



Full Requirements Contract Valuation using Hybrid Models

By Carlos Blanco, Josh Gray, Marc Hazzard, and Craig Jimenez

Introduction

This article is the fourth in a series on the FEA Power Sector Model. The first three articles provided an overview of the different components of the Power Sector model, focusing on calibration and simulation of spot power prices, fuel prices, load and weather using a hybrid stochastic-fundamental model. This approach more naturally addresses the joint evolution of factors driving the power price process. The last two articles of the series will focus on specific applications of the FEA Power Sector to value full requirement contracts and generation assets.

In a recent paper published by Standard and Poor's Rating Services, a warning shot was fired across the bow of the merchant energy sector. Its report outlined both the perceived mis-measurement and mismanagement of the risk contained in the full requirements contracts both entered into and inherited with asset purchases. Citing the "hidden risks" it believes are embedded in such deals, S&P outlined a method for assessing the risk to the enterprise. Considering that such increased scrutiny from the rating agencies has resulted in very punitive, non-market based valuations in the past, it would be prudent to explore a systematic approach to modeling and valuing such deals.

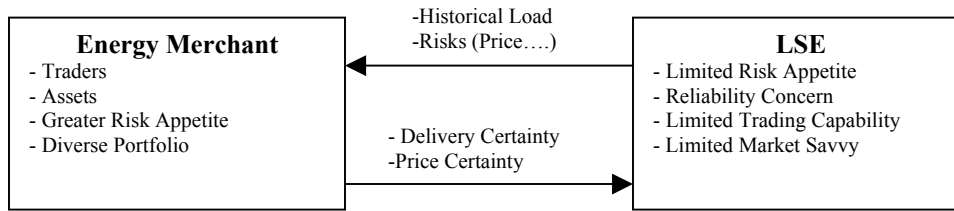
Using the FEA Power Sector Model to drive the underlying power price simulation, @ENERGY / Load Serve provides a flexible and detailed framework for valuing full requirements contracts. Here we will address some of the key features of these types of contracts, as well as their inherent risks, while demonstrating the applicability of Load Serve to valuing and risk-managing these contracts.

Full Requirements Contracts in the Energy Industry

In a full-requirements power agreement the writer of the contract (usually an energy merchant) is obliged to serve the electricity demand of the holder of the contract, usually a LSE (Load Serving Entity). These contracts are typically priced using the historical "load shape" or demand profile of the LSE and further knowledge of pricing mechanisms in the area in which the power is "served". Consistent with the merchant energy model, a premium is paid and risk transferred from a risk-averse LSE to a merchant energy provider who can best manage the individual pieces of a portfolio of similar deals. For a fee, the merchant sector aggregates and manages the risks of these deals, in theory reducing the redundancy costs to the LSE and ultimately to the end-customers.



Full Requirements Contract Illustration



The challenge for the energy merchant is to synthesize historical information, forward-looking assumptions (load growth and migration), as well as forward energy and option prices into a fixed price at which the energy merchant is willing to sell the LSE energy. The LSE has made the merchant responsible for price, volume, and exercise risk.

Naïve applications of variable quantity options and their generalizations have been the tools that the energy merchant or LSE has had to look to in the past to value these contracts. As these options rely on several weak assumptions regarding the relation between load and the price of power (e.g. a single correlation, lognormally-distributed load, simple power price processes, and a lack of explicit weather-dependence – to name a few) it is imperative that a more realistic model of the underlying power and load processes be used in cooperation with a malleable valuation tool.

@ENERGY / Load Serve, combines both the benefits and realism of FEA's Power Sector Model and offers a high degree of flexibility to model the most explicit contract details while directly exposing the results pertinent to managing these risks.

In the next sections, we will explain in more detail the different risks associated with full requirement agreements, alternative hedging vehicles and main benefits of using our suggested approach to value and manage the risk of these contracts.

Price Risk

The most obvious risk that the merchant takes on with the writing of a full requirements contract is price risk. Since the merchant is responsible for providing electricity to the LSE at a fixed price, there can be substantial price risk involved. Due to the fact that the expected load profile is shaped by hour, weekday, and season, there is an inherent mismatch between the hedging instruments available (forward power contracts and options for on-peak, off-peak, super-peak and their various combinations) and the underlying exposures arising from the full requirements power agreements, even if the LSE exactly takes his expected load.



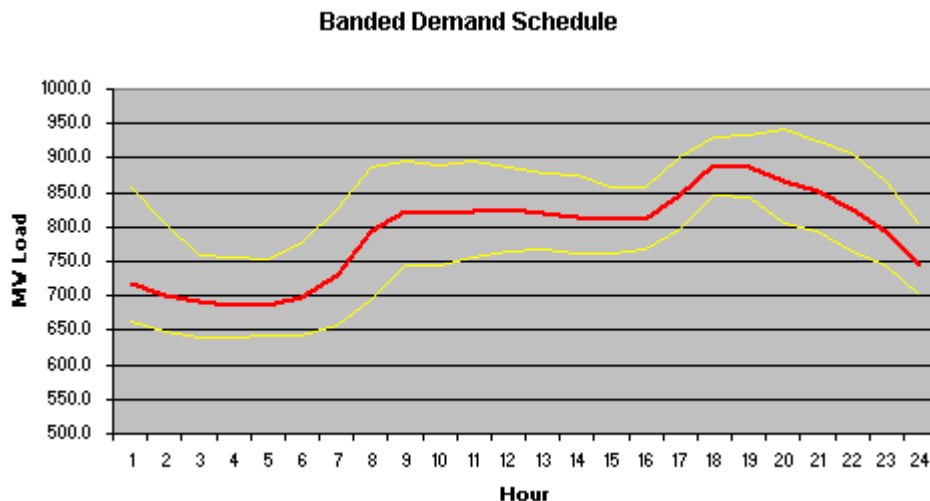
@ENERGY / Load Serve provides a choice of either fixed or floating strike types for which load will be served. In the case of the fixed strike, a full 24 x 8 block of scheduled strikes can be specified for any range of dates within the contract's term. This permits the LSE to mitigate known price exposures (e.g. on- versus off-peak prices, or by season) as well as incorporate other significant power price movements.

Hedging Vehicles: With a portfolio of generating assets at its disposal, the merchant can shift the risk from the power forward price curve to the marginal fuel forward price curve. By indexing a deal to the floating fuel price, this risk can be largely eliminated. Load Serve allows for this type of hedging vehicle by also allowing floating strikes tied to the marginal fuel simulation.

Volume Risk

Perhaps less obvious is volume risk. This is the risk that the LSE will “take” more or less than their expected load amount when prices are high, or take less than expected when prices are low. This volume risk is usually linked to extremes in realized weather. A relatively mild summer or winter can mean that the merchant is left with excess power and is forced to re-sell it into a plunging market. A relatively extreme summer or winter can leave the merchant short of energy in a rising spot market. This is the event that can put an entire enterprise at risk.

@ENERGY / Load Serve allows for a 24 x 8 block of baseload amounts, as well as maximum and minimum load amounts, for which there is an associated premium for exercising these embedded “swing” options. As in the case of the price risk, the ability to freely shape the contract to incorporate known demand levels helps define the contract and reduce the volumetric risk encountered. Typically a “banded” load schedule accounts for both the expectation and several standard deviations of demand.





Hedging Vehicles: Volume risks are particularly difficult to hedge due to the lack of available instruments. Weather derivatives can provide some degree of coverage if customized to specific requirements. Double and triple trigger contracts whose payoff is based on a combination of weather, power and fuel prices can also be an effective tool to hedge volume risks.

Exercise Risk

Full requirements deals are predicated on the LSE making “operational” exercise; the LSE takes energy solely to serve its load, without any consideration of market prices. Various factors can cause a merchant to unwittingly take on non-operational exercise risk. These include, but are not limited to the LSE’s capacity to resell energy supplied at fixed prices, buy additional supply through swing contracts, and ability to aggregate additional customers when market prices exceed contract prices. Due diligence is therefore incomplete and expensive.

Weather is the most salient driver of the LSE’s load. An increasing number of operational-exercise contracts are being replaced by weather-triggered options (LSE can exercise a fixed-price call when extreme weather would force them to buy in the spot market. LSE may also have a fixed-price put when mild weather would force them to be selling power in the spot market). These instruments are transparent, impossible to manipulate, and amenable to risk transfer in the secondary market. Because reduced-form hybrid models focus on the co-movement of weather and prices, they are excellent vehicles for pricing and hedging weather triggered options. A subsequent paper in this series will address this emerging application.

While the LSE may alleviate exercise risk by arranging a schedule of maximum and minimum swing amounts, or otherwise purchasing a number of swing rights themselves, @ENERGY / Load Serve values full requirements contracts under a variety of exercise strategies.

The first of these strategies is the “load matching” scenario, whereby the owner of the contract exercises its load options only to match a particular retail load, regardless of the implicit economic exercise boundary. The implicit assumption here is that the owner either has no access to the spot market, or has decided to simply rely upon a single electricity provider (i.e. the merchant) in meeting load obligations. Due to the nature of these assumptions, the contract value can easily become negative and describes a sub-optimal exercise strategy, and hence, places a lower bound on a load service deal.

The remaining 3 strategies rely on full or partial economic exercise of the swing amounts. The holder with full “economic” exercise rights will typically swing to the maximum or minimum amount based upon which side of the exercise boundary (i.e. the strike plus any swing premium) the power price is on at any given time. As such, the economic strategy represents the upper bound to a load service deal.

The partially economic exercise strategies describe the instances where the contract owner does not have full access to the spot market. For example, the “economic buyer” may buy on the spot market if prices are favorable yet he may not sell into the spot market. Thus, when encountering price spikes for example, the owner may only exercise enough options to meet the demand for electricity, but may not take advantage of the situation by requesting the maximum allowed load and sell the excess electricity on the spot market. On the other hand, the “economic seller” may sell on the spot market, but may not buy from the spot market.

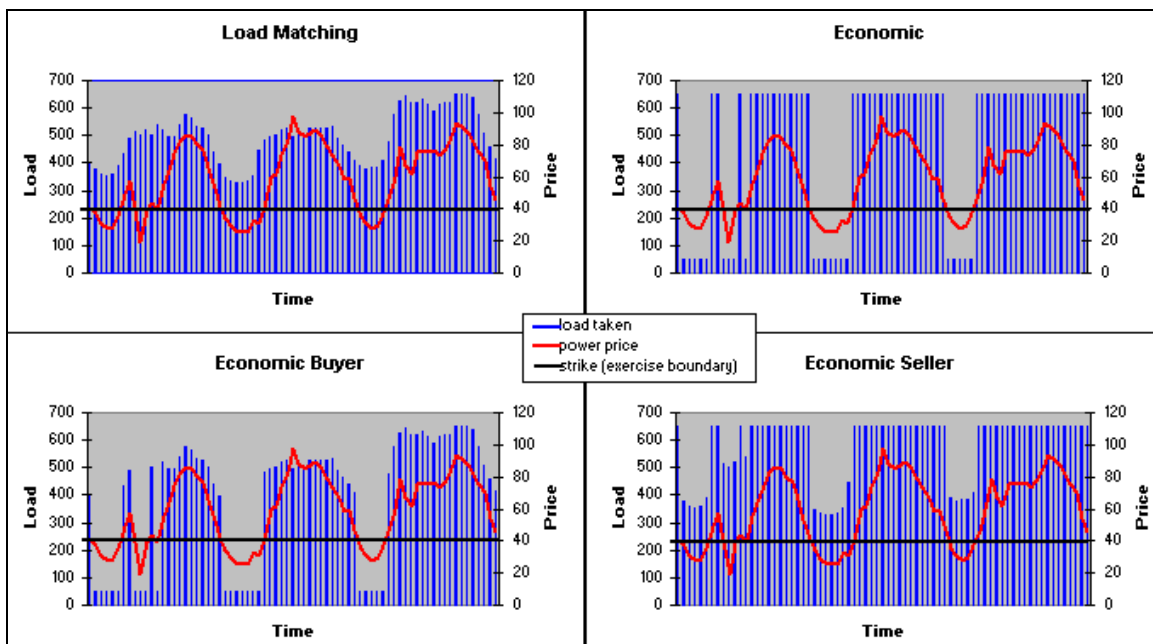


Figure 1: load taken versus power price for different exercise strategies in @ENERGY/Load Serve

Other Risks

Load Migration – The risk that historical load will cease to be contractually served. In a market with competitive providers, load may choose to leave the contract and be served by another provider. This would make the writer of the contract longer power than expected. This risk can be measured by estimating the future migration pattern of the valued retail load.



Load Growth – The risk that the historical load will increase (or decrease for negative load growth) due to economic or population movements. With a fair amount of industrial load, there is economic sensitivity present. With a booming population, there can be a relatively large increase in the amount of power needed to serve the contract. This risk can be measured by the use of a load growth assumption.

In both cases, only an outright forecast based on population and development trends and plans will suffice to incorporate an active view of these risks. Again, the flexibility of @ENERGY/Load Serve’s specification of a schedule of baseload, minimum and maximum load comes to the rescue. Not only can predicted seasonal variations in subscription be accommodated, but hourly variations as well. For example, consider the scenario where a retail load is predicted to shrink in its residential base, but grow in its industrial base. A judicious adjustment of the on-/off-peak hourly amounts allow for a rather detailed analysis.

The Mark-to-Market Challenge: Valuing Full Requirements Contracts using Hybrid Models

Cost to Serve

The valuation of a full requirements contract is a matter of stating the expectation of both price and load for every hour of the contract period. If these were not random variables all we would have to do would be to multiply the “expected” levels of demand and price (however we attain these values) and tabulate the results to come up with a total cost of serving the demand. This value would then be a “mark to market” estimate of the full requirements contract.

Since power prices and future electricity demand are random variables whose structures have some dependence on each other, we must include the *covariance* of load and price in the calculation of this value

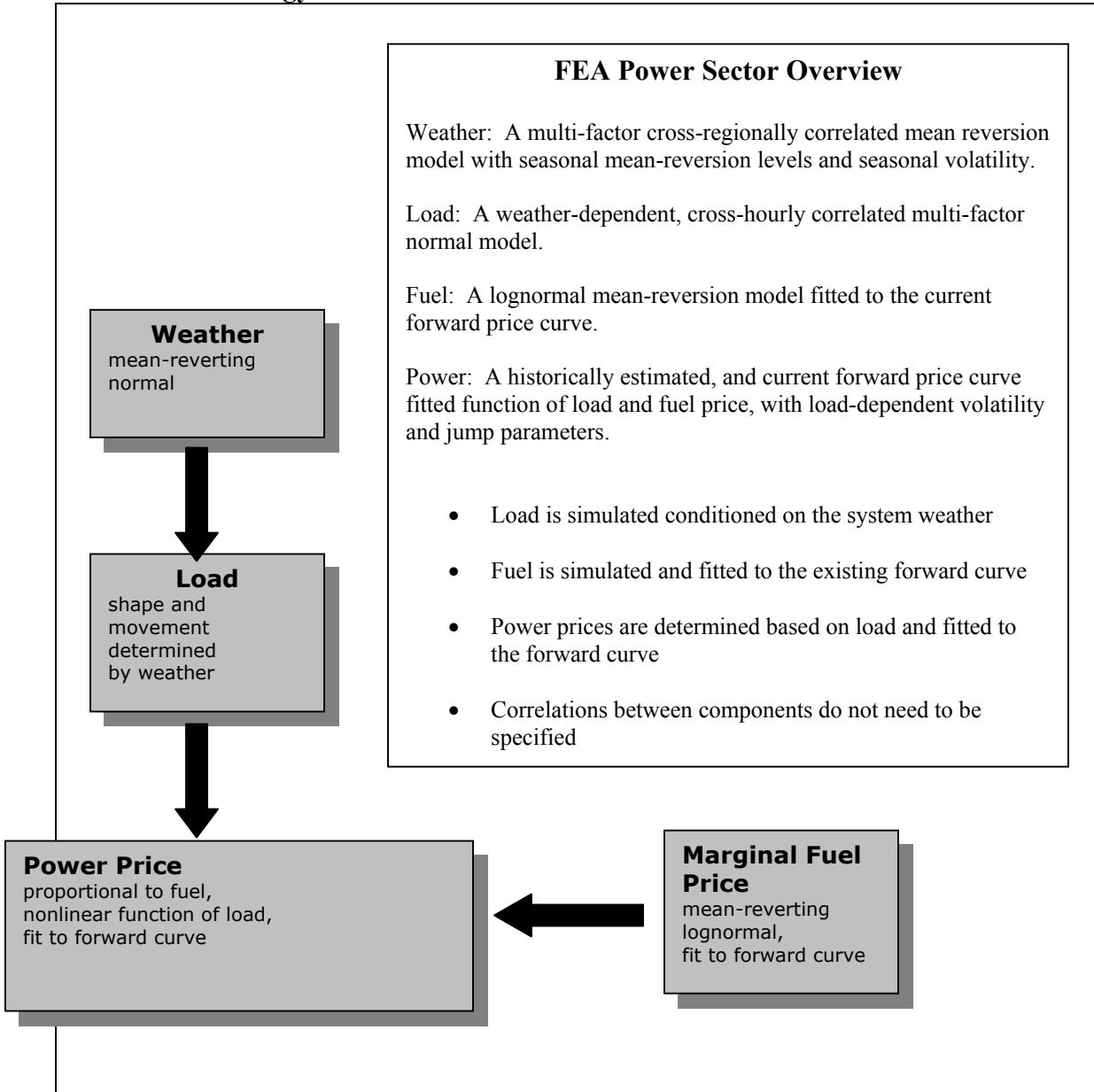
Furthermore, the covariance depends on the correlation of price and load and the product of their standard deviations. Therefore, in order to calculate the mark to market of these contracts, we need to be able to estimate the variance and covariance parameters of load and price reliably.

Modeling the Joint Distributions with a Hybrid Model

By stating that the valuation of a full requirements contract depends not only on the expected value of price and demand, but also their covariance, we have once again entered the murky world of co-dependence estimation. To specify the joint distribution of power and load, we would need to estimate the codependence (e.g. by estimating the correlation) of these two variables for the length of the contract period.

Since these parameters can hardly be estimated by risk-neutral methods, we would once again be forced to dive into a limited data set and extract a linear correlation coefficient that may be ill-defined and unstable. At the inception of our hybrid model, one of the goals was to largely remove the estimation of such parameters and let the fundamentals determine the co-movements between these variables.

Box 1. Methodology Review: The Power Sector model.





Conclusion

Full requirements contracts are complex beasts whose value and risk depend on a mish-mash of contract assumptions, regional characteristics, weather, and the complex interaction of price and demand. Using FEA's Power Sector Model, we can use the flexibility of a hybrid stochastic-fundamental approach to modeling joint distributions to estimate the value of these contracts, measure their risks, and try to overcome the gauntlet set down by the ratings agencies in terms of understanding and disclosure requirements. The large dollar value of such contracts and the increasing skepticism shown by auditors to opaque valuation practices make such an attempt both timely and necessary.

Bibliography

- Soronow, D., Pierce, M., and Wang, K. 2002. The Power Sector Model. New Frontiers. January.**
Blanco, C., Gray, J., and Hazzard, M. 2003. Finally....A realistic model of power prices: The FEA Power Sector Model. The Risk Desk. Vol. III, No. 3.
Blanco, C., Gray, J., and Hazzard, M. 2003. Weather Contingent Load Simulation. The Risk Desk. Vol. III, No. 4.
Blanco, C., Gray, J., and Hazzard, M. 2003. Power Price Simulation using Hybrid Models. The Risk Desk. Vol. III, No. 5.
Eyedland A., and Wolyniec, K. 2003. Energy and Power Risk Management: New Developments in Modeling, Pricing, and Hedging.
Hsieh, T. 2003. Analyzing Requirements Contracts in the U.S. Power Industry. S&P Research Note.

Dr. Carlos Blanco directs the Global Support and Professional Services Group at FEA, a Barra Company. Dr. Josh Gray, Craig Jimenez, and Marc Hazzard are Senior Derivatives Specialists in the same group. The authors thank David Soronow, Michael Pierce, Dr. King Wang, and Dr. Angelo Barbieri for advice and assistance.