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Risk Management of the Electricity Portfolio

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When buying electricity, we naturally think first about price. But recent experience shows that risk is at least as important as price, and, unaccounted for risk can quickly create unacceptably high prices. This is true for electricity acquired to serve retail customers in all states, regardless of the status of restructuring.

Today's electricity markets have at least four sources of risk that offer management challenges to all participants:

1. Increased exposure to market power (FERC and California are arguing whether market power cost the state $3 or $9 billion, but either amount is staggering);
2. Increased exposure to short-term markets and related price volatility, as spot markets price all sources of power at the cost of the marginal unit;
3. Increased reliance on natural gas generation (often the marginal unit), which has not only put upward pressure on the cost of natural gas, but also adds the recent jump in gas market volatility to the volatility of the electric markets, amplifying uncertainty in both; and
4. The availability of financial instruments to manage electric market risk — instruments that are not yet well understood and may also be sources of risk.

This paper discusses how portfolio management practice can reduce both these new market risks and the ordinary risks that have always been present in the electric industry. Portfolio management can be applied both by vertically-integrated utilities in states without retail competition and by default service providers in states that have been restructured.

Portfolio management can reduce risk, but good portfolio management only helps retail customers if the benefits of the portfolio flow to customers. This has emerged as one of the challenges for regulators in states that bid out default retail service.

Diversification

A basic tenet of financial management is that a diverse portfolio is less risky than any single investment. The same is true for commitments for commodity supply, such as electricity. Because prices of different investments are not perfectly correlated, a decline in the value of one investment is often offset by a rise in the price of the other. When we apply this notion to power supply and efficiency alternatives, we can take advantage of similar variations. Each technology and resource option has its own cost structure, operational characteristics, and economic drivers. For example, gas generation

1 Much of this paper has been excerpted from Synapse Energy Economics, 2003. *Portfolio Management: How to Procure Electricity Resources to Provide Reliable, Low-Cost and Efficient Electricity Services to All Retail Customers,* October. This paper can be found at www.raponline.org and at www.synapse-energy.com.

has moderate capital costs, but significant fuel costs — driven by natural gas prices. Wind energy has high capital costs but is insensitive to changes in fuel prices — indeed it has no fuel costs. By combining resources in appropriate proportions, we can get a mix with a lower, more stable cost than by relying on any one resource alone.[2] A diversified portfolio would have a mix of supply- and demand-side resources, rely on a variety of different power plants using different fuels and technologies, and make use of both firm power contracts of varying durations and starting dates, and financial derivatives to shift risk when it is cost-effective to do so.

Diversification reduces the risk of volatility in prices. The unique part of the uncertainty in any individual investment is diversified away when one investment is grouped with others into a portfolio of different investment types and durations. Overall, diversification gives the portfolio manager more flexibility and protection from unknowns. In addition, if some generation in the portfolio is owned, risk protection will be further enhanced by applying the same portfolio management approaches to fuel acquisition — a technique long practiced in that part of the utility industry. Risk management alternatives can be evaluated in terms of the degree of volatility removed, implementation cost, and susceptibility to regulatory scrutiny.

Identifying Sources Of Risk

Any individual investment or generation alternative brings with it two categories of risk. The first is unique risk (also referred to as business risk), which results from events that are specific to an individual investment or resource. For common stocks, unique factors are those that affect a particular company or sector, such as management, errors, a disaster affecting the company's production, the appearance of a more advanced technology, or a broader set of events affecting supply of a particular commodity essential to the sector. For generation resources, unique risks include a failure at a specific plant or discovery of a generic technological flaw, disruption of fuel supply, and unexpected regulatory costs affecting a technology.

The other type of risk is systematic risk, such as risks due to macroeconomic factors that threaten all investments or power supplies equally. With respect to the stock market, these risks affect the stock prices for all companies or all sectors in roughly the same manner and can include changes in interest rates, exchange rates, real gross national product, and inflation. For generation assets, recessions or booms that change the demand-supply balance are types of systematic (or market) risks.

Specific types of risks facing the electricity market include:

- Fuel price risk
- Fuel availability risk
- Performance risk
- Technology risk
- Uncertain ability to balance supply and demand of electricity
- Market failure risks, including liquidity shortages and suppliers' market power
- Transmission congestion costs
- Environmental compliance costs
- Environmental operating restrictions
- Ancillary service costs

2 Awerbuch, Shimon. *Getting It Right: The Real Cost Impacts of a Renewables Portfolio Standard,* Public Utilities Fortnightly, February 15, 2000.

- Counter party credit risk
- Uncertain availability of resources — including demand-side management and distributed generation — or uncertain completion of transmission and central station generation projects
- Electricity market structure uncertainty

"The Western energy crisis painfully underscored the danger of not owning your own energy resources and over reliance on the short-term power market.... Puget Sound Energy doesn't want to place itself, or its customers, at the mercy of the market. Obviously, the risks are much too great."

– Stephen Reynolds, President and CEO, Puget Sound Energy, *The Olympian,* Olympia, Washington, October 23, 2003.

Quantifying Risk

Portfolio managers should begin by emphasizing orderly risk identification and data collection. Historical data on resource availability and price volatility of key cost inputs should be available for most resources. We recommend starting by estimating portfolio price variability, as described above, followed by a qualitative evaluation of other risks. Such an assessment should include careful analysis as to the degree by which risks affecting the cost and performance of the underlying physical resources are truly independent. If they are not, determine if there are any connections between the risks already in the portfolio and the guarantees made by vendors. Whenever feasible, portfolio managers and regulators should quantify the probabilities and price consequences of the most salient counter-party and regulatory risks affecting the most important portfolio components.

To illustrate this process, consider two types of uncertainty: price volatility and counter-party risk.

Price volatility can be assessed quantitatively for each resource, and the portfolio as a whole, in terms of the standard deviation of the price. For fixed price, firm contracts, this is zero (ignoring the risk of supplier default). For many renewables, the variable cost is zero, but the total cost depends on the kWh output. If the output's variability is known, the "price" variability can be computed. For example, variable output from a wind turbine may translate into a varying amount of power to be purchased at market rates.

*Counter-party ris*k — the risk that a party to the delivery obligation will not perform — is more challenging to quantify. It requires an assessment of the likely sources of such risk, the probabilities of those risks materializing, and the price impact if they do.

For example, one counter-party risk always present is the possibility of vendor bankruptcy. In bankruptcy, the vendor can reject the contract.[3] Assessing the probability of bankruptcy for a particular vendor is difficult but may be informed by the vendor's bond rating and leverage, as shown in its audited financial statements (if available) and the nature of the resources — physical or otherwise — upon which the vendor relies.[4] Using these probabilities, together with an estimate of replacement power cost, allows the increment of variability that counter-party risk will contribute to the overall variability of the contract to be estimated.

3 Other possibilities, such as a renegotiation of the contract, can be analyzed in a similar manner.

4 Relatively recent credit scoring methodologies from the finance industry may be of use here. See, for example, Gleason, James T. 2000, *Risk: The New Management Imperative in Finance,* Bloomberg, Princeton, NJ, p. 167 ff.

Getting A Handle On Risk

While the task of quantifying risk may seem daunting, it is useful to look at a spectrum of possible outcomes. This is a way of asking "How bad can the result be?"

For example, in the extreme, one might observe that a supply portfolio composed entirely of spot market purchases represents one "maximum" risk profile — maximum price volatility and uncertainty. At the other extreme, a portfolio composed entirely of long-term contracts (e.g., life of plant contracts), represents a different "maximum" risk profile — maximum exposure to the risk of long-run efficiency and technology gains. Conversely, the spot market portfolio maintains the maximum flexibility, while the long-term portfolio has the least flexibility.

Although at opposite ends of the same spectrum, these two extremes are not symmetrical. The spot market portfolio is exposed to price fluctuations — the entire supply price can go up and down in essentially unlimited fashion. On other hand, the long-term portfolio's risk is bounded by how low the spot market can go. One regrets having purchased a long-term portfolio only if the spot market price is lower.

Service providers or regulators issuing RFPs for power to supply monopoly or default service customers should require the necessary data (under seal if need be) for such analysis. Neither those who solicit power (utilities, default service providers, or some regulators) nor wholesale power vendors are accustomed to RFPs for power products that quantify the level of risk desired or offered. Parties on both sides of such solicitations should work to develop this capacity. Until then, for competitive solicitations, regulators should specify that selection will be based on both price and some defined measure of risk, such as estimating either price variability in offers or the degree to which a promised price is backed by physical resources, with known prices and availability.

Not all risks can be quantified reliably, if only because historical data are lacking or future performance cannot be relied upon to replicate history. In such cases, qualitative assessments, such as management audits, may need to be used. In some cases, such as analyzing risks of additional environmental regulation, estimates of the likely costs of compliance with new regulations can be applied.

Managing Risk

There are several means to address risk in the development of the optimal portfolio. The first is in the selection of supply- and demand-side resources. If the demand side of a portfolio is dominated by one or a few major loads that may mushroom or evaporate by market prices for fuels or wholesale power, or by specific environmental regulations risks, then modifications are needed to the portfolio to protect against these uncertainties. For example, a supply portfolio dominated by uncertain natural gas prices warrants consideration of added energy efficiency or renewable energy resources to mitigate exposure, even if gas prices are currently low. In general, portfolio optimization using energy efficiency and renewable resources will be able to deliver reduced risk at the same cost as the initial portfolio, or deliver the same risk at a lower cost, or some combination of the two.[5] Also, if a portfolio results in inappropriate costs for some classes of customers, or places some customers at higher risk than others, further changes may be needed. This could happen if a hefty firm power purchase were the least-cost way to serve a large, but uncertain industrial load but would overburden other customers if it were not needed.

Another way to address risk in portfolio management is through the use of financial hedging instruments, or derivatives. However, it is important to note that hedging is not free and, as learned in the ENRON implosion, can expose consumers to the counter-party risks

5 Awerbuch, *op cit.*

discussed above. Every financial hedging instrument relies, ultimately, on the cash reserves of speculators and the ability of those reserve funds to find the necessary commodity supply. If either is lacking, financial hedges may seem to mitigate portfolio risks, but will actually increase the overall riskiness of the market.[6]

Finally, portfolio managers need to analyze the risks associated with candidate portfolios, explicitly quantifying the variability and uncertainties associated with long-term resource planning. There are a variety of techniques; some of them familiar from integrated resource planning, that can help quantify the uncertainties associated with a given portfolio and allow alternative portfolios to be compared on the basis of cost and uncertainty. Some of these methods also help to identify the components of a portfolio or the environmental variables that contribute most to that uncertainty. This can be helpful in designing improved portfolios. The choice of risk estimation techniques includes several types of stress or scenario testing, computer simulations, decision tree analysis, and real option analysis.

Time Component Of Risk

Risks play out over different time scales. There is the day-to-day and month-to-month volatility of spot market prices for fuels and electricity and their impact on cash flows for utilities and prices for consumers. There are challenges in addressing very long-lived risks, like the viability of a new technology or the future of world

6 Bolinger, Mark, Ryan Wiser, and William Golove, 2003. *Accounting for Fuel Price Risk: Using Forward Natural Gas Prices Instead of Gas Price Forecasts to Compare Renewable to Natural Gas-Fired Generation,* Ernest Orlando Lawrence Berkeley National Laboratory, August. LBNL-53587.

Energy Efficiency Lowers Risk

Energy efficiency lowers risks in several ways, some of which are not obvious. Most important is that reducing the amount of energy one needs to buy also reduces exposure to uncertain electricity costs. Energy efficiency offers a variety of other benefits to utilities, their customers, and society in general:

- Reduce load growth, eliminating all the risks that come with expanding supply including potential overbuilding, siting and permitting uncertainty, construction delays and cost overruns, technology risks, increased reserve requirements, and transmission congestion.
- Help reduce the risks associated with fossil fuels and their inherently unstable price and supply characteristics and lessen the impact of unanticipated increases in fuel prices.
- Reduce the risks associated with environmental impacts. By reducing a utility's environmental impacts, energy efficiency programs can help utilities and their ratepayers avoid the hard to predict costs of complying with potential future environmental regulations, such as CO_2 caps.
- Improve the overall reliability of the electricity system. First, efficiency programs can have a substantial impact on peak demand, the times when reliability is most at risk.[7] Second, by slowing the rate of growth of electricity peak and energy demands, energy efficiency can provide utilities and generation companies more time and flexibility to respond to changing market conditions, while moderating the "boom-and-bust" effect of competitive market forces on generation supply.[8]
- Help reduce the stress on local transmission and distribution systems, potentially deferring expensive T&D upgrades or mitigating local transmission congestion problems.
- Result in significant benefits to the environment. Every kWh saved through efficiency results in less electricity generation and, thus, less pollution. Energy efficiency can delay or avoid the need for new power plants or transmission lines, thereby reducing all of the environmental impacts associated with power plant or transmission line siting.
- Promote local economic development and job creation, by increasing the disposable income of citizens and making businesses and industries more competitive, lowering total energy bills, and reducing the outflow of dollars from the local economy.
- Help a utility, state, and region increase its energy independence, by reducing the amount of fuels (coal, gas, oil, nuclear) and electricity that are imported from other regions or countries.

oil markets. In the medium term (three to five years), there are numerous risks affecting specific markets, generating facilities, and state and regional economies. A diversified portfolio of contracts of varied length and expiration dates can significantly reduce short- and medium-term risks. Financial hedging instruments can also help manage and reduce uncertainty in the mid term. To address long-term uncertainties, such as major market shifts or new environmental regulations, we need to pay attention to physical resources, both in the portfolio and those underlying long-term contracts and markets as a whole, and apply tools like diversification and demand-side resources. Shifting from a fossil fuel portfolio to a mix of natural gas, renewable generation, and energy efficiency, for example, can mitigate vulnerability to new greenhouse gas emission standards, while providing partial insulation from fossil fuel price volatility.

Integrated utilities, default service suppliers, and the regulators overseeing both need to find the optimal trade-off between price and flexibility through an appropriate mix of resources that offer 1) price certainty and low flexibility (such as forward contracts); 2) better flexibility at a reasonable extra cost (such as may be available from option contracts); or 3) unknown price and supply but maximum flexibility (such as relying on the spot market). Contracts of varying durations and types can help.

Two Simple Ways To Reduce Portfolio Risk

Price Averaging

One well-accepted risk management technique is "dollar cost" averaging where a buyer will divide purchases into equal dollar amounts at equally spaced time increments, regardless of price. For example, instead of buying a single forward contract on January 1 for $50 million of product (to be delivered in monthly increments), a buyer may instead purchase $5 million worth of goods every 36.5 days. While contract prices will be higher or lower, based on the market price on the given day of settlement, the mathematics of this technique guarantees that the buyer will acquire more goods when they are inexpensive and less when they are costly. However, instead of price fluctuations, buyers experience fluctuations in the volume of goods purchased. As long as the buyer can bear these changes in volumes — for instance by relying on a mature spot market — dollar-cost averaging is an excellent technique to manage price fluctuation risk.

Laddering

A portfolio made up of only forward contracts can still be diversified to reduce risk. Like a board of directors whose terms are staggered so that a certain fraction expire each year to assure turnover while retaining the benefits of management continuity, a portfolio of power supply contracts can be structured so that a modest fraction of the portfolio turns over each year. This laddered approach eliminates the risk of having to go to the market for all (or even a large portion) of the portfolio in a less-than-ideal economic environment when a single contract expires. For example, in Vermont (a non-restructured state), regulators are rightfully concerned that more than 60 percent of the state's electricity comes from two contracts, scheduled to end within a few years of each other. In Maine, 100 percent of the retail, residential default service is derived from a single contract, which expires on a single date.

New Jersey has a sophisticated auction for default service, with multiple contracts, but all contracts begin and end on the same date. Laddering is currently under discussion in each of these states.

Maintaining an Optimal Portfolio Over Time: Vigilance And Flexibility

Once an optimal resource plan has been determined, the portfolio manager must implement the plan flexibly and judiciously over time. Ongoing evaluation and updating will not only help realize the full potential of portfolio and risk management but will also allow portfolio managers to respond to unexpected developments in wholesale electricity markets and the industry in general. Both supply- and demand-side initiatives should be evaluated on a regular basis.

To ensure that the portfolio strategy is successfully implemented, an action plan should be prepared that covers 1) acquisition and disposal of portfolio elements; 2) monitoring of market conditions, counter-party risk, environmental trends, and electric loads; 3) monitoring of portfolio performance; and 4) evaluation of potential new acquisitions or hedging instruments.

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