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Better Power Contracts:
Using Flexibility to Increase Value

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Power Contracting and Uncertainty

Due to recent structural changes in the power industry, the importance of bilateral power contracts has grown enormously at both the wholesale and retail level. At the retail level, vertical integration and monopoly/monopsony service obligations have become somewhat less common, and arms-length transactions and supplier/customer choice have become more common. As Figure 1: U.S. Wholesale Electricity Market shows, the wholesale power market has grown from virtually nothing to a massive business over the past decade. This market is dominated by non-standard bilateral contracts rather than the standardized contracts typical of many commodity markets. Although precise figures are hard to come by, the annual value of bilateral power contracts is at least $100 billion.[1]

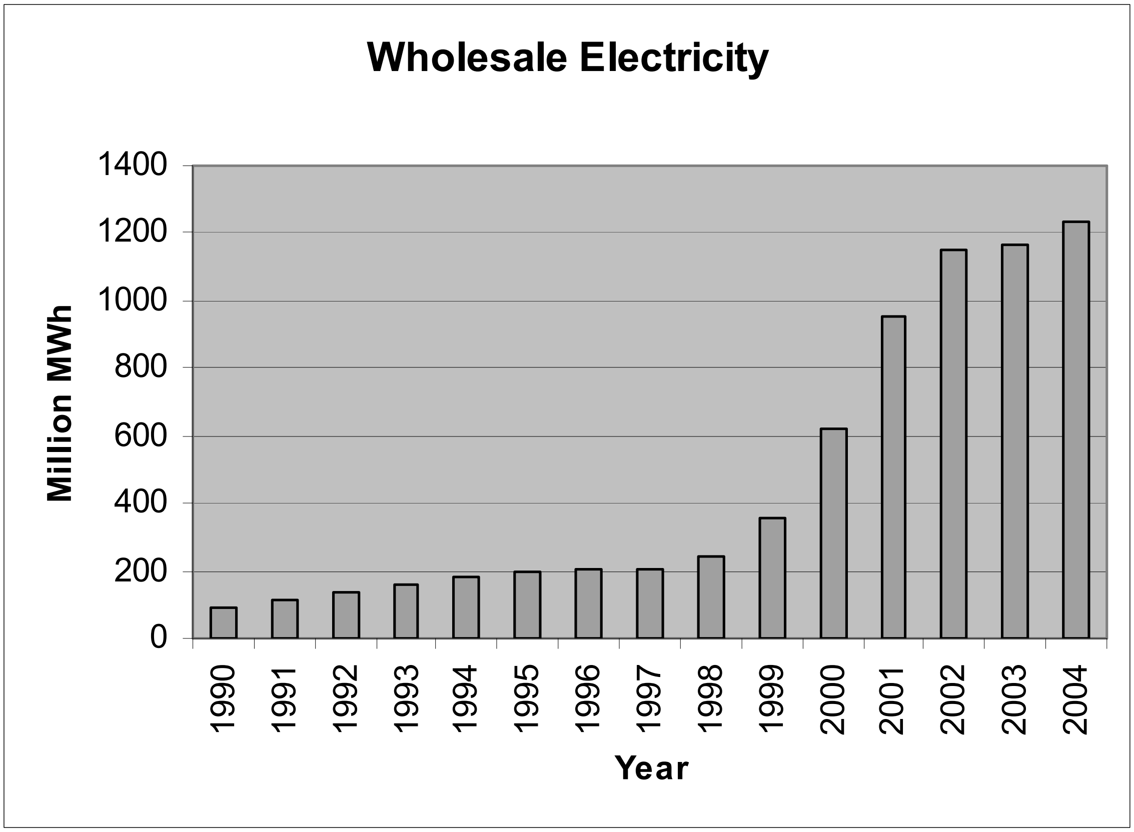

Figure 1: U.S. Wholesale Electricity Market (Source: EIA)

Concurrent with the rise in bilateral power contracting, another phenomenon in the power industry has also become more important. That phenomenon is business uncertainty. Three broad sources of uncertainty can be identified.

- Structural changes. First, the same structural changes that led to the rise in power contracting have also made the business environment more unpredictable. For example, it is now unclear what markets there actually will be (e.g., Will there be a market for ancillary services?), who the market participants will be (e.g., Will regulated or merchant generators be building new capacity?) and how those players will be regulated (e.g., How will transmission be priced?).
- Supply factors. Second, the key supply factors in the power industry – fuel, transportation and electricity itself – have become increasingly volatile. As Figure 2: California Average Spot Prices indicates, California electricity prices are a good, if extreme, example. This particular market exhibited a four-fold year-to-year increase followed by sequential 50% decreases. Short-term volatility is even more dramatic.
- Social/political forces. Third, typically unpredictable social and political forces, such as the climate change and nuclear energy issues, have remained a major influence for decades or more. And new issues, such as terrorism and security, have been added to this mix.

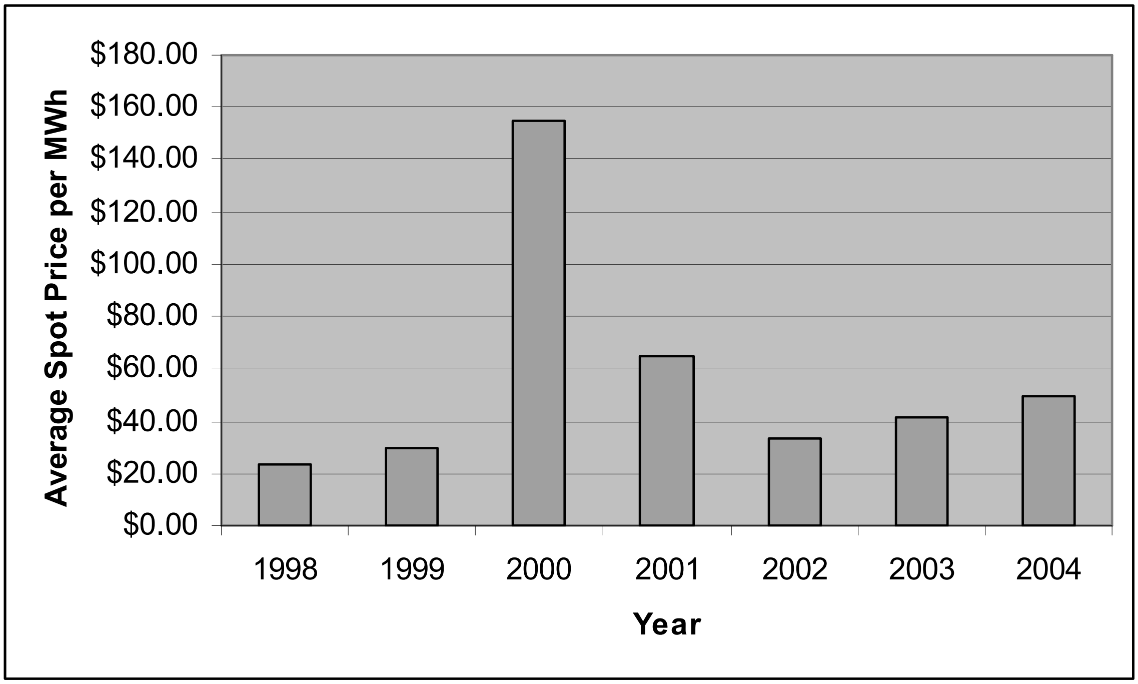

Figure 2: California Average Spot Prices

The Role of Contract Flexibility

Because of the increase in both power contracting and business uncertainty, industry participants face a difficult and important task: designing power contracts that appropriately address and distribute risks. Some participants adopt an approach that attempts to eliminate risk, seeking contract provisions that require counterparties to deal with any uncertainty. However, this approach consumes a great deal of time and effort, and is likely to be futile or uneconomic.

A more promising approach is to design contracts explicitly with flexibility; that is, with specific provisions or "options" that allow one or both parties to respond appropriately as conditions change. Such a proactive strategy is often the best means to prosper in a world of uncertainty. Our experience indicates that 3% or more additional value can be achieved in increased expected return and/or reduced risk exposure with appropriately designed flexible contract provisions.

Contract provisions can be divided into five broad areas:

1) Pricing (including non-performance penalties),
2) Duration,
3) Quantity,
4) Timing (season, time-of-day), and
5) Reliability (firm, unit contingent, interruptible).

Flexibility is relevant in all these areas, but is generally most important with respect to duration and quantity. Specifically, contracts can be designed with termination/extension provisions in duration or increase/decrease provisions in quantity.

Surprisingly, contract flexibility is often not examined or examined poorly. Three types of errors are especially common.

- A buyer or seller will often refuse to consider any flexibility requested by the counterparty, thereby effectively overstating the cost of providing it. This can lead to significant missed opportunities, which more savvy participants can capture by being willing to consider and value flexibility.
- When flexibility is included in contracts, terms are often designed and analyzed briefly and haphazardly. These back-of-the-envelope analyses can result in substantial overvaluation and undervaluation.[2] There is substantial competitive advantage for participants who invest the effort to make more accurate valuations.
- When rigorous analysis is performed, tools intended for standardized market contracts but inappropriate for custom bilateral contracts are often used. This can lead to paying too much or receiving too little. Again, participants can profit if they use tools better suited to the unique features of the power industry.

To help market participants become more savvy and achieve greater success, we propose a systematic process below that ensures that value-adding contract flexibility provisions are considered and appropriately valued using the right tools. This process starts with and builds on the simple "baseline" analysis that accompanies many contract negotiations. The three steps in this process are:

1) Uncertainty Analysis. Identify and analyze the uncertainties that affect contract value.
2) Option Analysis. Identify and value flexible contract provisions to address these uncertainties.
3) Negotiation. Use this valuation to negotiate the best possible deal with the counterparty.

Case Study

Each of the steps in this process is described in more detail below in the context of an example derived from several recent projects conducted by our firm Stratelytics. The actual details of the example are disguised. The example involves an investor-owned, regulated retail utility (ABC Power) seeking additional long-term additional power supplies. It is located in a region with a mix of regulated and merchant generators, a well-developed transmission system, and an active spot/short-term electricity market. ABC is currently evaluating a proposed twenty-year power contract from a merchant generator (XYZ Generation).

Baseline analysis indicates that, under nominal conditions, the power contract initially offered by XYZ compares poorly to simply relying on the spot market for energy needs and the short-term market for capacity needs. Specifically, the contract would result in a loss of $18M on a net-present-value basis. However, given the uncertainties noted above, ABC does not view the nominal -$18M necessarily as an accurate reflection of the contract value. Furthermore, ABC believes that flexible contract provisions might improve that value.

Step 1: Uncertainty Analysis

The first step in this process is to understand and analyze the uncertainties affecting the value of this contract. This value is related directly to ABC's need for additional power, and the cost of alternatives for delivering that power. ABC examined numerous factors that play a role in this area, and identified three major uncertainties that might make the proposed contract substantially more or less valuable than the baseline analysis indicated. Each of the three uncertainties falls into one of the three categories noted above.

1) Transmission Regulation (Structural changes). The first factor is a structural one. It is the possibility that transmission regulations will be changed. This change would directly affect the cost of delivering power to ABC, and indirectly affect regional power prices.
2) Electricity prices (Supply factors). The second factor involves a key supply factor: electricity. It is the price of power, both energy and capacity.
3) Nuclear availability (Social/political forces). The third factor involves an important social and political issue: nuclear power. It is the long-term availability of ABC's nuclear power plant. Like transmission regulation, this uncertainty has both a direct and indirect effect. It directly affects the need for power, and it indirectly affects regional power prices.

These uncertainties are shown in the form of an influence diagram (Figure 3: Influence Diagram of Uncertainties Affecting Value). This diagram provides a compact representation of the uncertainties affecting contract value and their relationships.[3]

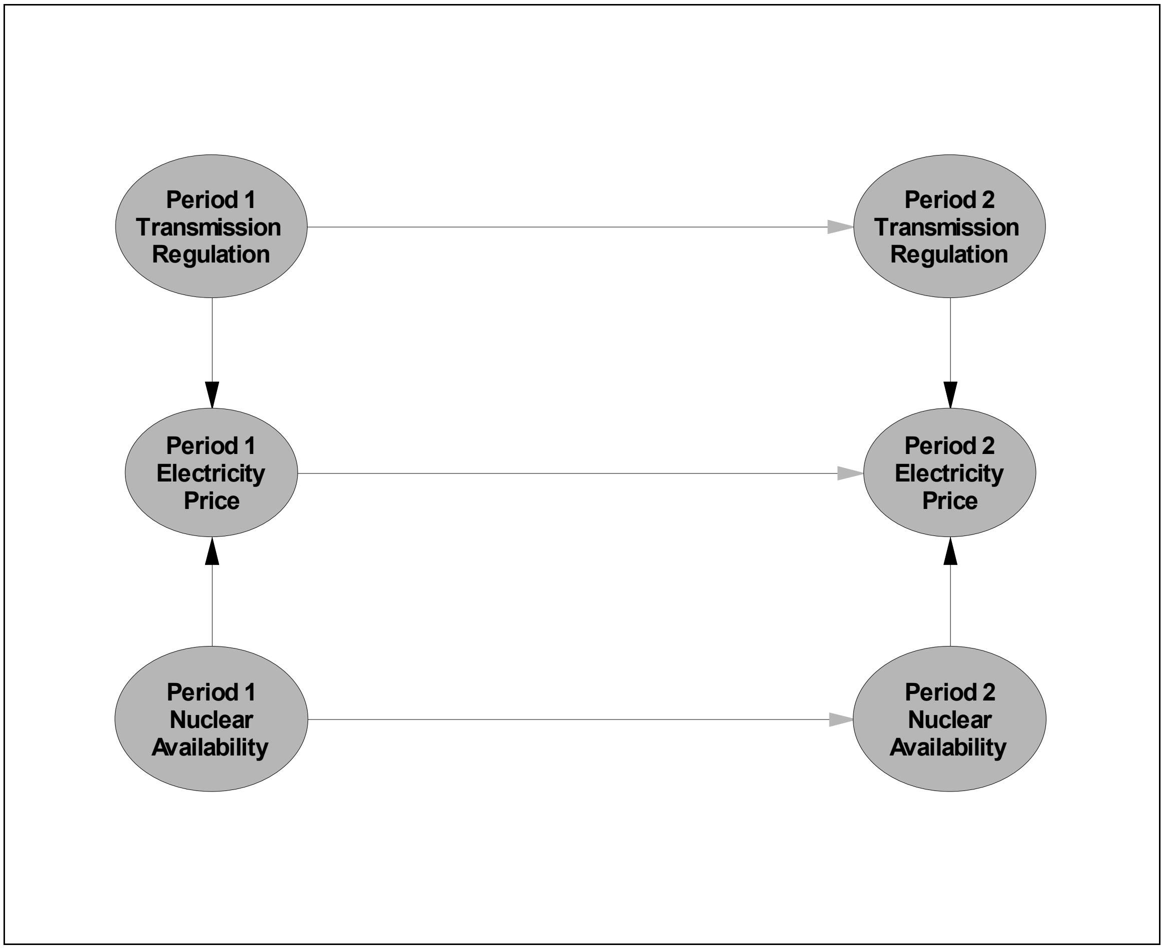

Figure 3: Influence Diagram of Uncertainties Affecting Value

The diagram shows the three uncertainties in two time periods. Each uncertainty is represented by an oval "chance node." The arrows between nodes show influences or relationships among the uncertainties. Transmission regulation influences electricity prices (i.e., new regulation makes low electricity prices more likely), as does nuclear availability (i.e., low nuclear availability makes high electricity prices more likely). Furthermore, each uncertainty in the first period influences its counterpart in the second period (i.e., high electricity prices in the first period imply high electricity prices in the second period).

Identifying these uncertainties can be useful in itself. However, to establish an accurate estimate of their impact on the contract value, they must be quantified. In this quantification, it is important to distinguish between "market" and "non-market" factors. Electricity price is an example of a market factor; that is, there are financial markets where this factor (or a close equivalent) can be traded by investors. Transmission regulation and nuclear availability are examples of non-market factors; that is, there are no financial markets where these factors or equivalents can be traded by investors. Quantifying the impact of uncertainty on value is particularly complex when both market and non-market factors are involved. In general, the best approach is to treat them somewhat differently.[4]

Transmission regulation and nuclear availability, the non-market variables, are modeled using discrete scenarios with probabilities, and data is obtained from expert judgment and/or history. Figure 4: Nuclear Availability Distribution shows the probability distribution on nuclear availability in Period 1 and the dependent probability of nuclear availability in Period 2. Probabilities are listed to the left and availabilities are listed to the right on each branch in the figure. This information was obtained from experts at ABC. As indicated in this figure, nuclear availability is expected to range from the low-80's to the mid-90's, improving somewhat from Period 1 to Period 2.

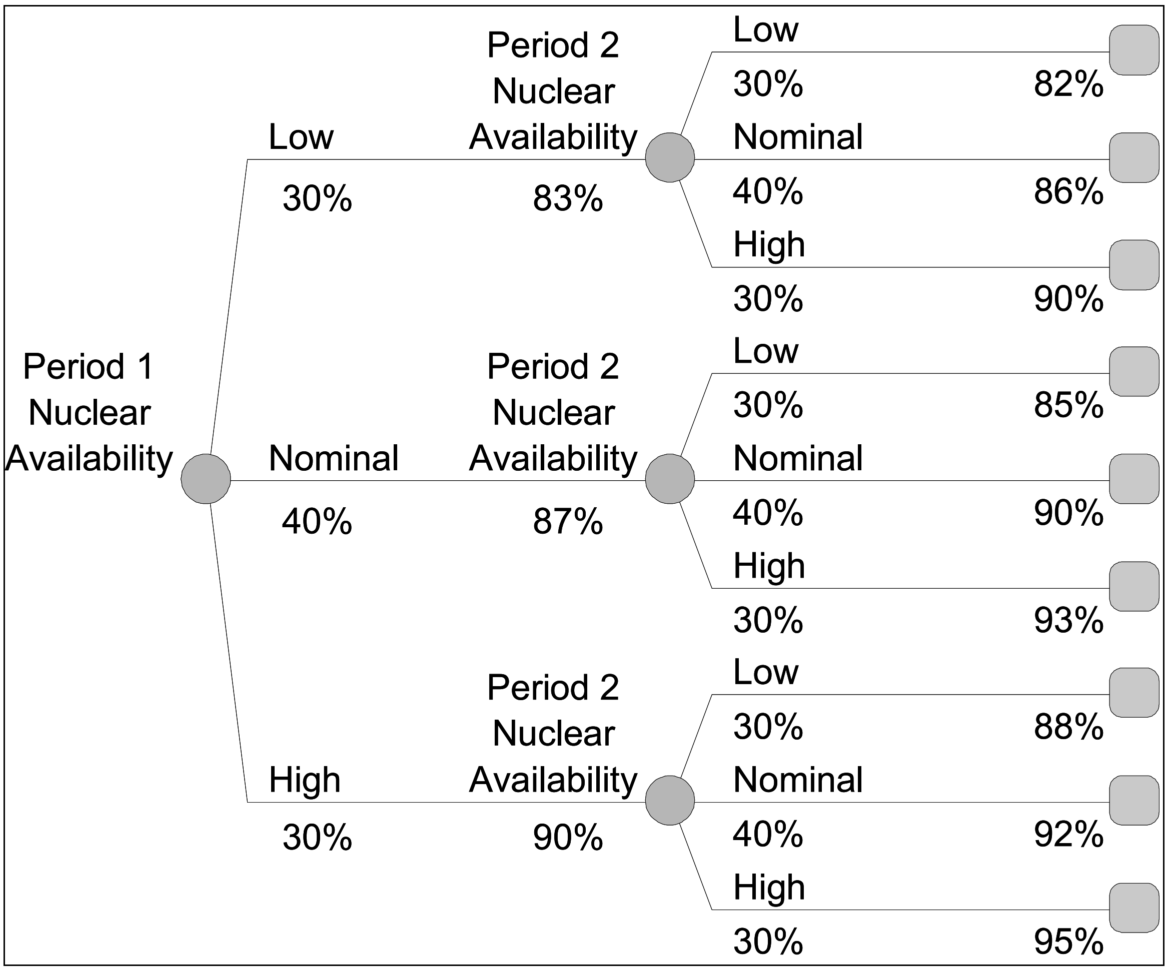

Figure 4: Nuclear Availability Distribution

Electricity price, the market variable, is modeled using a continuous stochastic process, and data to parameterize this process is obtained from commodity markets. Figure 5: Electricity Price Distribution illustrates the uncertainty in electricity prices over time. This information was obtained through careful analysis and modeling of regional power market data. The mean price and the 10%-90% interval prices (such that there is a 10% probability prices are lower than the lower price and a 90% probability prices are lower than higher price) are plotted. The distributions are risk adjusted and the price process is mean-reverting.[5]

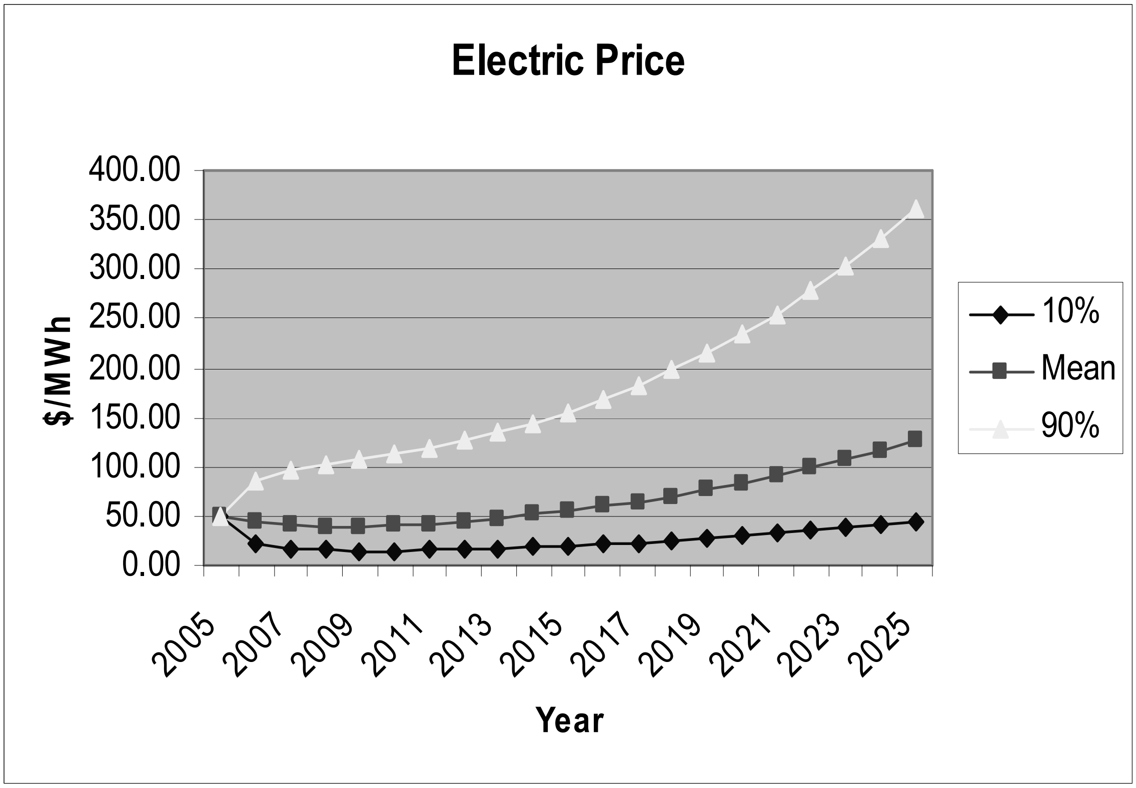

Figure 5: Electricity Price Distribution

Not surprisingly, the value of the proposed contract is sensitive to the outcome of these uncertainties. If spot electricity prices become high, for example, the power contract with its fixed prices looks increasingly attractive. If transmission regulations change, the power contract looks particularly unattractive because other sources are now more economic. Figure 6: Tornado Diagram of Uncertainty Impact on Value shows the sensitivity of the contract value to each of the six uncertainties in the form of a tornado diagram, a compact representation of the impact of uncertainty on value. The size of each bar shows the relative significance of each uncertainty. This figure indicates that the most important uncertainties are electricity price and transmission regulation, particularly in the first period. Each of these uncertainties can transform the contract from a bad idea (a negative value of -$18M under baseline or nominal conditions) to a good idea (a positive value of up to $70M). Nuclear availability has a considerably smaller impact on value than the other uncertainties.

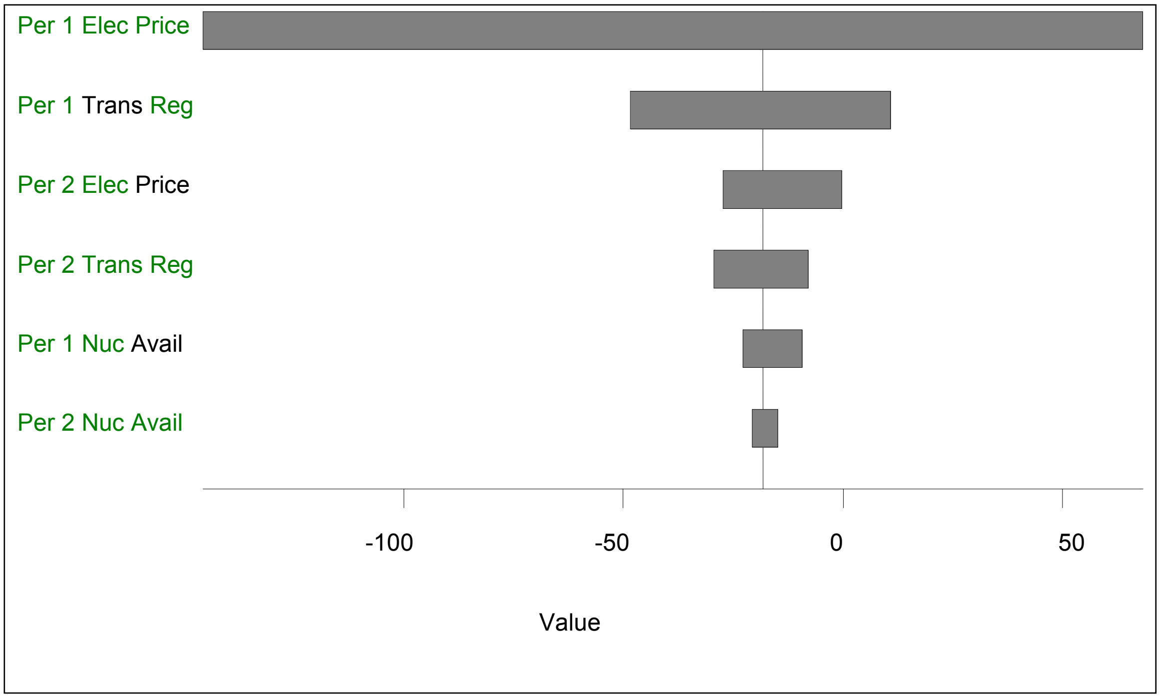

Figure 6: Tornado Diagram of Uncertainty Impact on Value

The probabilistic range of value of this contract given the six underlying uncertainties can be displayed in compact form as a risk profile. The risk profile (Figure 7: Risk Profile of Contract) displays the cumulative probability distribution of the contract value, together with the risk-adjusted expected value. As the figure indicates, the value varies from a low of -$200M to a high of $100M, with an expected value of -$25M.

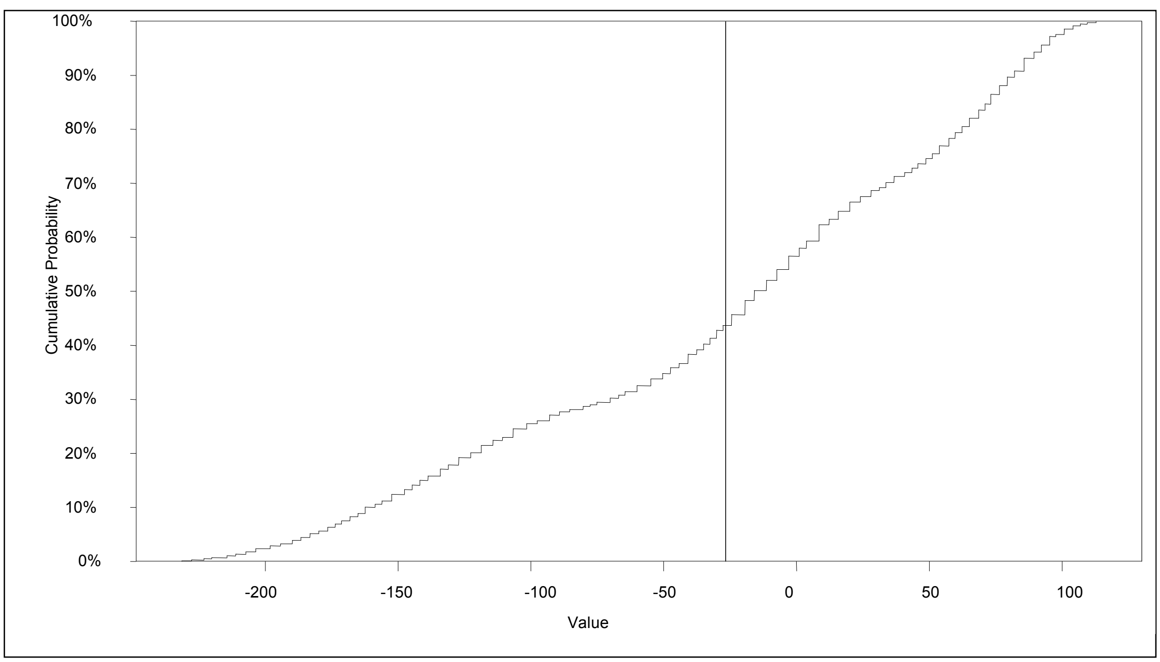

Figure 7: Risk Profile of Contract Value

This uncertainty analysis sends two distinct messages. It confirms that the inflexible contract as proposed is unattractive. The expected value (-$25M) is even lower than in the "nominal" case (-$18M), and the impact can be considerably worse. For example, on the downside, there is a 10% chance that the value is -$150M or worse. However, at the same time, the analysis shows there are scenarios where the contract produces considerable value. For example, on the upside, there is a 10% chance that the value is $75M or better. This indicates strongly that a flexible variation of this contract, designed to capture the upside while reducing the downside, could be very valuable indeed.

Step 2: Option Analysis

The uncertainty analysis reveals an important opportunity --- the possibility that a flexible contract, with options, could create considerable value. The second step is to understand and evaluate this opportunity. As discussed earlier, contract options often involve changing duration or quantity. In this case, ABC considered a variety of options and determined that the most important ones involved contract length; that is, early termination. In financial terms, one could think of this as a "put option" for ABC.

Figure 8: Tree Diagram of Inflexible versus Flexible Contract illustrates the original inflexible contract proposal and an important new flexible alternative in the form of a decision tree. The top branch represents the original proposal. As indicated, if ABC chooses this alternative, the value is determined by the outcome of all six uncertainties in the two periods over 20 years. There are no intervening or "downstream" decisions and no flexibility. The bottom branch represents a new alternative with an early termination provision at the end of Year 5. If ABC chooses this alternative, it can observe the outcome of the three uncertainties in five years at the end of the first time period, and then to cancel (or continue) the contract through the second time period of fifteen years. This alternative has intervening or "downstream" decisions and flexibility. Presumably, if conditions are favorable, ABC will choose to continue the contract. If they are unfavorable, ABC will choose to cancel it. The second period risks are only relevant to the contract value if it is continued.

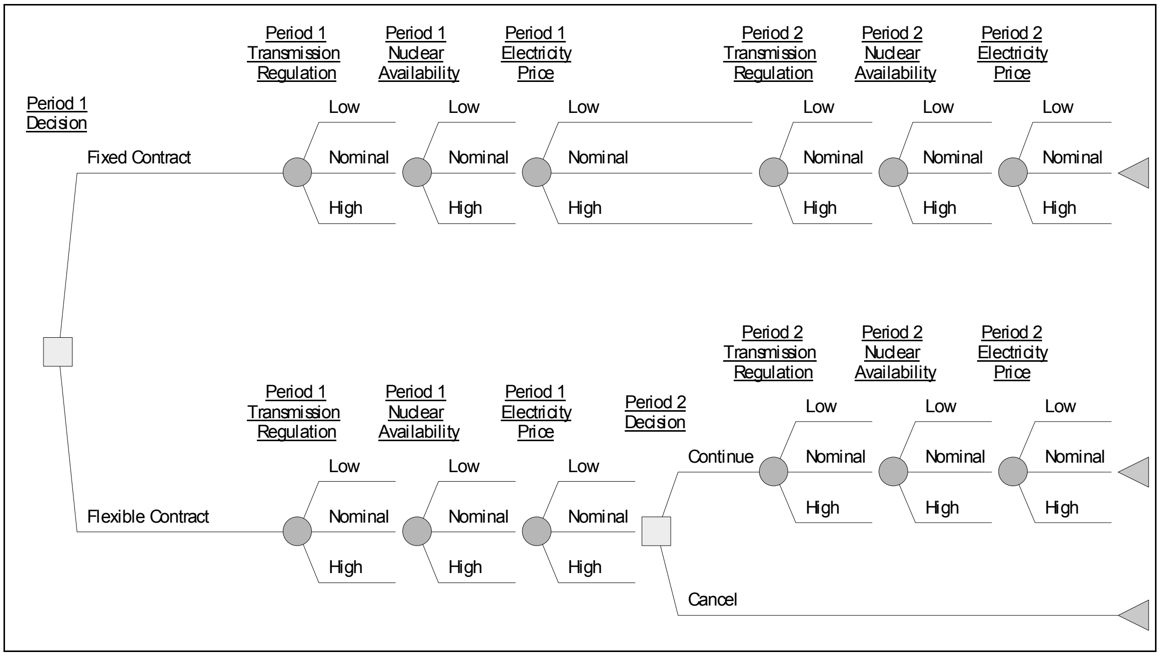

Figure 8: Tree Diagram of Inflexible versus Flexible Contract

Figure 9: Risk Profiles for Fixed and Flexible Contracts compares the risk profile of these two alternatives. As noted above, the original fixed contract has a -$25M expected value with a 10-90 range that extends from -$150M to $75M. The new proposed contract has a considerably improved, and positive, expected value of $15M. It also has a dramatically-improved range with a 10th percentile of -$40M. The analysis shows that the proposed contract with an early termination provision (a put option) after five years is highly valuable to ABC on a risk-adjusted expected-value basis.

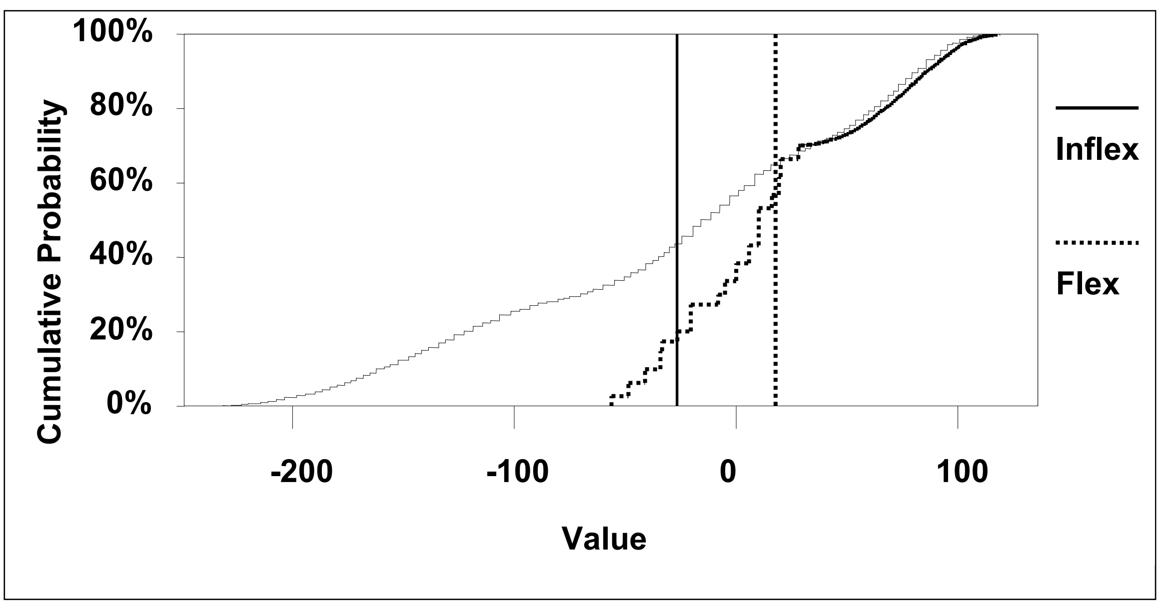

Figure 9: Risk Profiles for Fixed and Flexible Contracts

Step 3: Negotiation

The option analysis shows the potential value that ABC could realize from the right, flexible contract. The third step is to negotiate a deal that captures as much value as possible. It is clear that ABC should reject the original proposal. Both on the basis of expected value and risk, the spot/short-term market is preferred – even if there are no other contract alternatives.

The situation with flexible contract alternatives is entirely different. The contract with a 5-year early termination provision both increases value and reduces risk compared to the spot/short-term market. However, the counterparty may or may not be interested in providing this specific form of flexibility even at a premium.

Figure 10: Strategy Diagram for Flexible Contract provides key information useful in the negotiation process in a compact form known as a strategy diagram. Specifically, it shows how the value of the contract to ABC varies as two key negotiable parameters are varied - the year of the early termination option and the price premium (option cost) over the fixed contract. The shaded areas in the diagram indicate how the value of the contract changes for different combinations of the price premium and the early termination year (the locked-in period). As the figure indicates, the value of the contract increases as the premium and the locked-in period decrease.

The heavily-shaded area indicates the parameter settings where the risk-adjusted contract value is negative and the contract should be rejected. For example, a premium of $20M and a locked-in period of 7 years is in this area and therefore should be rejected. The lightly-shaded area indicates the parameter settings where the value ranges from $0 to $10M. Finally, the moderately-shaded area indicates settings where the value ranges from $10M to over $25M. For example, a contract with a $9M premium and a 3-year termination clause has an NPV in the $10 - $25M range, as does a contract with a $3M premium and a 7-year termination clause. While ABC may be indifferent between these two proposed contracts, one or the other may be preferable to the counterparty.

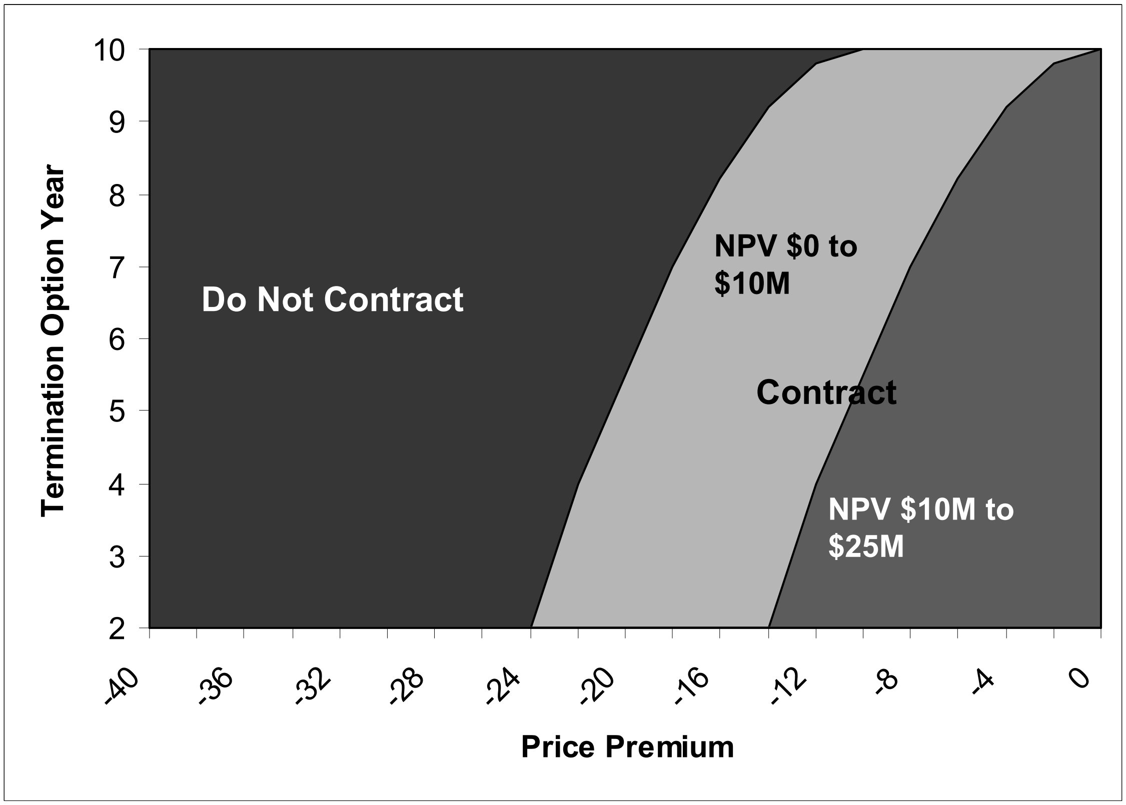

Figure 10: Strategy Diagram for Flexible Contract

As it turned out, the shortest locked-in period that the counterparty was willing to provide was 8 years. But they were willing to do so for a reasonable $6M premium over the fixed contract. The value of this flexible contract to ABC was $8M (compared to the -$25M value for the original fixed proposal). The $8M incremental value represents a 3% risk-adjusted net present value improvement over the cost of obtaining this power in the spot/short-term market. In addition, this contract provided significant risk reduction for ABC by reducing future variability in costs.

Conclusion

In recent years, the highly-integrated, tightly-controlled electric power industry of mid-20th century has been transformed. Not – as some expected – into something similar to long-standing commodity and equity markets with highly-liquid, stable, public markets and standardized financial instruments. But into something unique, with highly-unpredictable market/non-market forces and customized bilateral transactions. This unique environment calls for a unique response – using a rigorous, systematic approach to design and evaluate contract flexibility. As this article demonstrates, this approach can create significant value for savvy power industry participants.

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[1] Various government agencies and industry observers provide estimates of the size of wholesale and retail electricity markets, but most estimates do not specifically break out bilateral contracts, market contracts and short-term/spot markets. The U.S. wholesale market alone is estimated at $200 billion annually, and several other countries have sizable wholesale markets as well.

[2] The automotive industry appears to offer an excellent example of the downside of under-analyzing contract flexibility. In February 2005, General Motors agreed to pay Fiat $2 billion to void a put option that Fiat had negotiated in a contract between the two firms. Apparently, when the contract was signed, GM did not think seriously about the likelihood or consequences of this option being exercised. To quote Scott Sprinzen, Chief Auto Industry Analyst at Standard and Poor's, "…at the time of the transaction it was very distant from the minds of all the principals that this put option would ever be invoked." Of course, the option turned out to be very valuable to Fiat. For more information, see February 15, 2005 ***Business Week***.
[3] For more information on influence diagrams and other graphics in this article, see ***Making Hard Decisions: An Introduction to Decision Analysis*** by Bob Clemen. For software for developing and using these graphics, contact SyncopationSoftware (www.syncopationsoftware.com) regarding their DPL software. Most of the figures in this article were produced using DPL.
[4] The approach to valuation that treats market and non-market factors differently in this manner is known in the real options literature as the "integrated approach." For more information on different approaches to real options analysis including the integrated approach, see *Real Options Analysis: Where are the Emperor's Clothes?* by Adam Borison in the Spring 2005 ***Journal of Applied Corporate Finance***.
[5] In this mean-reverting process, the mean increases at a constant rate and the standard deviation as a percent of the mean becomes constant in the long run. The annual distributions are risk adjusted or risk neutral, reflecting market valuations rather than spot prices. Note that, because of the risk adjustment, it is often easier to assess non-market uncertainties such as the nuclear availability and regulatory change dependent on the price rather than vice-versa as indicated in the influence diagram.