Forecasting to understand uncertainty in electricity prices

The art of electricity price forecasting bears little resemblance to the utility practice it evolved from: trying to predict fuel costs. To predict prices, utilities and energy traders and wholesalers must resort to modeling electricity markets—no easy task. Price forecasting has become increasingly necessary and more complex for all market participants, as is evident from the variety of approaches being used today

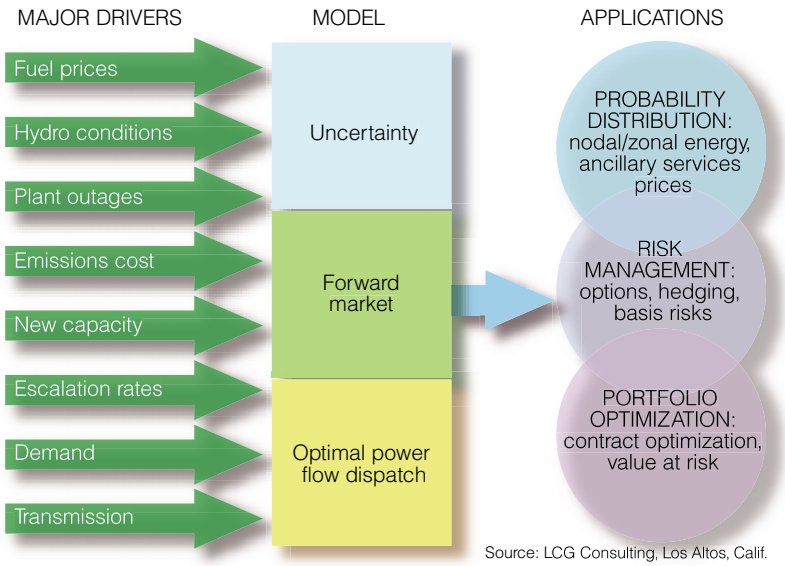
By Anne Ku

During the monopoly era, one of the most important things that utilities needed to predict was their fuel costs, because the price of their product was fixed by regulators. As markets are deregulated, prices are freed to rise or to fall. The key to predicting which way they will go is understanding the uncertainties and assumptions associated with the market drivers of price. The major market drivers are either used as inputs or calculated by forecasting models. Compared to load forecasting (Global Energy Business, March/April 2002, p. 20), price forecasting is far more complicated.

Who needs to know?

Plant developers, power generators, investors, and energy traders would love to be certain which way electricity prices will trend; their strategies and profits depend on betting right that the market will move in one direction or another. But they aren't the only market participants with an interest in forecasting prices and doing it well:

- Credit rating agencies need to monitor the exposure of different players in the market to price fluctuations and risks.
- Load-serving entities need to know how much power their customers are likely to use, and price has a big impact on consumption levels. Armed with a credible forecast of expected demand, distribution utilities can devise better strategies to meet it with supplies procured through a mix of long- and short-term contracts.
- Owner/operators of transmission grids need to know how much prices will differ among



1. Fundamental drivers of price and how they feed into model approach and

An educated forecast based on the fundamentals of supply and demand is much better than no forecast at all

regions, because the market's response to any big gap will be a rise in the level of inter-regional trading. Forecasts of prices (and demand) within its own region help grid operators predict and prepare for certain levels and types of generation dispatching.

Large industrial customers need forecasts to assess their exposure to price volatility. With a forecast they have confidence in, they can hedge their risks through such vehicles as long-term, fixed-price contracts, participation in demand response programs, the use of time-of-day pricing, offering interruptible load programs, and so on.

For all players, it is critical to have good numbers. Dr. Fereidoon P. Sioshansi, global manager of power market advisory products for Henwood Energy Services, Inc., Sacramento, Calif., believes that an educated forecast based on the fundamentals of supply and demand is much better than no forecast at all.

Project finance provides a good example of the important role that price forecasts play in the industry today. In project finance, price forecasts are commonly used as inputs to developers' and lenders' pro formas—the spreadsheets that model the performance of an investment over time. Daniel E. White, executive VP of Pace Global Energy Services, Fairfax, Va., explains that all pro formas rely on forward assumptions about costs and revenues. When developers and lenders are preparing to enter a volatile market with very uncertain forward prices, they pay more attention to the assumptions made about price drivers. The assumptions themselves can be quite complicated. For example, in U.S. markets with volatile fuel and power prices, pro formas for power plant financing are increasingly using more complex forecasts of fuel and power markets behavior, in an effort to more accurately model their plants'—and investments'—expected performance. Pace Global uses a range of quantitative and qualitative tools to develop their forecasts, including using different models for short-, medium-, and long-term predictions.

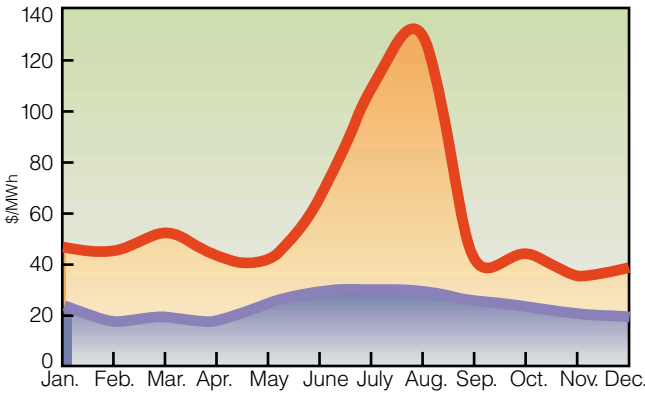
Which approach?

While many third-party commercial price forecasting models exist today, at their core all use one of two very different approaches to predicting future prices. The pure forecast approach takes prices generated from structural models that depict the hourly behavior of electric loads, generators, and market participants over many months and years into the future. The forward curve approach infers future prices from observable trades in the market. In immature markets like electricity, it is easy to confuse "forward curves" with "price forecasts" (see box, p. 62). In general, forward curves are made up of forward prices, which reflect what traders and end users are willing to pay today for power to be delivered in the future. The assumptions underlying the validity of forward price curves are that people are willing to make forward transactions, and that the market has enough liquidity to enable such transactions. Price forecasts, by contrast, attempt to predict the going rate for electricity at some specific time in the future—the spot price.

Pankaj Sahay, director of PricewaterhouseCooper's energy risk management group, elaborates on these two approaches. In illiquid markets or where no markets exist for long-term electricity sales, it makes sense to take the "fundamentals" approach of looking at the structural drivers of supply and demand—that is, the physical reality of plants on the ground, transmission assets, etc. In short-term and liquid markets, Sahay explains, you can infer prices from what's being traded in the market. Those prices are what make up the forward curve, which Sahay considers to be the single most important factor in financial valuations. The main difference between the two is whether you take your prices from a model or those that come from observable trades.

Another perspective comes from Dr. Aram Sogomonian, VP of risk management for Constellation Energy Group, Baltimore. He observes that most energy companies use a variety of tools—past history, extended market quotes, production models, heat-rate models, and replacement cost models (how much it costs to build a new plant)—to predict prices. Most trading-centric companies, says Sogomonian, tend to put more faith on heat-rate models and market quotes, while traditional utilities are more apt to rely on long-term supply/demand fundamentals. A company's approach may also reflect its accounting practices. According to Sogomonian, shorter-term forecasts tend to rely more on market feedback rather than models.

On-peak electricity price forecast for a region in the U.S. for 2004



2. Electricity prices are very volatile, as the range in this one-year forecast shows

He adds that auditors have an important part to play in ensuring consistency, because forecasts can be biased.

Models' tough tasks

Many forecasters have tried using time-series analyses to forecast electricity prices and their volatility. But this approach doesn't always succeed, claims Dr. Pushkar Wagle, senior economist at LCG Consulting, Los Altos, Calif. To avoid the pitfalls of an historical analysis, he says, you must recognize that electricity prices are driven by physical fundamentals—such as load distributions, hydrological conditions, fuel prices, plant operating characteristics, emissions allowances, and regional and interregional transmission capacity (Fig. 1). Moreover, to arrive at consistent forecasts across a range of products, the interaction between the various commodity, temporal, and location markets must be captured. In addition to local protocols, regional and national reliability policies influence how energy and its related markets operate. For example, energy, ancillary services, and emissions allowance markets all interact with each other, thereby affecting the bidding behavior of participants in them.

Wagle advises companies to choose a model that accepts inputs about multiple commodities (allowing generators to arbitrage among energy, ancillary services, and capacity reserve commodities), and can work across market boundaries (giving players the opportunity to pursue profit opportunities wherever and whenever they arise). What the model should be able to deliver is a consistent set of energy, ancillary services, and capacity reserve prices in forward and real-time markets.

Seasoned forecasters note that most models incorporate elements of both the pure-forecast and forward-curve approaches to price prediction. According to Dr. Andy Van Horn, managing director and principal of Van Horn Consulting, Orinda, Calif., the engineering-based approach—using power flow models and production cost simulations—relies on how systems have operated in the past by using data on the capacity of plants, heat rates, fuel costs, and transmission grids.

As Van Horn explains, econometric models, such as those used in load forecasting, assume that consumers will behave in the future much as they have in the past. But in the electricity business, today and tomorrow are often very different than yesterday. The introduction of ancillary service markets and markets with different rules and protocols, new supplies coming on-line, and the volatility of fuel prices make traditional econometric models poor foundations for price forecasting. Newer and more sophisticated models add aspects of market economics—such as the relationship between bidding behavior and opportunity costs—to the models based on fundamentals. The art of price forecasting, Van Horn says, lies in capturing the big picture as well as getting the details right.

Uncertainty: Never zero

In the early days of deregulation, many people thought that the ability to forecast electricity prices would make them a lot of money. But the reality is that no price forecast is as certain as death or taxes, so the best educated guesses must account for uncertainty. The many factors that contribute to determining market prices are as unpredictable as the weather. In fact, weather is a perfect metaphor for the unpredictability of electricity prices: temperature is a key determinant of demand, and rainfall affects hydropower supplies, and neither can be known far in advance.

Forward curves vs. price forecasts

Forward curves are used to mark trades to market. In liquid and deep markets—such as interest rates, foreign currencies, and widely traded physical commodities—forward curves are easily available and derived. But in immature electricity markets, it is less clear what forward curves actually predict. Often they are derived from a schedule of price forecasts, so the best interpretation is that forward price curves are predictions of the likely spot price of electricity several years in the future.

Forward curve	Price forecast
A snapshot of where market participants are currently willing to transact	A prediction of what might happen in the future
Either observed in the market or derived from arbitrage relationships between prices and rationality bounds	Based on economic/engineering analyses of future supply and demand, regulatory and technological trends, etc.
The market is always right. The purpose of generating forward curves is to portray where the market is going	The market can be wrong. To the extent that the forecaster believes that he has better information than other market participants, such information can be used to "beat the market"
Information is not useful for planning purposes	Information is useful for planning purposes
Used for marking positions to market and determining liquidation value	Should not be used for mark-to-market purposes
Forward prices can be locked in today	Price forecasts may not be locked in today
Can be used for deal pricing, to the extent that one expects to offset exposure shortly in the open market	Can be used for deal pricing, to the extent that one does not look for an offset but uses the transaction as a bet on future prices

Source: Kenneth S. Leong, The Forward Curve in the Electricity Market, published by Risk Books (www.riskbooks.com)

When deals are being marked to model, you [also] have to worry about model risk

Nevertheless, some people forecast electricity prices for a living. Dr. Vic Niemeyer, area manager for retail and power markets research at the Electric Power Research Institute (EPRI), Palo Alto, Calif., helps the utilities that fund EPRI estimate future electricity prices and their volatility. In his experience, a lot of the uncertainties driving prices aren't resolved until the last minute. For that reason, knowing the level of uncertainty of a price prediction is the next best thing to knowing the future price in advance. Any price forecast (Fig. 2) should be accompanied by some measure of its uncertainty.

One way for market participants to mitigate this inherent uncertainty is to be consistent about the way forecasts are developed and used. Dallas-based TXU, for example, takes a long-term, fundamentals-based approach to the problem to avoid being influenced by market emotions. The utility holding company usually relies on its own in-house forecasts. But it also pays attention to what others predict, especially when considering the long-term prospects for a proposed new power plant. For shorter-term guidance, TXU assumes that the market—if it is liquid—is right.

Yet the company realizes that few forecasts are on the money. TXU's VP of analysis and structuring, Manu Asthana, says that "there's more uncertainty in price forecasting than load forecasting, and it's more complex because we're forecasting both supply and demand. It requires other kinds of skills, particularly of the engineering variety. We take great care to take into account the uncertainty of our forecasts as we use them."

TXU runs its business as one global enterprise; all of its operations use the same risk management philosophy and disciplines. As you might expect at such a big company, price forecasts are rigorously and independently validated by a global middle office team led by its global chief risk officer.

Another way to cope with uncertainty is to compare and contrast different business scenarios, advises Van Horn. Most people, he says, tend to apply their uncertainty analyses to the "business as usual" scenario rather than to unlikely situations and events. What they also should be doing, Van Horn says, is performing sensitivity analyses to determine which variables affect prices and to what extent. Going this extra mile when applying price forecasts might entail using "real options" analysis to leverage the flexibility that executives have in making business decisions for the future and updating them as time goes by. But some price-driving variables still fall in the cracks, often because they seem too random to be predictable. As an example, Van Horn says that the impact of new environmental legislation often is not calculated by forecasting models because it is too difficult to anticipate and analyze.

The important thing, Van Horn says, is to understand the strengths and limitations of forecasting models because that can add to your own intuition about markets. Are you using the right models for the right purpose? According to Eric Toolson, a senior VP at Henwood Energy Services, understanding the drivers of price in a market is more important than being able to forecast price.

In-house or outsource?

According to Joanna Cloud, principal consultant at Atlanta-based New Energy Associates, most utilities use both purchased commercial models as well as models developed in-house to do price forecasting. In-house models typically take the form of a sophisticated spreadsheet or data base.

However, some utilities and other market players have taken to hiring outside consultants to maintain and run their models or even purchasing the forecasts outright. As for outsourcing in general, the considerable effort required for data maintenance and model support often makes this a better strategy than allocating dedicated resources in-house.

One reason outsourcing price forecasting makes sense is that commercial models have taken a long time to develop and are continuously refined. "You not only get quality control and embedded capability from years and years of refinement, but impartiality as well. In-house models often die when the key developer leaves," says Greg Turk, president of M.S. Gerber and Associates, Columbus, Ohio. "What's more," he adds, "commercial models provide a measure of institutional stability. Running and maintaining both a detailed production cost model and a faster one that does multi-area modeling is a full-time job. If [a company] also develops its own data base, it will get killed over time."

Leasing rather than buying a forecasting model is sometimes the preferred method for capital expenditure reasons. According to Don Winslow, VP of mid-office for Portland (Ore.)-based PacifiCorp Power Marketing (a subsidiary of Scottish Power), the company's in-house price forecasters work closely with the internal risk manage-

Visit these sites for more information

(Vendors of commercial price forecasting models and forecasting consultants)

Henwood Energy Services, Inc. . . . . www.hesinet.com
LCG Consulting . . . . . www.energyonline.com
M.S. Gerber & Associates, Inc. . . . . www.msgerber.com
New Energy Associates . . . . . www.newenergyassoc.com
Pace Global Energy Services . . . . . www.paceglobal.com
PricewaterhouseCoopers . . . . . www.pwcglobal.com
Van Horn Consulting . . . . . www.home.earthlink.net/~vhconsult

ment group, which validates their assumptions. "We use a combination of a leased vendor model, consultants' forecasts, and our own spreadsheets, which incorporate forward prices for natural gas and power. Our primary motivation for using the models is to understand the drivers of price and their relationship to regional prices (as opposed to determining an absolute estimate of the price levels). The single biggest driver of the models' outputs is the price of natural gas. Accordingly, our predictions of long-term power prices are only as good as our estimates of long-term gas prices."

Another take on the usefulness of price forecasting models comes from Dr. Tony Ligeralde, GM of research and analytics for Cinergy Corp., Cincinnati. He has been investigating price forecasting for several years. His group originally hired consultants to build proprietary models, but has since moved maintenance and modifications of them in-house.

Cinergy continues to compare its own forecasts to independent forecasts to get an understanding of what others are thinking. Ligeralde warns against relying solely on a pure price forecast because the prediction might not be even close to the actual market price. He says that such discrepancies naturally give rise to this question: "Is the model wrong, or is the market just not providing enough information?" Answering the question, Ligeralde says, is especially important when valuing longer-dated deals where the market is less liquid. For purposes of marking such transactions to market, calibrating the model to visible market indications helps ensure consistency between market reports and the forward curve the model generates.

Ligeralde anticipates that new financial disclosure requirements imposed by rating agencies in response to the Enron collapse will accelerate the development of an industry standard for modeling the non-liquid portion of the price curve. He says, "When deals are being marked to model, you [also] have to worry about model risk."

Less data, more uncertainty

The final thing you need to know about price forecasting models is that they are very data-intensive. Henwood's price forecasting model MarketSym, for instance, takes data from 500 different sources. As more markets go competitive, companies will have less incentive to report and share information. Gone are the days of free public data pulled from FERC forms. "The emphasis of price forecasting will shift away from data points to uncertainty about the data," says New Energy Associates' Cloud. What this means is that collecting specialist data—already a niche industry—is likely to be a lucrative business. Such data experts will become increasingly valuable as the sophistication of price forecasting models grows. ■