# FINANCIAL TRANSMISSION RIGHTS MARKETS

Çiğdem Çelik
*e-mail: celik@bilgi.edu.tr*
*Istanbul Bilgi University, Department of Economics, Inonu Cad.No:28, Kustepe 34387 Sisli Istanbul, Turkey*

*Key words: Deregulation, privatization, transmission pricing, financial transmission rights*

## ABSTRACT

Unbundling of the electricity power markets into its individual generation, distribution and transmission components started with the privatization of the industry in the United Kingdom. As a result, the old paradigm of vertically integrated utility concept is over. Scales of economies favor a regulated single transmission operator. Transmission component and related issues stand at the center of electricity market designs. The basic market principles are open access and non-discrimination. Financial transmission rights play a crucial role in electricity market designs since they facilitate competitive open transmission access. This article presents major features of the FTRs and FTR market implementation across the globe.

## I. INTRODUCTION

Unbundling of the electricity power markets into its individual generation, distribution and transmission components started with the privatization of the industry in the United Kingdom. As a result, the old paradigm of vertically integrated utility concept is over. While scales of economies favor a regulated single transmission operator, there are no physical constraints to having more than one provider of generation and distribution services [1,2]. Transmission component and related issues stand at the center of electricity market designs.

The basic market principles are open access and non-discrimination. Financial transmission rights (FTRs) play a crucial role in electricity market designs since they facilitate competitive open transmission access. Critical market activities with respect to transmission require standardization so that it can support efficient operation with open access and non-discrimination. The design of the transmission component usually relies on a single entity, known as the independent system operator (ISO). Under a single tariff umbrella, the IS operates the transmission system, coordinates the spot market for energy and ancillary services.

In the US, the markets are evolving to a centrally dispatched bid-based and security constrained model, known as the locational marginal pricing (LMP). These market designs, in general, include bilateral contracts with a transmission congestion fee. The difference between what the generators get paid at the point where they inject power and where the load serving entities (LSE) pay at the point where they withdraw power is known as congestion fees. FTRs are financial tools that the market participants can employ against these congestion fees. FTR holders between points of injection (sources) and points of withdrawal (sinks) would be indifferent to any differences in the LMPs for those points. Congestion fees for the New York (NY), New England (NE), PJM (Pennsylvania, New Jersey and Maryland), and California (CA) ISO's for the years 2000 and 2001 were in several hundred millions [3,4,5,6].

This article will concentrate on the FTRs and how they can be utilized to mitigate transmission pricing across different ISOs or power transmission network operators. It also discusses FTR market implementation across the globe.

## II. FINANCIAL TRANSMISSION RIGHTS

Financial transmission rights have been used in the PJM Interconnection since April 1, 1998, in New York since September 1, 1999, in California since February 1, 2000, and in New England since March 1, 2003. They were introduced in Texas in February 15, 2002 [7]. PJM has introduced FTR obligations and options, while New York and New England have introduced FTR obligations, and are now evaluating FIR options. Various jurisdictions have chosen different FIR designs. PJM, New York, New England and Texas have chosen purely financial contracts and TransPower New Zealand plan to do the same [8]. California has introduced contracts that have both a physical and a financial element and that have similarities to flowgate rights (FGRs) and is currently evaluating congestion revenue rights, which are similar to financial transmission rights. In this paper we firstly discuss the properties of financial transmission rights. Next, we describe market performance criteria. Then, we survey the FTR markets in PJM, New York, California, New England, New Zealand and Texas. The emphasis is on the PJM and New York markets, since they are the most mature markets. Finally, we make some concluding remarks and compare the different markets.

### *HEDGING MECHANISM*

FTRs provide a hedging mechanism for the risk-averse market players against congestion fees that arise due to

differences in marginal prices of electric energy at different locations within a transmission network and at different times of usage. ISOs collect the congestion fees, and redistribute these through FTRs. FTRs facilitate efficient use of scarce resources. FTRs provide a mechanism for rewarding transmission investments, as well. They give investors a tradable contract in return.

The ability to hedge against transmission usage is an important feature in facilitating an efficient electricity market. Efficient pricing of FTRs through liquid trading should provide economic signals for location of generation, load and transmission investments. FTRs provide an instrument for converting historical existing transmission usage entitlements into tradable contracts that provide a hedging mechanism for their owners while enabling them to cash out if others can make more efficient use of them. An attractive public policy feature of FTRs is that they offer a convenient paradigm for competitive open transmission access.

Electricity flows according to Kirchoff s laws. In real-time, it is difficult, if not impossible to trace the flows with respect to the existing point-to-point contracts within a transmission network. Transmission usage definition evolved from fictitious contract path to flow-gates, and finally to point-to-point implicit flows. The contract path definitions were based on linear network models that tried to calculate the flows due to each bilateral contract that was imposed on the system. Key assumption included a power network with known power transfer distribution factors (PTDs) that decompose a transaction into flows over the branches that the transaction flowed. Later on, flow-gate definition was introduced to reduce the extreme book keeping requirements of contract definition based models. Flow-gate based models assumed that the network could be divided into a few number of zones that did not exhibit congestion within themselves, but exhibited transmission constraints on branches (gates) between these zones. Eventually, the market designers have converged on point-to-point transmission rights (FTRs) that are believed to most feasible hedging instrument in practice [9].

The FTRs are typically allocated through auctions, but FTRs may also be allocated to transmission service customers who pay the embedded costs of the transmission system. The allocation and the auction designs depend on the market structure of a particular ISO. FTRs can be obligations and options. The obligation FTRs entitle (or obligate) its holder to the difference in locational prices times between its source(s) and sink(s). The optional FTRs do not carry obligatory risks.

### *LOCATIONAL MARGINAL PRICING*

The payment to the holder is calculated through Quantity in MWs times (locational price at the sink – locational price at the source). Accordingly, an obligation FTR holder would be paid by the ISO if the locational price at the sink is higher than the at the source, and the holder would have the pay if the congestion is in the other direction, i.e., source price higher than sink price). The option FTR holder would still get the credit if the congestion is in the direction towards the sink, but would not have to pay otherwise.

In case the contractual volume matches the actual traded volume between the source and sink points, an FTR is a perfect hedge against volatile locational prices. FTRs can be balanced (for congestion) and unbalanced (for losses).
FTRs for existing transmission capacity can be allocated in a number of different ways. The allocation can be based on existing transmission rights or agreements or on long-term auctions. The revenues from an auction can be allocated in different ways as well. The implementations depend on the final market structure. Short-term auctions provide a mechanism for reconfiguration of FTRs where the players can adjust their positions with respect to changing system conditions. FTR amounts are determined by the market players and the clearing prices. Most market designs also include a secondary market environment to stimulate liquidity. The FTRs may have duration from months to years.

The revenue collected with locational prices in the dispatch should at least be equal to the payments to the holders of FTRs during the same period, so that the ISO can maintain the credit standing. This is known as revenue adequacy. In the physical world, this corresponds to the fact that the FTRs satisfy the simultaneous feasibility conditions that are defined by the transmission system constraints. Negative locational marginal prices have been shown to cause revenue inadequacy [10].

The energy market that the FTR market is operated in parallel with is based on locational marginal price as well. Trading is managed by the ISO as well, and a security-constrained optimal power flow model is utilized for this purpose. The contingency constraints may be numerous.
FTR model has been shown to create incentives for transmission investment under some assumptions that there aren't any increasing returns to scale and sunk costs that locational prices fully reflect consumers are willing to pay, that network externalities are internalized by locational prices, and the ISO does not introduce any preferences regarding transmission operations.

Among the main disadvantages for an LMP based market design and FTRs is the fact that LMP model gives market power to major generation players with for significant FTR holding to manipulate the real-time conditions to create spurious congestion in the local markets. There is consensus among the researchers that the behavior of the generators in the FIR market should then be regulated; [11,12,13,14].

The FTR market is efficient in terms of providing the correct incentives for transmission investments when they are small and aren't lumpy. Regulation is also necessary to prevent market power abuse [15,16]. In evaluating the performance of FTR markets, there are two important issues: a. how good they are as hedging tools, b. how liquid the markets are and the FTR prices [17]. The large number of possible FTRs gives relatively low liquidity. There are few secondary markets that enable reconfiguration and reselling. Since the simultaneous feasibility test and FTR revenue sufficiency are interrelated, simultaneous feasibility test is an important factor in preserving the quality and value and amount of the FTR hedges. An efficient FTR market must anticipate not only the uncertainty in transmission prices, but also the shift in the operating point within the feasible region determined by the economic dispatch [17].

## III. EXISTIN FTR MARKETS

### *PENNSYLVANIA, NEW JERSEY AND MARYLAND ISO (PJM)*

The day-ahead market in PJM is considered to be the most liquid market in the USA. PJM introduced an LMP based market in April 1998. The FTR market with obligations was introduced in May 1999. Option FTRs were introduced in June 2003 when PJM introduced its second generation FTR market. During the same transition, the allocation process moved to an annual based on four stage auction from the former grand-father FTR process. Thus, there is currently an annual FTR auction, and monthly auctions for the residual transmission capacity. In addition, a secondary market administered by PJM provides a platform for the market players to adjust their holdings. PJM also offers auction revenue rights (ARRs) to distribute the revenues from the FTR auctions to the market participants.

FTRs are not necessarily a perfect hedge against congestion fees. Studies for the PJM market indicate that FTR holders hedged between 80 to 90% during 2001 and 2002. In addition, FTRs provide hedging against real-time congestion charges only. Market players can hedge against the real-time congestion charges by submitting energy schedules into day-ahead market. Since there may be a large number of points of sinks and sources, and this leads to a significant number of combinations for FTRs, the monthly auction was introduced in PJM to increase market liquidity. PJM's 2002 annual market report indicated that the FIR market was competitive in 2002 [6]. In the monthly auctions, it seems like the bid volume on average was larger than, about 45000 MW, than the offer volume, about 5500 MW. Only one third of the cleared bids was from the residual capacity, the rest was supplied by the sell bids [6]. The FTRs that cleared through the auctions rose from 3 percent of all FTRs in 1999 to 20 percent in 2002. In the November 2002 monthly auction, the auction FTRs comprised 29 percent of all FTRs for that month [6].

### *NEW YORK ISO*

The New York ISO introduced the FTRs under a different name, transmission congestion contracts (TCCs) in September 1999 [5]. In the New York TCC market, the clearing prices are calculated using an AC network model, i.e., full network model instead of the linear DC model used at PJM ISO. In the NY ISO market, congestion charges apply uniformly whether the customers undertake a bilateral transaction or buy energy through the ISO based on the LMP based forward market.

TCCs are offered on auctions biannually by the NY ISO to all eligible market participants. ISO also administers a secondary market for those who want to adjust their holdings, and, may hold monthly reconfiguration auction [5]. The auctioned TCCs have increased every year since their inception and reached about 140 GW in 2002. However, the FTR market does not appear efficient at hedging complex transactions involving larger exposures (greater than $l/MWh) or across multiple congestion interfaces. In this case TCC buyers pay prices including an excessive risk premium which is far from being reasonable. The market players do not seem to learn how to use the FTR market more efficiently over time, either [17].

### *CALIFORNIA ISO*

California introduced firm transmission rights in February, 2000. Firm transmission rights are significantly different than FTRs. California has been working on a market redesign since the energy crises [18].

In its initial market design, California opted for zonal pricing. In zonal pricing, the network is divided into several zones among which there exists transmission congestion. Within the zones, the congestion is assumed to be insignificant. Since the crisis of 2001 [18], the energy markets are primarily managed by the ISO and several features of the initial market design have been abandoned, such as a separate power exchange that scheduled the forward markets. However, the firm transmission rights market that were introduced in 2000 will stay in effect until the new market based on locational marginal pricing takes [1]. Unlike the FTRs in the PJM and NY markets, the firm transmission rights in California have one financial and one physical aspect. They give the owner a priority over others in physically transferring power as well as the sharing the usage charge revenues collected by the ISO due to congestion over a particular path between zones. These paths are usually referred to as flowgates [19]. The holder receives a credit equal to the amount times the shadow price of the binding constraint if the congestion is in the same direction as specified in the contract.

If the FTR holders choose not to use their right of scheduling of energy across flowgates in the day ahead market, ISO can assign it to other users and charge an associated fee if there is congestion. The FTRs are provided in an annual auction and have a duration of one year. They are also traded in the secondary and in the hour-ahead markets to allow the market participants adjust their positions. Data shows that the annual volume of auctioned firm transmission rights stayed pretty stable from 1999 to 2003 at about 10 GW.

Under a new filing with FERC, the California ISO has started the implementation of an LMP based transmission market under the name of congestion revenue rights (CRRs). CRRs are similar to the FTRs at PJM and NY ISOs.

### *NEW ENGLAND, NEW ZEALAND and TEXAS*

New England introduced financial transmission rights (FTRs) in March 2003. Currently they are available as obligations only. They can be acquired through bi-annual or monthly residual auctions. NE ISO is planning to move to annual auctions once the market stabilizes and becomes more liquid [1].

An LMP based wholesale market was introduced in New Zealand in 1996. The system operator, Transpower New Zealand, offered restricted insurance against nodal price differences [8]. This product was withdrawn in 1998, because there was little interest among the players. Currently, stakeholders are discussing the design for the FTR market [20]. The LMP model uses the full network, i.e., the AC network model. FTRs will consist of balanced FTRs for congestion and spot FTRs for losses. Initially, the FTRs will be auctioned monthly. After an introductory phase, the FTR market will include annual FTRs.

ERCOT employs a bilateral contracts market model. All market players submit balanced schedules through scheduling coordinators. There is no spot market. For the transmission rights market, ERCOT introduced a zonal model that uses flowgates in February 2002. Each year, commercially significant transmission constraints are identified, and corresponding zones are defined. Transmission congestion rights (TCRs) as they are called at ERCOT entitle its holder in proportion to flow amount times the shadow price of the binding flowgate in the energy balancing market. TCRs are auctioned off at monthly and annual auctions. They also trade in a secondary market for the players to adjust their holding quantity and time period.

## IV. CONCLUSION

The design and the rules of these markets are evolving continuously. Limited liquidity and short-term hedging property have been a problem with the FTR markets. Unbundling, using auction revenue rights and multiple rounds should increase liquidity, enhance price discovery and avoid fire sales. Grandfather FTRs allocated based on historic service by the utilities and transmission owners have also limited liquidity of the FTR markets. Allocation rules need to be carefully designed to avoid such problems. Experience also indicates that the FTR market could be utilized as efficient tools for hedging congestion involving large and complex interfaces. If properly designed, the buyers across different ISOs and regional transmission operators can avoid paying prices that include significantly large risk premiums.

## REFERENCES


1. W. Hogan, “Reshaping the Electricity Industry,” John F. Kennedy School of Government, Harvard University, November 1994.
2. “The Changing Structure of the Electric Power Industry: Selected Issues, 1998,” Energy Information Administration, U.S. Department of Energy, 1998.
3. California ISO (2003). available: http://www.caiso.com.
4. New England ISO (2002). NEPOOL Manual for Financial Transmission Rights Manual M-06, October, available: http://www.iso-ne.coml.
5. New York ISO (2003). available: http://www.nyiso.com/markets/tcc-info.html#info.
6. PJM ISO, available: http://www.pim.com.
7. Energy Security Analysis, Inc. (2001). Hedging Instruments in U.S. Power Markets-Overview of Liquidity and Gap Analysis, Final Report to Edison Electric Institute. ERCOT - the Texas Connection (2004). TCR Program Reports, available: https://tcr.ercotcomldefaultdm?func=tcrpostings
8. Transpower New Zealand (2003). available: http://www.transpower.co.nz.
9. Lyons, K., Fraser, H. and H. Pannisano (2002). An Introduction to Financial Transmission Rights, The Electricity Journal, Vol. 13, No. 10.
10. Philpott, A. and G. Pritchard (2004). Financial Transmission Rights in Convex Pool Markets, Operations Research Letters, Volume 32, Issue 2, March, 109-113.
11. Oren, S. (1997). Economic Inefficiency of Passive Transmission Rights in Congested Electricity Systems with Competitive Generation, The Energy Journal 18 No.1, 63-83.
12. Chao, H-P. and S. Peck (1997). An Institutional Design for an Electricity Contract Market with Central Dispatch, The Energy Journal, 18: 85-110.
13. Cardell, J. B., C. C. Hitt, and W. W. Hogan (1997). Market Power and Strategic futeraction in Electricity Networks, Resource and Energy Economics, 109-137.
14. Bushnell, J. B. and F. Wolak (1999). Regulation and the Leverage of Local Market Power in the California Electricity Market, POWER Working Paper PWP-070R. University of California Energy fustitute, available: http://www.ucei.berkeley.edu

15. Hogan, W. W. (2003). Transmission market design, Texas A&M conference paper, available: http://www.whogan.com.
16. Hogan, W. W. (2002b). Financial Transmission Rights Formulations, mimeo, Center for Business and Government, JFK School of Government, Harvard University, available: http://www.whogan.com.
17. Siddiqui, A. S., Bartholomew, E. S., Marnay, C. and Oren, S. S. (2003). On the Efficiency of the New York Independent System Operator Market for Transmission Congestion Contracts, forthcoming Managerial Finance.
18. Çelik,F.Çiğdem. The New Market Design for California's Electricity Power Market, 4th Balkan Power Conference,Sarajova,May26-28 2004.
19. Hogan, W. W. (2000). Flowgate Rights and Wrongs, mimeo, Center for Business and Government, JFK School of Government, Harvard University, available: http://www.whogan.com.
20. Transpower New Zealand (2001). Financial Transmission Rights (FTRs) Design, available: http://www.transpower.co.nz.