

MARKET PRICING—The Valuation of Transmission Rights

INTRODUCTION

This edition of ENERGY presents a framework for the valuation of transmission rights in deregulated electric power markets. This includes rights that arise from physical investments in merchant transmission assets as well as financial investments in transmission rights and congestion contracts. Instead of having a specified return, as under cost-of-service regulation, the value of these investments depends upon the market price for energy, capacity, and ancillary services in addition to the expected physical usage of the underlying transmission assets. Standard methods for the evaluation of utility investments may yield misleading results and lead to value-diminishing decisions. Option-pricing and decision-analysis methods can provide more accurate assessments of value, aid in the choice among alternative project configurations, or help in the determination of the timing of a project.

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The electric transmission system consists of not only physical assets, but also intangible elements. These are the systems for the assignment of the rights to control and benefit from the use of the physical assets. Deregulation has changed dramatically the determination of the rights to control and benefit from the transmission system. Under traditional utility regulation, vertically integrated utilities controlled the system, and cost-of-service principles determined the allocation of benefits. Following deregulation, the use of market prices to guide investment and to determine the rewards to owners of specific transmission assets is under consideration.

In the United States, the movement towards market pricing of transmission rights has been motivated largely by changes in federal policy. In 1999, the Federal Energy Regulatory Commission (FERC) issued Order 2000, which outlined the basic functions of Regional Transmission Organizations (RTOs). The FERC specified that RTOs adopt market-based pricing systems for congestion management and system expansion. Since Order 2000, the Commission has continued to encourage the growth of RTOs and market-based pricing for transmission system usage.

The assignment of the rights to the benefits created by the use of transmission assets can take a number of different forms. The rights to the benefits from the use of an asset may be coupled with ownership of the underlying physical assets. For instance, the developer of a merchant transmission line may retain both ownership of the line itself and the rights to use the line after it is in service. On the other hand, rights to the benefits from transmission assets can also be divorced completely from physical ownership. The holders of Transmission Congestion Contracts (TCCs) and Financial Transmission Rights (FTRs) have the rights to the benefits created from the use of a transmission asset but do not have physical control or ownership.

MARKET PRICING—THE VALUATION OF TRANSMISSION RIGHTS

Valuation issues arise when transmission rights are created through new transmission investment or when rights to existing assets are bought or sold. Some of the contexts in which valuation issues arise include the following:

MERCHANT TRANSMISSION DEVELOPMENT

While relatively new, interest in merchant transmission has been growing. Merchant transmission lines are either already underway or under construction in Europe, North America, and Australia. Rights are created through the development of a new facility. These rights may be either retained by the developer or sold.

REGULATED TRANSMISSION EXPANSION

The construction of regulated transmission facilities also creates rights to the use of those facilities. However, rather than retaining the rights to the benefits of the line in a regulated project, rights are ceded by the developer to the system operator. Valuation, though, is not a moot point. The analysis of locational pricing signals to compare the benefits from the expansion of regulated transmission networks to the costs is likely to become increasingly important in transmission planning studies and regulatory filings.

TRANSFERS OF TRANSMISSION HOLDINGS

In the past, when utilities transferred the ownership of transmission assets to or among subsidiaries, these transfers were generally based on book value. With congestion-based pricing for short-term transmission services, book values may differ substantially from the market values of these assets.

PURCHASE AND SALE OF TRANSMISSION RIGHTS

Valuation questions arise for both buyer and seller when FTRs and TCCs change hands. When transmission rights are distributed initially to system participants, perhaps through an auction, buyers need to form some estimate of the value of these rights. In addition, in many regions, there is active trading in FTRs and TCCs in secondary markets and through bilateral exchange.

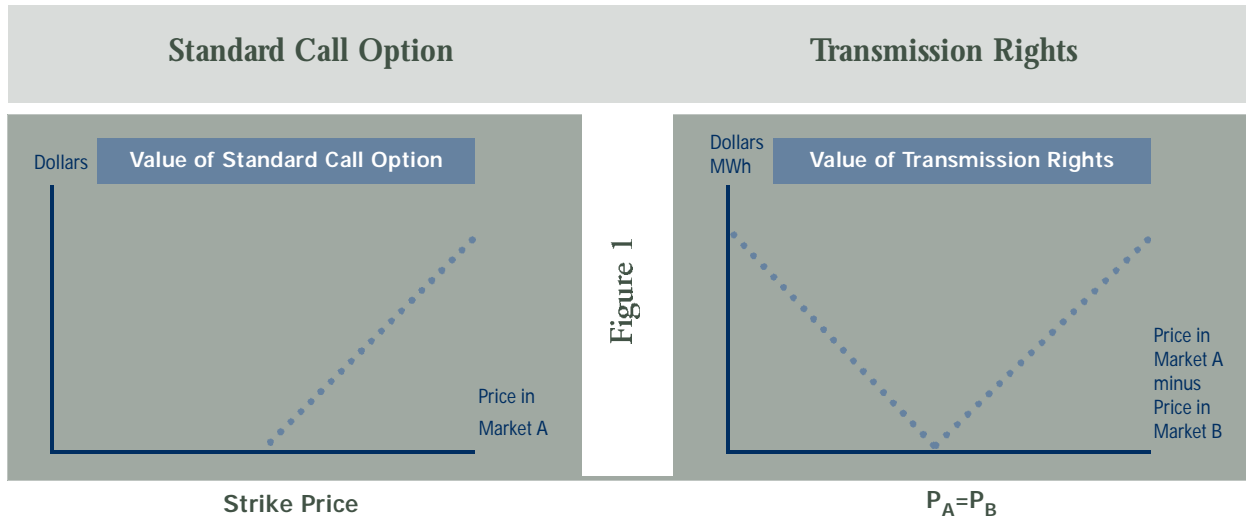
A CONCEPTUAL FRAMEWORK

Transmission, like other types of transportation services, creates value through facilitating the movement of goods from one location to another. The value created depends on the marginal costs and the willingness of buyers to pay for the transported goods at the origin and at the destination locations. Locational pricing provides a signal of short-run marginal costs. This includes locational pricing differentials set within a centrally dispatched market as well as trade-induced price differentials between market areas spanned by transmission linkages.

The value created by a transportation network is the product of the difference in the price of a good between the points of origin and destination times the amount moved, accumulated over the life of the asset. Consider the value of transmission rights on a network between two hypothetical locations on the grid, locations A and B. If the price of power is higher at location A than at B, the holder of rights to the line in the direction from B to A realizes congestion revenues of $P_A - P_B$ for each flowing megawatt of power. If the amount of power moving from one location to another is Q , holders of directional rights realize total revenues of either $(P_A - P_B) \times Q$ or $(P_B - P_A) \times Q$, when the flow is in the opposite direction.

This example assumes that the holder controls transmission rights in both directions across the line. However, this is just one possible arrangement. The rights to the use of the line may be split among parties such that one party holds the rights to the line for flows from point A to B, while another holds the rights in the opposite direction. For instance, a utility with a native-load obligation at point A that exceeds its local generation resources may be interested only in the rights to use the line to move power to point A rather than to export it to B.

MARKET PRICING—THE VALUATION OF TRANSMISSION RIGHTS



Because a line has value whether $P_A > P_B$ or vice versa, it cannot be valued properly using conventional techniques based on the expected value of $P_A - P_B$. Instead, option valuation techniques commonly used in financial economics can help assess the value of transmission rights. Figure 1 illustrates the payoff from two types of options. On the left is a standard call option, in which the holder realizes value when the price of an asset exceeds the strike price of the option. The panel on the right depicts the payoff to the holder of 1MW of transmission rights in both directions between points A and B. The set of payoffs is more complex since the options have value both when the price at A exceeds the price at B and B exceeds A. Further, both prices (hence both exercise prices) are uncertain.

The value of the rights depends on 1) the proportion of time that the price on one end of the line exceeds the price at the opposite end, 2) the size of the corresponding price differences, and 3) the amount of power flowing over the line for any given price differential. In practice, these nuances make it difficult to use simple option valuation expressions to evaluate transmission lines, though such formulas may provide insights. However, the value of transmission rights may be estimated using Monte Carlo simulation, supplemented by flow studies that address the amount of power flowing between specific points in the transmission network. Such methods are consistent with the fundamental concepts behind option valuation, but some analytic refinements are required, as described below.

CASE STUDY: THE EVALUATION OF MERCHANT TRANSMISSION INVESTMENTS

The valuation of the transmission rights created by merchant transmission investments raises at least three important methodological issues:

- Transmission investments tend to be long lived. During the useful life of a transmission line, new generation may enter and older units may be retired in markets spanned by the line. Changes in fuel prices may affect relative prices if the generation mix differs between the markets at each end of the line. Thus, the distribution of possible price differentials across the line may change over time, and will be very sensitive to the correlation between spot power prices at each end.
- Once in service, a merchant transmission line will tend to reduce congestion and thus reduce potential price differences throughout the network. The reduction in price differentials diminishes the value created by the line. This does not mean that merchant transmission investments will be unprofitable, only that one must account for the effect of the merchant investment itself on market prices. (In principle, one could build a transmission line and not have to take this into consideration if it were possible to trade power at both ends of the line forward over the line's entire life. However, power forwards are not yet this liquid or available.)
- The value of transmission rights depends on the absolute difference in, rather than the average level of, prices at each end of the line. Equivalently, price volatility is critical. Price volatility is affected by both structural factors and chance events. Typical structural models of electricity markets will tend to understate the volatility of prices at both ends, and hence understate the value of transmission rights.

MARKET PRICING—THE VALUATION OF TRANSMISSION RIGHTS

The Brattle Group's approach to transmission valuation begins with market-modeling forecasts of the electricity spot prices at each end of the proposed investment. Alternate scenarios are developed that allow for differences in controlled structural conditions—such as generation capacity, transmission network capabilities, fuel costs, and regulatory restrictions. Inputs into the price forecast are modified to account for dilution from the proposed merchant transmission line itself.

In actual power markets, the level of observed volatility in power prices is generally higher than the estimates from market models. By itself, modeling software cannot account for the effects of human error, short-term weather, and possible strategic interactions between market participants.

To capture the amount of price volatility not simulated by market-modeling scenarios, *The Brattle Group* backcasts its market models to a period in which actual spot price data are available. That is, the market model is calibrated to produce price estimates that reflect prior periods of actual market prices in locations spanned by the merchant line. The actual historical data are further adjusted for the effect of the transmission investment on the distribution of prices. This calibrates for the variations in prices not due to structural changes captured by scenario modeling of electricity prices. Historical data also provide correlations for prices at either end.

Given the distribution of electricity prices in markets at each end of the line, option-pricing concepts can then be used to determine the value of the transmission rights per unit of line capacity. Some price distributions may permit the use of closed-form analytical methods for determining the value of the transmission rights. Alternatively, *The Brattle Group* has employed Monte Carlo simulation to determine the value of transmission rights. Monte Carlo techniques are more flexible in that the analyst specifies an empirical rather than a theoretical distribution for electricity prices.

ADDITIONAL ASPECTS OF VALUE ANALYSIS

Transmission projects give rise to a wide range of strategic considerations. These include issues such as how the line could affect up- or downstream corporate assets, as well as the merits of alternate line size and timing. Some additional sources of value that developers of a market-based transmission project may consider are:

NON-ENERGY SERVICES

The foregoing has focused on the value of a transmission line to create/capture a share of energy savings in the market area it spans. There may be additional value from improving ancillary services (such as voltage levels), grid security, or generation reliability (capacity value). The economic value of these will depend critically on local pool rules.

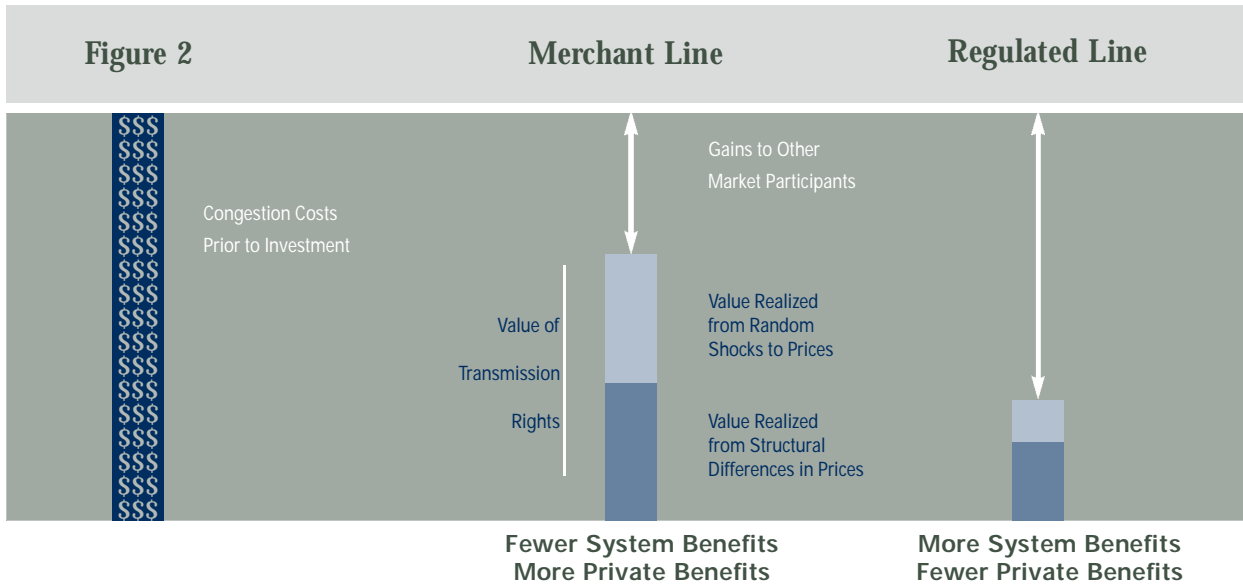
TIMING OF THE INVESTMENT

The value of a transmission investment may either be enhanced or diminished by the future entry of new generation, demand changes, the construction of complementary or substitute transmission facilities, and regulatory changes. A line investment's value may be enhanced by the decision to delay until some uncertainty is resolved. Alternately, there may be reasons to speed up an investment based on what is in the offing from other developers or generators.

SIZING AND DEVELOPMENT OF COMPLEMENTARY FACILITIES

The cost to build transmission facilities per unit of capacity generally decreases with the size of a line. That is, the cost to build a line with 200MW of capacity is less than twice the cost of a 100MW line, generally. Even if the additional capacity cannot be utilized fully, it provides value to the developer by allowing for additional flexibility to meet future increases in demand or shifts in supply. Likewise, the development of a merchant project may require investments (by the developer or other parties) in facilities that provide for the offtake of power or enhance the actual capacity (as opposed to rated capacity) of a line. As such, the prospect for and effect of complementary investments should be a consideration in the evaluation of a merchant transmission facility.

MARKET PRICING—THE VALUATION OF TRANSMISSION RIGHTS



REGULATED OR MERCHANT TREATMENT OF THE LINE

Merchant transmission lines can be very risky investments, arguably requiring returns as high or higher than merchant generation. If the values of transmission rights after the line enters service appear substantial, then merchant treatment may allow an adequate return. If the bulk of the benefits from the development of the line are realized at the system level, i.e., through a general reduction in power prices at both ends (hence reduced congestion), then regulated treatment of the line may be more appropriate.

CONCLUSION

Transmission rights are property rights that allow the holder to benefit from the use of certain transmission assets. The creation of market mechanisms for aspects of pricing electricity has allowed for the use of locational prices to help value transmission rights. Conceptually, the approach to the valuation of transmission rights is similar to that used for the evaluation of financial options. The value of these rights over time depends on the structural evolution of electricity markets, the contribution of random events to the variation in electricity prices, and decisions about the size, timing, and potential expansion of the asset. *The Brattle Group* has developed a framework for the analysis of these factors. This framework can be applied to the evaluation of merchant and regulated transmission projects as well as the value of financial and physical transmission rights.

NEXT ISSUE:
FERC’s Standard Market Design—Notice of Proposed Rulemaking(NOPR)

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BRATTLE'S TELECOMMUNICATIONS
PRACTICE WELCOMES REGULATORY EXPERT
WILLIAM ZARAKAS

The Brattle Group is pleased to announce that William P. Zarakas has joined the firm as a Principal. He is based in our Cambridge office. Bill is an economist with expertise in strategic and regulatory analyses in the telecommunications and utility industries. He has worked extensively with telecommunications carriers, electric and gas utilities, industry associations, regulatory commissions, and state and local governments.

Mr. Zarakas will be joining the firm's Telecommunications Practice, which includes U.C. Berkeley Professor and Nobel Laureate Daniel McFadden, former Acting Deputy Assistant Attorney General for Economics at Department of Justice Marius Schwartz, and former Chairperson of the Illinois Commerce Commission Ellen Craig, along with other regulatory economists at *The Brattle Group*.

NATIONALLY RENOWNED REGULATORY
ECONOMIST JOINS *THE BRATTLE GROUP*

The Brattle Group is pleased to announce that William Lindsay, a nationally renowned economist in regulatory economics and former Director of the Office of Electric Power Regulation at the FERC, has joined the firm as a Senior Advisor. "We are very pleased to have Bill join our global utilities practice," states *Brattle's* Energy Practice leader Paul R. Carpenter. "Bill is well known and widely respected for his work in regulatory costing, pricing, and service design issues, as well as access policy and other restructuring matters. His institutional knowledge is very broad and very practical."

BRATTLE ESTIMATES ECONOMIC IMPACT OF
LIFTING CUBA TRAVEL BAN

In response to a request from the Center for International Policy, *The Brattle Group* analyzed the impact on the U.S. economy of lifting restrictions on travel by Americans to Cuba. To predict future travel to Cuba by American tourists, *Brattle* looked at the incidence of travel to Cuba by Canadian tourists. *Brattle* also examined how often Dominican Americans visit family and friends in the Dominican Republic, as one basis for estimating travel to Cuba by Cuban Americans. See *The Brattle Group's* website at brattle.com for a summary of *Brattle's* findings, including the impact of additional travel on U.S. airlines, U.S.-based cruise lines, and the broader economy. Or contact Dorothy Robyn or James Reitzes in our Washington office at 202.955.5050.

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