Wholesale Electricity Procurement Strategies for Serving Retail Demand

*By Joseph Cavicchi**

Introduction

With retail electricity competition starting out slowly in those states where the ability to choose a supplier has been introduced, there has been limited visibility into the challenges facing companies that compete to supply electricity supplies at retail. Due to the proliferation of administratively determined retail rates that resulted from most states' electricity industry restructuring laws, large numbers of retail electricity consumers have enjoyed stable, low rates during the transition process that has been ongoing in many states over the past several years. The combination of the end of these transition periods and a significant excess supply of new generation units is starting to spur more competitive solicitations to supply these retail loads. At the same time, state regulatory commissions are beginning to grapple with how to ensure that those consumers who are not receiving competitive supply offers will realize stable, competitive rates in the future. With these changes now beginning to take hold, an increased focus on bridging the wholesale and retail electricity markets will emerge. The ability of entities to carefully manage load and price volatility will increase as companies test the limits of the wholesale markets to provide the types of flexible products needed to manage retail loads. These increased experiences will help to define procurement approaches that will stand the test of time and offer parties on both sides of a contract the type of protection they need. At the same time, consumer demands will begin to be registered more accurately in the forward and spot markets as wholesale purchases and sales become more active.

This paper discusses approaches available to wholesale suppliers for pricing retail offers either to large groups (or classes) of consumers or to individual consumers or consumer classes. Because we believe that the approach that results in manageable risks requires the purchase of fixed priced hedges, and on occasion options, we provide empirical analyses that show how the premiums for these combinations of products will impact retail price offerings. Our analytical approach relies on a set of forecasts of future hourly spot prices[1] and market-based forward prices that are then combined with concurrent expected hourly loads to evaluate pricing levels that minimize cost variance for suppliers, but that explicitly consider future supply and demand levels. We believe that these types of analyses will become more common (if they have not already, given the increased availability of hourly data) as industry participants engage the more transparent wholesale markets that are emerging as a result of industry restructuring.

Our results clearly show that it is possible to use combinations of wholesale electricity products to manage price and demand risk while offering consumers short- and medium-term fixed prices. The use of forward market hedges permits suppliers (and could also permit large users) to levelize their estimates of cost to offer services by limiting ability to benefit from lower future prices and protecting against higher future prices. In addition, the use of options can provide insurance against both price and demand risk, although this insurance comes at a cost that requires careful consideration vis-à-vis low probability high price or high load migration events. In all cases these various approaches are actively reducing the amount of volatility that suppliers (and consumers) face in the wholesale market. The final outcome is limited exposure to occasional short-term market price spikes.

Although during recent times it may have seemed that competitive wholesale electricity markets were slow to provide benefits, many entities have expended significant efforts to ready themselves to compete in these markets, and it is only a matter of time before the increased efficiencies that are resulting will appear in the form of lower prices and improved service offerings. As market participants enhance their ability to use wholesale market products and various bilateral contracts as a means of offering fixed prices to consumers, a mature group of competitors will begin to solidify, using some of the techniques described in this paper to manage the risks associated with selling electricity.

Various Future State Default Service Policy Changes Will Increase Demand for Various Fixed-, Longer-, and Shorter-Term Retail Rates

The increased focus on default service has been noted in many forums.[2] In many states the restructuring process included the provision of electric service to most consumer classes at rates that were established through regulatory proceedings. Unless a state envisioned offering retail consumers rates that were determined by ongoing competitive solicitations, consumers are insulated from wholesale market price variations.[3] Behind many of these fixed rates are either long-term supply contracts between electricity distribution companies and those entities that now own or have built power plants in the region where load is located, or power plants that continue to be owned by a corporate entity that has both regulated and unregulated operating divisions. Throughout the transition period, wholesale price variation risks have largely been managed through these contracts and/or plant ownership.

The impending modification of default service pricing policies will significantly impact the retail and wholesale marketplaces. In many instances, default service pricing that has been utilized to date did not require that consumers understand the types of price risk they actually faced given the invariant rates.[4] Heretofore these risks have been falling on suppliers or distribution companies, although in many instances back onto consumers through ex post rate adjustments carried out at some date in the future long after the

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[1] See footnotes at end of text.

expenditures were incurred. Depending upon contractual arrangements between suppliers and distribution companies, and upon how distribution companies' transitions were managed by regulators, there are various levels of monies in dispute related to the distribution of this price risk.

As regulators consider modifications to default service pricing policies, there is considerable discussion about how to ensure that consumers see rates that are consistent with the regulatory goals outlined by various states. Because the onset of competitive suppliers has varied significantly among rate classes, we see approaches being taken to managing default service provision that vary along the lines of consumer class. For example, Massachusetts has recently decided that larger consumers should have default service rates that are closely tied to the wholesale markets, while residential consumers should have available rates that do not change too often.[5] Similarly, Maryland has recently completed a significant investigation of the provision of standard offer service (in Maryland, this is default service) and determined that competition to supply residential consumers is limited and that it is in the public interest to provide these consumers with rates based on portfolio procurements of electricity.[6] New Jersey has recently adopted descending auction formats to solicit its default service supplies (basic generation supply) for its distribution company consumers that are not served by competitive suppliers. Default service procurement policies can vary considerably, and given the large number of consumers served on these rates, how suppliers are asked to price service to these loads will impact the wholesale market and drive the types of contractual arrangements that are necessary to manage the risks.

For example, if distribution companies are required to establish short-term rates for certain consumer classes, then LSEs will be in the market regularly buying potentially large quantities of power for delivery in the next month or quarter. Because prices are much more volatile over shorter versus longer terms, these rates will be elevated compared to rates that are levelized over some longer time period. The expectation is that consumers facing these rates will solicit supplies from the competitive market in order to manage this price risk. To the extent this occurs, the wholesale market benefits as generation plant owners ultimately see more stable revenues and buyers face more stable prices. Because suppliers have rarely been asked to provide these sorts of products to distribution companies, their need will drive the development and use of various techniques to meet these uncertain demands over time.

At the same time there are several states that will act to stabilize the rates faced by consumer classes that are not aggressively courted by competitive suppliers.[7] Currently there are some default procurement policies that provide limited rate stability to these smaller consumers while still exposing them to changes in wholesale prices,[8] while there are some policies that clearly do not expose these smaller consumers to wholesale market price variations. As default policies are reviewed and modified to adapt to the end of restructuring transition periods, an increased demand will be placed upon retail suppliers to offer various longer-term fixed rate products. The demand for these products will be important to the underlying health of the generation side of the industry and will also lead to innovation and creativity in the types of techniques used to manage the risks associated with these longer-term products. Although there are currently these types of longer-term agreements in place between large generation-owning companies and their affiliate LSEs, when the regulatory framework begins to shift to further embrace competition, there will be greater competition to provide these products.

At the same time, regulators can consider offering consumers who receive default service under rates that have been historically invariant new rate structures that link usage to market-based pricing. Even though these consumers' demands will be planned for by default service providers, to the extent they experience rates that engender an interest in searching for an alternative supplier (e.g., an entity willing to provide a fixed price over some time frame), their demand will be registered elsewhere. This risk of consumer migration can be managed by suppliers as a function of individual company wholesale market price expectations. In many instances, consumers may be switching to the same supplier and paying less as the certainty provided to the supplier will lead to a lower price, but over a longer time period. Therefore, it is possible to continue efforts on programs to improve consumer pricing while at the same time allowing wholesale markets to mature.

As we continue to adapt to the new institutional structures that have been put in place to facilitate the provision of electricity service competitively at both retail and wholesale, market participants will actively adapt themselves to meet these new challenges.[9] Surely many of the most interesting arrangements will remain invisible to the outside world, although their complexity has already increased dramatically, and the means by which contracts are satisfied, and risks are distributed, will change accordingly. The rest of this paper focuses on illustrating various approaches that can be utilized to manage wholesale procurement in order to satisfy fixed retail rate commitments. Going forward, these types of approaches, and others, will emerge, as market participants become comfortable with the types of analyses that are required to manage these risks. It is the management of these risks that we have asked the competitive market to handle and the demands placed on suppliers will greatly impact the later stages of transition. The need for good, efficient contracting (and institutions that support it) is crucial to the success of the industry.

Wholesale Procurement Approaches to Satisfy Retail Loads at Fixed Prices

In this section we empirically examine hedging approaches for using standard wholesale market electricity products to provide supplies for delivery at retail. To conduct these pricing analyses, we used forecasted locational marginal prices for various future scenarios (calculated using a security-constrained dispatch model) in combination with publicly available electricity forward price data.[10] In adopting this analytical approach, we are recognizing that first, historical market price data for electricity products have only been widely available and truly market-based for a few years, and second, that discrete decision-making is more easily bounded by a scenario analysis that includes various options. This analysis can be thought of as a branch of a decision tree where other branches might be to own or build a resource, procure only on the spot market, or use combinations of physical and financial hedges.[11]

Before adopting this approach, we considered a more explicit statistical approach, but due to the limited availability of historical data it is very difficult to rely on statistical pricing approaches as a primary means of estimating future costs to supply various consumer classes.[12] Additionally, statistical techniques require that assumptions be made for the distributions of underlying random variables (most notably price), and currently there is no general agreement on the most suitable distribution assumption for hourly electricity prices.[13] By using a structural modeling approach, we are able to consider location risks, supply disruptions, regulatory frameworks, and other important elements of actual wholesale electricity markets.[14] Therefore, we have elected to rely on structural modeling techniques combined with well known decision-making approaches that can be effectively used by businesses.[15]

A major issue of importance in our analysis was the use of a portfolio of supplies, including various types of hedge products. Pricing formulations tend to rely on accurate statistical measures that can then be used to calculate prices that presumably can be offered without hedging if the statistical results are accurate. Although hedges and options can increase costs, they provide the type of insurance against major risks that entities desire when participating in electricity markets. Using a scenario-based structural approach allows a straightforward investigation into the potential benefits that result when using different purchasing strategies.[16] For example, when buying hedges for firm delivery and/or put and call options, it is possible to calculate the projected costs and benefits of these approaches based on expected spot prices and demands. Although the process is not exhaustive (compared to a Monte Carlo approach), it does provide considerable insight into how costs can change under various future scenarios and permits an analyst to focus on those uncertainties that are the most significant from a risk management perspective. Our analysis focuses on evaluating a spectrum of costs that could be incurred to serve various demand patterns, given the recognition that some level of insurance is necessary to account for future uncertainty.[17]

In the following sections, we present various analyses that use hourly locational marginal price forecasts and forward market data as a means of developing retail price estimates. We provide examples of how wholesale markets can be exclusively used to supply retail consumers for terms of between months upwards to three to five years. We examine thE costs and benefits of using various hedging scenarios compared to the alternative of relying exclusively on the spot market. Our results are reported as expected costs to serve various retail consumer classes; these values represent ranges of pricing that could be proposed by a supplier bidding to serve retail loads. New suppliers providing the type of mid-term, fixed-price products we evaluate will be critical to the ongoing competitive transformation of the electricity industry.

Procurement Approaches

The provision of fixed price electricity services can entail a considerable amount of risk. Because most widely traded electricity forward products envision the delivery of fixed blocks of power, we cannot rely on an analytical formulation that envisions a product that cannot be purchased in a conventional forward contract.[18] There are actually a variety of approaches that can be envisioned for developing pricing based on available wholesale products, although each has the potential to under- or over-estimate future supply costs so that offering a fixed price can, in some instances, be a rather risky proposition. Below are three approaches that can be used to resolve this problem. We first describe the elements of the approach that are common across all three examples; we then describe in greater detail components that are specific to an individual approach. Finally, we present and discuss the results of the analysis for each approach and compare it with a no-hedging approach that assumes all purchases are made at the forecasted hourly spot prices.

Each of the following approaches relies in part on a so-called overall procurement approach that refers to the underlying portfolio of supplies that a buyer decides to have available to serve its consumers. For example, a buyer that has, or expects to have, the responsibility to serve a set of consumers over a time frame of a few years will likely elect to procure various supply products ahead of expected delivery. For example, an entity might elect to buy 20% of its expected deliveries for a term of three years in advance, 20% two years in advance, and 30% one year in advance in order to provide some cost certainty. Remaining amounts can be procured using various risk management approaches applicable to purchases made in months, weeks, or days prior to expected delivery. Various combinations of terms and quantities can be explored within the price and quantity expectations that a buyer develops (i.e., within each approach there can be a range of expected costs to meet demand). Estimates of the costs associated with these various approaches can be developed, recognizing the risks associated with electricity procurement. Finally, with any of the approaches there has to be recognition and inclusion of various additional costs incurred by a supplier including, but not limited to, transmission fees (including losses), ancillary services fees, capacity costs, congestion costs, and overhead and profit.

Our three examples illustrate how fixed retail prices could be calculated under different procurement approaches. Our analyses focus on the state of Massachusetts in the Northeast and Pennsylvania in the Mid-Atlantic. In the analyses for each of these states we calculate estimates of the costs to supply retail service for various consumer classes under each of the three approaches (these estimates would form the basis of pricing offers). One approach assumes that a combination of the spot market and annual forward market products are used exclusively to procure supplies (limited hedging); a second approach assumes that additional forward procurements beyond those envisioned in the limited hedging scenario are made on a monthly or seasonal basis (a larger portfolio of short- and long-term contracts) in order to provide additional cost certainty and less reliance on the spot market; and, a third approach assumes that in addition to the portfolio of short- and long-term contracts developed for scenario two, call options are purchased as insurance against short-term (less than one year in the future) price and load volatility. The general approach for making these calculations is described as follows.

First, as we described above, for each approach we make purchasing assumptions that intend to strike a balance between forward and spot purchases.[19] In the limited hedging approach, we assume all purchases are made as a combination of forward market annual contract purchases and future hourly spot markets (ISO-New England and PJM Interconnection). For the remaining two approaches, we make portions of the purchases ahead of the delivery time and accordingly reduce exposure to the spot markets. For each approach we report calculated cost estimates as weighted averages, although the calculations are made on an hourly and monthly basis before averaging.

Table 1 shows numerically the considerable difference in volatility of these price streams. The low volatility products are those that provide supplies for months and years, while the high volatility supplies are for short-term delivery such as day-ahead. Limiting exposure to the high volatilities while capturing the benefits available from the lower volatility products is a key focus of our analysis. Each of the approaches is described as follows.

Table 1
Daily, Monthly and Annual Volatility within NEPOOL Forward and Spot Markets

	Spot Market Houly Prices	Forward Market Year 2001 on-Peak Contract	Forward Market Year 2002 on-Peak Contract	Forward Market Year 2003 on-Peak Contract
Daily Volatility	26.11%	1.97%	1.18%	5.21%
Monthly Volatility	128.83	9.04	8.27	23.86
Annual Volatility	444.52	31.18	28.55	82.32

Note: The assumes 250 peak days per year and 21 peak days per month.
Source: NEPOOL and Natsource.

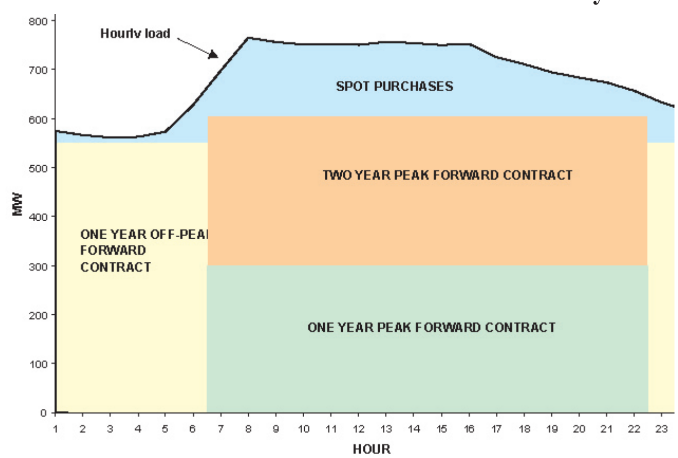
Approach 1: Limited Hedging

Methodology

This approach might be utilized if an entity has the expectation that future spot market prices will not be very volatile, or if an entity has a physical hedge available. The basic idea behind this approach is to determine minimum expected monthly hourly on-peak and off-peak demands and make forward purchases to cover these minimums, and then assume that the balance of the required energy is purchased from the spot market using expected hourly spot market prices (i.e., the forecasted location marginal prices). A practical description of an approach to carry out this calculation is as follows.

First, we need to select procurement quantities consistent with the approach we are using. We use consumer class monthly hourly demands developed from historical data to determine forward purchase amounts that are designed to avoid the need to sell back supplies during shoulder hours.[20] Using this analysis we establish procurement quantities in megawatts on-peak and off-peak per month. Figure 2 illustrates an example of how we identify quantities for this portfolio approach. The figure illustrates how forward purchase quantities for ISO-New England's Northeast Massachusetts/Boston area were determined for the analysis. Based on the forward market data available during Spring 2003, we determined the minimum yearly hourly demand and assumed the purchase of a one-year off-peak energy delivery contract at this level for the years 2003 and 2004. Thereafter we determined the minimum on-peak hourly demand and assumed the purchase of one-year and two-year forward contracts that both are at a quantity that splits the yearly minimum on-peak demand evenly.[21] The result is a portfolio of purchases made at forward market prices that prevailed during Spring 2003.

Figure 2
Limited Hedging Procurement Strategy-Samle Load Curve and Breakdown of Purchases for a Day



With assumed forward contract purchases identified, we then use forward contract price data to establish estimates of costs that will be incurred to carry out these forward purchases. We then calculate average total energy costs to serve the projected consumer class hourly demands using appropriate combinations of forward contract and forecasted locational marginal spot prices as applicable by year.[22] Finally we add 1.5 cents/KWh for other additional costs such as ancillary services, transmission, capacity, and overhead and profit that need to be added to the energy price to determine a complete estimate of the cost to serve.[23]

Results

The results of the calculations are shown on monthly and annual bases in Tables 2-4. The results presented are

Table 2A
Forecast Monthly Electricity Cost Using Various Procurement Strategies to Meet Retail Demand Massachusetts-Boston Region

Procurement Cost and Range (cents per KWH)*
(range in parenthesis)

Consumer Class/ Month	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential				
Jul-03	5.88-7.26 *(1.37)*	5.63-6.36 *(0.72)*	6.36-6.50 *(0.14)*	6.45-6.62 *(0.17)*
Aug-03	6.56-8.13 *(1.57)*	5.98-6.86- *(0.89)*	6.35-6.63 *(0.28)*	6.46-6.66 *(0.2)*
Sep-03	5.25-5.88 *(0.63)*	5.20-5.46 *(0.26)*	5.37-5.52 *(0.15)*	5.36-5.51 *(0.15)*
Jan-04	4.40-5.83 *(1.42)*	4.88-5.76 *(0.88)*	5.72-6.03 *(0.31)*	5.72-6.03 *(0.31)*
Feb-04	4.19-5.47 *(1.28)*	4.75-5.52 *(0.77)*	5.69-5.87 *(0.19)*	5.65-5.85 *(0.21)*
Large C&I				
Jul-03	5.76-7.07 *(1.31)*	5.42-5.92 *(0.5)*	5.86-5.99 *(0.13)*	5.99-6.14 *(0.15)*
Aug-03	6.41-7.89 *(1.48)*	5.68-6.32 *(0.64)*	5.93-6.19 *(0.26)*	6.05-6.24 *(0.19)*
Sep-03	5.16-5.75 *(0.59)*	5.11-5.28 *(0.18)*	5.19-5.32 *(0.12)*	5.18-5.31 *(0.13)*
Jan-04	4.33-5.64 *(1.32)*	5.08-5.59 *(0.51)*	5.59-5.78 *(0.19)*	5.53-5.76 *(0.23)*
Feb-04	4.13-5.32 *(1.19)*	5.02-5.45 *(0.43)*	5.55-5.69 *(0.13)*	5.49-5.66 *(0.16)*
Medium C&I				
Jul-03	5.99-7.53 *(1.53)*	5.72-6.52 *(0.8)*	6.47-6.64 *(0.17)*	6.65-6.83 *(0.17)*
Aug-03	6.69-8.37 *(1.68)*	6.06-6.99 *(0.94)*	6.44-6.75 *(0.31)*	6.59-6.81 *(0.22)*
Sep-03	5.33-5.98 *(0.65)*	5.27-5.57 *(0.29)*	5.49-5.63 *(0.14)*	5.48-5.63 *(0.15)*
Jan-04	4.42-5.84 *(1.42)*	5.00-5.75 *(0.75)*	5.82-6.04 *(0.22)*	5.74-6.01 *(0.27)*
Feb-04	4.20-5.49 *(1.29)*	4.88-5.56 *(0.68)*	5.78-5.92 *(0.14)*	5.70-5.88 *(0.18)*
Small C&I				
July-03	5.80-7.14 *(1.34)*	5.60-6.39 *(0.8)*	6.27-6.49 *(0.22)*	6.46-6.62 *(0.16)*
Aug-03	6.43-7.93 *(1.49)*	5.95-6.88 *(0.93)*	6.32-6.62 *(0.3)*	6.41-6.66 *(0.25)*
Sep-03	5.13-5.72 *(0.59)`*	5.09-5.39 *(0.3)*	5.27-5.44 *(0.16)*	5.27-5.44 *(0.16)*
Jan-04	4.32-5.63 *(1.32)*	4.80-5.60 *(0.8)*	5.54-5.86 *(0.32)*	6.14-6.42 *(0.28)*
Feb-04	4.12-5.30 *(1.18)`*	4.70-5.39 *(0.68)*	5.48-5.69 *(0.21)*	5.53-5.72 *(0.18)*

*Cost range results from evaluating future procurement costs using five forecast scenarios for hourly electricity prices. The values shown are the calculated energy cost plus a 1.5 cent cost adder that is used to account for additional costs such as ancillary services, transmission (to utility boundary) capacity, overhead and profit.

Table 2B
Forecast Monthly Electricity Cost Using Various Procurement Strategies to Meet Retail Demand Pennsylvania-Central East Region

Procurement Cost and Range (cents per KWH)*
(range in parenthesis)

Consumer Class/ Month	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential				
July-03	5.94-7.38 *(1.44)*	5.48-6.20 *(0.72)*	5.91-6.07 *(0.16)*	6.04-6.19 *(0.14)*
Aug-03	6.61-8.22 *(1.61)*	5.8-6.65 *(0.85)*	5.94-6.24 *(0.3)*	6.05-6.29 *(0.24)*
Sep-03	5.26-5.90 *(0.64)*	4.97-5.21 *(0.23)*	5.05-5.20 *(0.14)*	5.04-5.20 *(0.15)*
Jan-04	4.39-5.79 *(1.4)*	4.63-5.56 *(0.94)*	5.08-5.51 *(0.43)*	5.95-6.34 *(0.39)*
Feb-04	4.18-5.44 *(1.26)*	4.50-5.29 *(0.8)*	5.05-5.30 *(0.25)*	5.94-6.17 *(0.23)*
Large C&I				
Jul-03	5.74-7.03 *(1.29)*	5.16-5.65 *(0.48)*	5.45-5.58 *(0.13)*	5.55-5.69 *(0.14)*
Aug-03	6.37-7.82 *(1.45)*	5.41-6.00 *(0.59)*	5.52-5.79 *(0.28)*	5.60-5.82 *(0.22)*
Sep-03	5.15-5.74 *(0.59)*	4.82-4.99 *(0.17)*	4.87-5.00 *(0.13)*	4.85-5.00 *(0.14)*
Jan-04	4.33-5.66 *(1.33)*	4.81-5.21 *(0.39)*	5.03-5.20 *(0.16)*	5.00-5.20 *(0.19)*
Feb-04	4.13-5.33 *(1.2)*	4.72-5.08 *(0.36)*	5.01-5.12 *(0.11)*	4.95-5.11 *(0.16))*
Medium C&I				
Jul-03	5.80-7.15 *(1.34)*	5.22-5.79 *(0.57)*	5.52-5.70 *(0.18)*	5.69-5.84 *(0.15)*
Aug-03	6.46-7.96 *(1.51)*	5.52-6.24 *(0.72)*	5.63-6.94 *(0.31)*	5.77-6.00 *(0.22)*
Sep-03	5.20-5.80 *(0.61)*	4.87-5.08 *(0.21)*	4.93-5.06 *(0.13)*	4.93-5.06 *(0.13)*
Jan-04	4.36-5.72 *(1.36)*	4.80-5.30 *(0.5)*	5.06-5.29 *(0.23)*	5.09-5.29 *(0.2)*
Feb-04	4.15-5.38 *(1.23)*	4.67-5.15 *(0.48)*	5.02-5.18 *(0.16)*	5.77-5.92 *(0.15)*
Small C&I				
Jul-03	5.91-7.36 *(1.45)*	5.41-6.14 *(0.73)*	5.81-6.03 *(0.21)*	6.03-6.18 *(0.15)*
Aug-03	6.61-8.23 *(1.62)*	5.75-6.63 *(0.88)*	5.90-6.22 *(0.32)*	6.06-6.29 *(0.23)*
Sep-03	5.27-5.90 *(0.63)*	4.97-5.23 *(0.26)*	5.06-5.19 *(0.13)*	5.06-5.19 *(0.14)*
Jan-04	4.38-5.77 *(1.39)*	4.72-5.43 *(0.71)*	5.11-5.41 *(0.3)*	5.92-6.21 *(0.3)*
Feb-04	4.18-5.44 *(1.26)*	4.60-5.25 *(0.65)*	5.08-5.28 *(0.2)*	5.99-6.21 *(0.21)*

*Cost range results from evaluating future procurement costs using five forecast scenarios for hourly electricity prices. The values shown are the calculated energy cost plus a 1.5 cent cost adder that is used to account for additional costs such as ancillary services, transmission (to utility boundary) capacity, overhead and profit.

for a representative utility distribution company in each state examined. In the case of Massachusetts, the analysis is focused on the Boston region, while in Pennsylvania, the focus is the central-eastern region of the state. The results show the estimated future costs to meet the demands of four consumer classes (residential, and large, medium, and small commercial and industrial) for various months, and on an annualized basis, using the three different procurement approaches described above to manage risk. The case where all supplies are assumed purchased on the hourly spot market is also shown to illustrate the benefits of hedging. The resultant values can be thought of as the price level, or range of price levels, that an entity would charge to provide service to a particular consumer class. Tables 2A-B depict the monthly results of the analysis for those months where we assumed hedges would be purchased. Table 3 shows similar results, although they are presented on an annualized basis. All the results shown in Tables 2A-B and 3 are the estimated range of monthly and annual costs that result from using five different hourly spot price forecasts to make the calculations.[24] Finally, Table 4 shows the same results for a single price forecast where we test the impact on the results of introducing 30 $500/MWh spikes during the months of July and August. Most importantly, the results show how the procurement approaches impact price range and level and reveal the premiums associated with insuring against spot market volatility.

Table 3
Forecast Monthly Electricity Cost Using Various Procurement Strategies to Meet Retail Demand
July 2003 - June 2004
Massachusetts - Boston Region
Procurement Cost and Range (cents per KWH)*
(range in parenthesis)

Consumer Class	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential	4.84-5.92	5.10-5.67	5.37-5.73	5.38-5.73
	(1.08)	*(0.58)*	*(0.36)*	*(0.35)*
Large C&I	4.81-5.81	5.16-5.51	5.32-5.54	5.33-5.55
	(1)	*(0.35)*	*(0.22)*	*(0.22)*
Medium C&I	4.94-6.05	5.20-5.76	5.46-5.80	5.47-5.80
	(1.11)	*(0.56)*	*(0.34)*	*(0.33)*
Small C&I	4.79-5.79	5.02-5.59	5.27-5.63	5.40-5.73
	(1)	*(0.57)*	*(0.36)*	*(0.33)*

Pennsylvania-Central East Region
Procurement Cost and Range (cents per KWH)*
(range in parenthesis)

Consumer Class	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential	4.83-5.92	4.86-5.45	5.01-5.39	5.50-5.86
	(1.09)	*(0.59)*	*(0.38)*	*(0.35)*
Large C&I	4.81-5.80	4.84-5.16	4.92-5.14	4.93-5.15
	(0.99)	*(0.32)*	*(0.22)*	*(0.23)*
Medium C&I	4.85-5.88	4.87-5.27	4.96-5.23	5.13-5.37
	(1.03)	*(0.4)*	*(0.27)*	*(0.24)*
Small C&I	4.91-5.98	4.91-5.43	5.04-5.38	5.40-5.70
	(1.08)	*(0.52)*	*(0.34)*	*(0.3)*

*Cost range results from evaluating future procurement costs using five forecast scenarios for hourly electricity prices. The values shown are the calculated energy cost plus a 1.5 cent cost adder that is used to account for additional costs such as ancillary services, transmission (to utility boundary) capacity, overhead and profit.

In the case of the limited hedging strategy we immediately observe the significant reduction in the estimated range of costs that would be incurred when serving the different consumer classes. In particular we see that just simply buying a portion of the expected required supply in annual contracts leads to a substantial reduction in the risk of cost variance. For example, Tables 2 and 3 show that the range of estimated costs decreases by nearly 50% (or more) on both a monthly and an annual basis. Results in Tables 2A-B show how substantial additional benefits occur in the summer months, when not only is the range of cost much lower, but both the low and high cost estimates are reduced, showing the benefit of making long-term purchases where pricing is much less volatile. Tables 2A-B also show how the benefits of the annual contracts are less prominent in winter months, when low side costs increase and high side costs do not decrease as much when compared to the summer months. Table 3 shows how the results change when we consider annualized values. Here we consistently see that the low-end cost estimates increase, while the high-end values continue to decrease. Of particular interest in these results is how the low-end increases are higher for Massachusetts when compared to Pennsylvania.

Table 4
Forecast Monthly Electricity Cost Using Various Procurement Strategies to Meet Retail Demand
Price Spike Case
Massachusetts - Boston Region
Procurement Cost (cents per KWH)

Consumer Class/Mo.	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential				
July-03	7.84	6.72	6.56	6.54
Aug-03	8.75	7.26	6.74	6.68
Jul03-Jun04	6.02	5.74	5.75	5.74
Large C & I				
Jul-03	7.63	6.19	6.10	6.07
Aug-03	8.46	6.63	6.30	6.24
Jul03-Jun04	5.92	5.56	5.56	5.54
Medium C & I				
Jul-03	8.21	6.95	6.78	6.74
Aug-03	9.03	7.41	6.87	6.81
Jul03-Jun04	6.17	5.83	5.83	5.81
Small C & I				
Jul-03	7.71	6.78	6.63	6.59
Aug-03	8.49	7.26	6.72	6.67
Jul03-Jun04	5.89	5.66	5.65	5.73

Pennsylvania-Central East Region
Procurement Cost (cents per KWH)

Consumer Class/Mo.	No Hedging	Limited Hedging	Intermediate Hedging	Aggressive Hedging
Residential				
Jul-03	8.00	6.58	6.20	6.17
Aug-03	8.86	7.05	6.36	6.31
Jul03-Jun04	6.02	5.51	5.42	5.83
Large C & I				
Jul-03	7.58	5.91	5.68	5.66
Aug-03	8.38	6.28	5.87	5.83
Jul03-Jun04	5.90	5.21	5.15	5.14
Medium C & I				
Jul-03	7.72	6.09	5.83	5.79
Aug-03	8.54	6.57	6.08	6.02
Jul03-Jun04	5.98	5.33	5.25	5.37
Small C & I				
Jul-03	7.99	6.53	6.18	6.14
Aug-03	8.86	7.04	6.38	6.31
Jul03-Jun04	6.10	5.51	5.41	5.69

*The values shown are the calculated energy cost plus a 1.5 cent cost adder that is used to account for additional costs such as ancillary services, transmission (to utility boundary) capacity, overhead and profit.

Additionally the results reveal the variation in costs to serve different consumer classes. The benefits of serving load shapes associated with larger customers are noticeable—consumers with load shapes that permit hedging strategies to be highly effective provide greater price reductions. Consumer classes that see less benefits from the hedging strategies we examined—residential and small commercial and industrial—might call for more refined hedging approaches. The structure of the analysis permits additional research into how best to serve individual and combinations of consumer classes.

Finally, comparing the results from Tables 2A-B and 3 with those of Table 4 provides some insight into the estimated costs of protecting against 30 price spikes.[25] Here we see how limited hedging significantly reduces cost exposure in the summer months where we simulated the price spikes. Although limited hedging provides protection, a comparison of these tables clearly reveals that price spikes drive up estimated costs considerably when compared to the results obtained using the five hourly price forecasts. This is because in the less-hedged strategies, there are procurements made at the higher price spike levels that are eliminated as hedges are put in place. But the added hedges result in losses in lower load hours due to selling back excess power that offsets some of the gains of the hedges.[26] This emphasizes the importance of carefully considering how likely wholesale market price spikes are in various spot markets. To the extent they are likely, procurement strategy can be altered accordingly, as we discuss below.

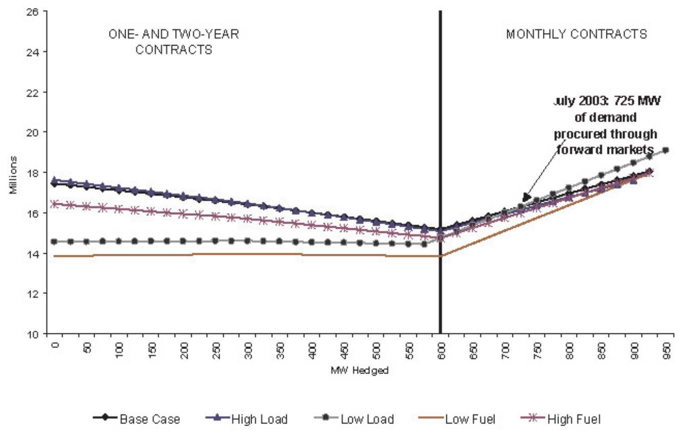
Approach 2: Intermediate Hedging

Methodology

This approach utilizes a portion of the limited hedging approach, but does not assume that all required energy above a certain minimum amount is purchased through the spot market. Instead a portion of the expected hourly demand above monthly minimum on-peak demands is purchased for future delivery, recognizing that some of the quantity purchased will not be needed in certain hours and will therefore need to be sold in the wholesale market on the day of delivery.[27] To achieve the envisioned hedging requires the use of more in-depth analytical techniques. The following additional analysis beyond that described in the limited hedging approach is required to execute this strategy.

Using our forecast scenarios of hourly spot prices, we developed an analysis that examines the costs and benefits of purchasing various fixed-price forward market on-peak hedges. We determined the point where monthly quantity hedged would provide both downside and upside protection that are approximately equal given future expected spot prices. The result of this particular portion of the analysis is the identification of a quantity of electricity that is purchased for firm delivery. For example, Figure 3 shows the results for the month of July 2003, where we selected a hedge purchase quantity of 725 MW for the large commercial and industrial classes. The figure depicts estimates of the costs to serve these consumers for the month of July using five expectations of future spot prices and incorporating various combinations of hedges and spot market purchases against quantities of firm hedges purchased. The figure includes both the annual hedges described in the limited-hedging approach (depicted to the left of the vertical line) and a representation of the change in estimated procurement costs as firm hedges are added for the month.

Figure 3



Selection of Monthly Hedge Quantites

The selected hedge quantity is the amount where the increase in costs associated with the need to sell back portions of the hedge that are not needed in the spot market are approximately equal to the benefits provided by the hedge as a means of price protection. This balance point is shown on Figure 3 as the area where the lines intersect with one another.[28] This is the point where, given these different expectations of future spot prices, estimated costs are roughly equalized at the shown hedge quantity. We then evaluated these hedge purchases for all applicable months with expected hourly on-peak spot prices and calculated an expected overall cost of energy for various future hourly price forecasts. We then add any remaining costs as described in the limited hedging approach.

Results

Tables 2-4 also show the results for the intermediate hedging approach. Once again the intermediate hedging results clearly show how the range of expected costs narrow compared to a spot market-only strategy; the results also show that the range also narrows considerably when compared to the limited-hedging approach. The compressed cost range we observe is lowering the expected variance in cash flow that a company faces when serving these time-variant demands. Unfortunately, this more narrow range comes at a cost—the low-end cost estimates are significantly higher than those we observe in the case of limited hedging. In effect, we are starting to see a cost premium associated with hedging; as with more firm hedges—purchased on a monthly basis where volatility is higher—we are giving up opportunities to purchase power on the spot market when prices are low in exchange for having fixed cost supplies available when the spot market prices are high. The result is substantial protection against high price outcomes, especially in summer months, with lower benefits available to reduce low-end costs.[29]

Comparing the results from Tables 2A-B and 3 with th se of Table 4 again provides some insight into the estimated costs of protecting against 30 price spikes. In the intermediate hedging case, we see a similar outcome where costs are elevated, but we also see that the additional protection lowers expected costs, revealing that additional benefits are realized in the case where there are price spikes. These benefits put downward pressure on expected annualized expenditures that are also shown on Table 4. To the extent price spikes are a significant concern, it is worthwhile to consider using the intermediate hedging strategy.

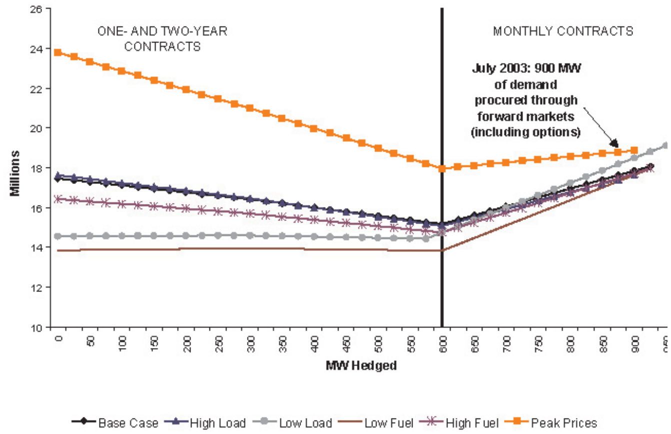
Approach 3: Aggressive Hedging

Methodology

This approach utilizes the intermediate hedging strategy as an initial approach, but then adds the purchase of call options as a means of insuring against future price and load risk. To the extent a supplier faces the risk of consumer migration (if serving a default service contract) or just plain uncertainty related to the weather, it can purchase call options that will provide a specific quantity at a set price if the electricity is perceived as necessary.[30] The call option simultaneously provides insurance against load and price variation. As the results below show, the use of these instruments can be expensive and it can be difficult to forecast the costs of options for any period longer than six to twelve months. Suppliers will clearly need to gain experience managing load and price volatility risk using these instruments in order to estimate the costs. To add these options to the portfolio required the following additional analysis beyond that described in the intermediate hedging approach.

The intermediate hedging approach is used as a starting point to determine how much load remains to be served given the fixed purchases made for the portfolio. The hourly loads are analyzed on a monthly basis, and we examined for various months (those that can reasonably be expected to have volatile prices and loads) the potential amount of additional demand that might need to be served on an hourly basis. This provided a quantity that could be considered as potentially necessary to meet demand on a given day during a specific month. To simulate the costs of hedging against the potential need to serve this demand, we envisioned the purchase of call options.[31] We did not optimize the purchase of these call options, but instead assumed that we would buy options up to the point where the risk faced from potential excessive spot market spikes was limited. For example, using Figure 4 (Figure 3 with an added cost line), we depict an estimated cost line that includes price spikes of $500/MWh during the months of July and August of 2003. Figure 4 shows that a quantity of 175 MW of call options (difference between 900 MW and 725 MW shown in Figure 3) provides protection against these price spikes at demand levels greater than those selected using firm hedges based on spot price estimates. We then evaluate the impact of the cost of the options based on whether they would be exercised, given our various forecasts of hourly prices. Finally, we calculate the overall cost to serve for each of the future forecast scenarios as in the other two cases.

Figure 4
Selection of Monthly Option Quantities



Results

Tables 2-4 show the results of the aggressive hedging approach. Although these results show a narrowing of expected expenditures, as we have observed in the other hedging cases, we now see that low- and high-end costs are both rising when we envision the purchase of call options. This is primarily due to the fact that the strike price for the call option is nearly equal to the cost of procuring a monthly forward contract. Therefore, the purchase of the call option's up-front premium payment is not completely offset by the savings obtained when the option is called. In effect, even though there is no sell-back required with the call option, the premium payment is resulting in a financial loss similar to that experienced when selling back power at prices less than what was paid in the forward market. In our examples, there are limited benefits associated with the purchase of call options.[32]

Comparing the results from Tables 2A-B and 3 with those of Table 4 again provides some insight into the estimated costs of protecting against 30 price spikes. Here we clearly see that the estimated costs of using call options are similar to or higher than the estimated costs using the other hedging strategies. These results reveal that very little is gained by using call options when compared to the purchase of firm monthly hedges. Overall, the intermediate hedging strategy provides the best protection to a risk-adverse market participant while leaving some opportunity to obtain exposure to lower-than-expected market prices.

Conclusions

With careful consideration of risk tolerance levels, wholesale electricity markets can be utilized to meet retail demands. As the market begins to see a greater number of standard offer service-type solicitations, there will be a greater emphasis on developing hedging strategies that draw on portfolios of supplies to serve these varying loads. We have shown that just using mid-term wholesale products to hedge expected retail demands results in a clear ability to understand the costs and benefits of hedging. The reductions in cost variance we observe in our results translate into reduced risks of higher costs, which lower potential cost exposure by millions of dollars. Going forward, it will be critical that these wholesale markets be available and utilized to ensure price transparency and an ability to obtain hedges that make managing risks possible.

Furthermore, with models in place that easily allow repetitious analyses to be completed for a variety of different input assumptions, we can easily develop several different cost estimates based on different combinations of wholesale products. For example, it is straightforward to introduce more structured bilateral contracts into the analysis as hedges and then evaluate a more complex portfolio of supplies. With the building blocks of an analysis in place, all that is required to ensure new and innovative supply offerings is transparent wholesale markets and a sufficient number of competitors. In most parts of the country, the marketplace is able to provide what is necessary to secure the benefits of retail competition.

Footnotes

[1] Thanks are extended to Tabors, Caramanis and Associates for providing a set of hourly locational marginal price forecasts for the 2003-2004 time period. Thanks are also extended to Zeljka Bosner and Marin Boney for their valuable assistance with various aspects of the analysis.

[2] See, for example, Graves, Frank C., and Wharton, Joseph B., *New Directions for Safety Net Service – Pricing and Service Options*, EEI White Paper, Edison Electric Institute, May 2003; and Center for the Advancement of Energy Markets, *Electricity Retail Energy Deregulation Index*, April 2003, at 9-13.

[3] Maine, Massachusetts, and New Jersey currently utilize competitive procurements to supply certain captive retail loads, while many other states (for example, Connecticut, Pennsylvania, Ohio) are in the process of deciding how retail consumers' rates will be set following the completion of transition periods.

[4] An example of where consumers face this risk regularly is the purchase of home heating oil. As any consumer with a home-heating system that utilizes oil knows, price variations season-to-season and year-to-year can be considerable, and most suppliers offer various levels of insurance in the form of fixed and/or fixed/variable pricing arrangements.

[5] Order Number D.T.E. 02-40-B, Investigation by the Department of Telecommunications and Energy on its own Motion into the Provision of Default Service, April 24, 2003.

[6] Order No. 78400, In the Matter of the Commission's Inquiry into the Competitive Selection of Electricity Supplier/Standard Offer Service, Case No. 8908, April 29, 2003.

[7] In states that have retail competition, offers to supply residential consumers have for the most part been limited. Although aggregation efforts have overcome this problem in certain states, there is clear evidence that even when it would appear that competitive suppliers could capture retail consumers, competitive offers are not made by suppliers.

[8] For example, Maine and New Jersey.

[9] Numerous trade press articles report the adoption of new consumer care systems and back office computing systems that can be used to more closely monitor consumers' demands and wholesale market prices.

[10] Using these forecasts of hourly price and demand for various geographic regions, we were able to calculate estimates of the wholesale costs to serve various utility consumer classes assuming different levels of risk management. Our analysis assumes that various over-the-counter electricity products (both energy and capacity products) are available, as well as reasonably well-behaved wholesale spot markets (i.e., limited price spikes as capacity is assumed to be compensated through longer-term markets).

[11] Our branch then becomes "bushier" as different hedging options are evaluated.

[12] We consider consumer classes to be residential, and large, medium, and small commercial and industrial.

[13] Many pricing formulations require that prices be distributed lognormally. The validity of this assumption has not yet been thoroughly tested, especially given that price distributions can be bimodal. Also, time series econometric price forecasting techniques are also difficult to implement, given the sensitivity of electricity prices to changes in supply from month-to-month and year-to-year.

[14] This approach is, of course, not new, but is likely now easier to apply given the time that has elapsed since the introduction of transparent spot markets and the development of more liquid forward markets. See, for example, Henney, Alex, and Keers, Greg, "Managing Total Corporate Electricity/Energy Market Risks," *The Electricity Journal*, October 1998, Volume 11, Number 8.

[15] When considering other approaches we reviewed various formulaic approaches available to convert electricity forward market pricing information into an annualized fixed price that can then be offered to a retail consumer. (There are some formulas available to make this calculation, although they rely on an extensive amount of input data that must be estimated using either various modeling techniques or the analysis of historical data. See for example, Eakin, Kelly, and Faruqui, Ahmad, "Pricing Retail Electricity: Making Money Selling a Commodity," in *Pricing in Competitive Electricity Markets*, Kluwer Academic Publishers, 2000.) Although these formulations rely on forecasted spot prices in the same way that our analysis does, we wanted an approach that allowed us to explicitly evaluate the impacts of hedging expected demands. Additionally, there are various statistical techniques available to price hedge products that could be offered directly to consumers facing real time rates (based on analyses using similar forecast data), although the number of consumers facing hourly rates is small and it is likely that most consumers large enough to face these rates would prefer greater price certainty. (See for example, Chapman, Bruce, *et al.*, "Hedging Exposure to Volatile Retail Electricity Prices," *The Electricity Journal*, June 2001.)

[16] There are also new approaches being developed that combine structural and statistical approaches to evaluate market place interactions dynamically. See, for example, Ilic, Marija D., and Skantze, Petter L., Valuation, *Hedging and Speculation in Competitive Electricity Markets*, Kluwer Academic Publishers, 2001.

[17] An advantage of this approach is the ease with which the exposure of an entity to price spikes can be tested. (Price spikes introduce significant problems for statistically based approaches.) Once scenarios have been established and expected hourly prices calculated, it is simple to review the impacts of extremely volatile prices in order to assess the potential liability of a low probability event. Through this type of analytical exercise the level of volatility that is implied in options prices can be examined directly against the risk that is taken when short-term expected demand is expected to exceed hedged positions. This permits a degree of *ex ante* consid-

(Continued on page 18)