownership, meter ownership and meter use, the issue arises of who will pay for the meters. Utilities currently hesitate to invest in new meters because of ongoing questions regarding whether or not the metering function will stay with the retail utility; if not, then the investment could become "stranded."

Existing government regulations form another set of obstacles to market-based pricing, both at the state and federal level. The traditional rate structure, fixed by state regulation and slow to change, presents a substantial barrier to double-sided markets. Predetermined load profiles inhibit market-based pricing by ignoring individual customer variation and the information that customers can communicate through choices in response to price signals. Furthermore, the persistence of standard offer service at a discounted rate (i.e., a rate that does not reflect the financial cost of insurance against price risk) stifles any incentive customers might have to pursue other pricing options. In state-level regulation, standard offer service requires the distribution utility to offer a discounted and average electricity price that does not vary. The discount means that the price does not reflect the financial insurance benefits of fixed electricity prices and consequently underprices the financial insurance component of electricity prices, at least for certain customers.

Other government barriers include regulatory uncertainty about future government regulations and market design, including price caps, market power mitigation and *ex post* refund power. This uncertainty tends to make participants stick with the known, yet unsatisfying, regulatory pricing environment. At the federal level, FERC price caps and market mitigation rules, whether soft or hard, also reduce customer incentives to participate in voluntary demand response programs. At the state level, ISOs can and do stifle demand response through their focus on supply and generation in wholesale markets, where there are fewer participants that trade larger volumes. But ISOs can still play a role in developing demand responsiveness, by accepting different types and sizes of market participants that are not able to participate in ISO system balancing as it is currently arranged. (Hirst June 2002, p. 10). This participation is a linchpin of our double-sided market model. Finally, the lack of coordination between state and federal jurisdictions, and between wholesale and retail institutions that affect retail demand, have increased the transaction costs of moving to a more demand-responsive, integrated electricity market.

The most important, yet also the most intangible and difficult to change, obstacle to double-sided markets is the set of incentives for inertia. The primary stakeholders in the industry – utilities, regulators, and customers – all have status quo bias. Incumbent utilities face incentives to maintain the regulated status quo to the extent possible, given the economic, technological and demographic changes surrounding them; they have been successful at using the political process to achieve this objective. Customer inertia is deep because they have not had to think about their consumption of electricity and the price they pay for it; consumer advocates typically reinforce this bias by arguing for low, stable prices for highly reliable power as an entitlement. Regulators and customers explicitly value the stability and predictability that the vertically-integrated, historically supply-oriented and reliability-focused environment has created. But what is unseen and unaccounted for is the opportunity cost of such predictability – the foregone value creation in innovative services, empowerment of customers to manage their own energy use, and use of double-sided markets to enhance market efficiency and network reliability. Compare this unseen potential with the value creation in telecommunications, where even young adults can understand and adapt to cell phone pricing plans, and benefit from the stream of innovations in the industry.

The utility, the regulator, and the customer all have almost a century of experience and tradition underpinning their current decisions, and are disinclined to change. As long as consumers, utilities, politicians, and regulators continue to accept the obsolete argument that electricity prices should not vary over time, we will all lose the opportunity to use double-sided markets to manage our price risk and bring innovative services into being. The status-quo bias remains one of the most potent and challenging obstacles to customer empowerment and system reliability through retail choice.

V. Conclusion

The benefits of double-sided markets include increased static and dynamic efficiency, better capacity utilization, pricing patterns that better reflect actual costs, reduction of price spikes, decentralized mitigation of market power, and improved risk management. All of these benefits create additional system reliability and infrastructure security through the decentralized actions of motivated buyers and sellers. Harnessing the beneficial tensions between buyers and sellers in

both wholesale and retail markets provides a wider range of value than has heretofore been seen through the sporadic implementation of demand response programs through utilities and ISOs.

Customer response to price changes benefits not only those who respond, but also other customers and the system as a whole. Reducing peak use reduces wholesale market prices and long-run investment requirements that affect all customers, not only those who choose to see price changes. Giving customers the right and ability to say “not at that price” is a powerful tool for both efficiency and fairness. In demand response pilots, customers have been empowered to save up to 15 percent on their monthly bills (GAO 2004).

Our double-sided market model incorporates integrated wholesale and retail markets, with price signals transmitting information among them from both buyers and sellers in both types of markets. It also relies on integrated spot and forward markets to ensure that those price signals communicate information regarding future expectations, including robust investment signals. In this model, the role of the ISO is to perform transparent system operation functions, and to offer one, although not the only, market platform for these integrated markets. Relegation of demand response to an ancillary service or to a program is an insufficient substitute for the vigorous interaction of supply and demand across time and supply chain in integrated, double-sided markets.

Utilities can also benefit from ISO demand response programs, and from double-sided markets. The historic development and regulation of the industry has led to a culture in which the prevailing business model for a utility is “sell more power, make more profit.” In this world, utilities are prone to perceive the load reduction that can come from demand response as a direct assault on their profits. But what demand response and double-sided markets show is that electricity can be sold as a differentiated product according to time, not just as homogeneous electrons. Furthermore, that differentiated product can be priced in ways that reflect the true cost of selling it in that hour. A differentiated energy product could also sell different levels of reliability at different prices to cater to heterogeneous preferences, thereby creating more dimensions on which the ISO can manage system operations and reliability.

Double-sided markets open up the potential for utilities to make more profit by selling less power, because they enable the dynamic pricing that can increase revenue on power sold in peak hours. But they have to see it as a viable business proposition, and regulators have to show leadership in enabling utilities to offer their customers a portfolio of contracts from which to choose, even those that include choosing to pay higher prices some of the time, or choosing to pay less for lower reliability or lower quality service.

Double-sided markets can also reduce the utility’s costs in the long run. The level of peak demand determines investment in generation and transmission assets, and the more extensive active demand and double-sided markets become, the longer is the timeframe between costly and unpopular investments. Unfortunately, in the current regulatory environment based solely on cost recovery and profit as a rate of return on assets, neither the utility nor the regulator has incentives to provide the means for saving on future investment.

If utilities, regulators, and politicians consider the possibility that utilities can offer different value propositions to their customers than just “juice coming through the wall,” utilities can benefit from using market-based pricing as a tool for offering an attractive portfolio of service options to their customers. Creating value from this change, though, requires vision, and getting the transitions and the institutions right can be extremely difficult. Consumers will have to change how they think about buying electric service, and what that service is, exactly. For that change to occur, politicians and regulators will have to act on the leadership and vision that would allow consumers to take responsibility for their individual purchasing choices.

All efforts to reform the electric industry are failing because of the lack of two-way markets. Yet each region has something to build on. The RTOs have a fair amount of competition for generation and strong dispatch systems that have the capacity to price location and time properly (though that doesn’t work in practice yet for most customers). The West has a strong bilateral market with a long and mostly successful history. The southeast has the most experience with real-time pricing. The path for evolution in each place should build on what works today. There’s no reason to despair – or to be complacent – anywhere. Real benefits to customers are lost the longer we fail to empower them with retail competition, undergirded by ISO system operation and by robust wholesale markets.

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