Financial Transmission Rights

Financial transmission rights (FTRs),[1] also known as transmission congestion contracts (TCCs) or congestion revenue rights (CRRs), provide a financial instrument for market participants to hedge against congestion costs in the system.[2]

The main purposes of the FTRs are to allow:[3]

- Market participants to eliminate or greatly reduce the cost uncertainties resulting from congestion transmission charges.
- The Regional Transmission Organization (RTO) and the Independent System Operator (ISO) to redistribute any over collection of money (due to transmission congestion) to market participants.

In the absence of any transmission constraints, all locational marginal pricing (LMP) nodes would price at the lowest-priced generation resource. However, there is not enough physical transmission to deliver electricity from low-cost resources to the place demanding the electricity at all times. Thus, some nodes will, by necessity, use power from higher-cost resources and therefore the LMP at that node will be higher. The difference in day-ahead LMPs congestion components[4] between two nodes that is attributable to the transmission constraints multiplied by the transfer amount is called "congestion cost" or "the cost of congestion." There is an overload of congestion dollars during constrained conditions because the RTO collects more from loads than it pays to generators. Since an RTO is a non-profit organization, the RTO cannot keep the difference. The FTR is used to redistribute this over collection back to market participants.

The FTRs are not associated with physical delivery rights (FTRs do not represent a right for physical delivery of power).[5] The FTRs can be thought of as a "reservation" for access to a specific transmission path (e.g., between LMP nodes) for a specific timeframe, but they do not actually correspond with a physical right to deliver energy. Rather, the FTRs will create a revenue stream (or charges) based on the difference between two congestion components of day-ahead LMP at specific times.

The FTRs are bought and sold in long-term, annual, and monthly auctions. An RTO/ISO cannot grant more FTRs than the transmission system is capable of supporting. Both market and non-market participants can register to acquire the FTRs. Methods and auction processes of the FTR vary by the RTO and ISO.

The FTRs are characterized by:[3]

- Quantity – number of MWs desired to buy or offered for sale
- Price – buy bids and sell offers in $/MW
- Class type – peak, off-peak or 24-hour

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[1] Many of the technical terms used in this primer are defined in a companion *Glossary for Power Market Primers.*

[2] The financial transmission rights (FTR) are a service offered by PJM, Midwest ISO, and ISO New England. Transmission congestion contracts (TCC) are a service offered by New York ISO. The congestion revenue rights (CRR) are a service offered by ERCOT and California ISO.

[3] PJM. (2013). *ARR and FTR 101.* Retrieved on February 16, 2013, from http://pjm.com/Globals/Training/Courses/ol-arr-ftr-101.aspx

[4] Since marginal losses were implemented in the calculation of LMP (LMP = marginal energy price + marginal congestion price + marginal losses price) only the difference in the marginal congestion price component between two nodes has been used to value the congestion costs. In the given examples, it is assumed that the marginal losses price is equal 0.

[5] ISO New England. (2013). *ISO New England Manual for Financial Transmission Rights*. Retrieved on February 16, 2013, from http://www.iso-ne.com/rules_proceds/isone_mnls/index.html

- Path – a point of injection (source location) and a point of withdrawal (sink locations). The locations can be any pricing node, zone, or hub. The source and sink locations are selected by the FTRs buyers and sellers.
- FRT Hedge (Credit) = (Day-ahead LMP congestion component $_{\text{sink location}}$ –Day-ahead LMP congestion component $_{\text{source location}}$)*FTR quantity award

Example 1 – FTR as a hedging instrument to provide price certainty An ISO/RTO receives the bids and offers, for a particular hour, from two producers and one consumer, shown in Exhibit 1. Gen Company 1 is located in Area 1, and Gen Company 2 and a consumer are located in Area 2. Area 1 and Area 2 are connected with a transmission line with a power limit of 350 MW. Gen Company 1 is willing to sell 500 MWh at $25/MWh and Gen Company 2 is willing to sell 250 MWh at $35/MWh. The consumer is willing to buy 275 MW, regardless of the electricity price. The ISO/RTO sets the MCP to $25/MWh and energy is traded at 275 MWh.

Gen Company 1 meets all demand and sells to the grid 275 MWh at $25/MWh. The consumer draws 275 MWh and pays $25/MWh. Power flow over the transmission line is 275 MW from Area 1 to Area 2. The generating company's total revenues ($6,875) are equal to the total of the consumer's payments ($6,875) because there is no congestion in the system. The ISO/RTO used the cheapest generation company to provide energy for the consumer's demand.

Exhibit 1 Simple electric energy system

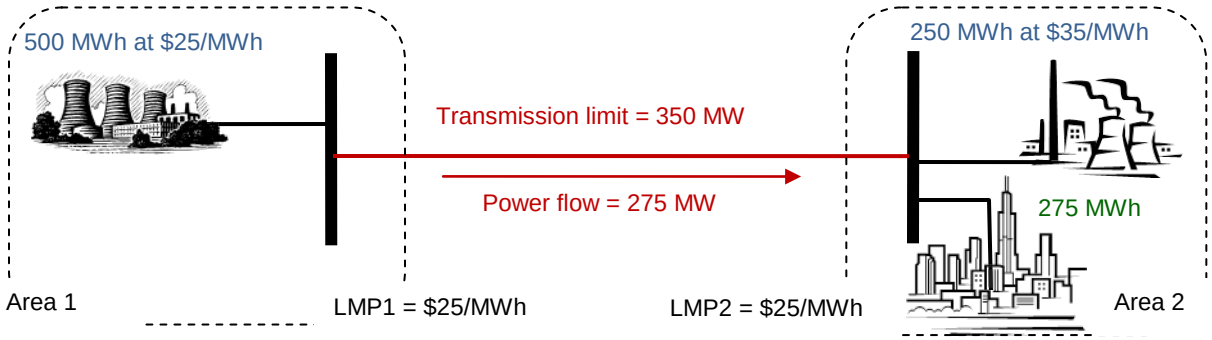


Image developed by NETL.

Assuming the transmission limit is 250 MW, the situation becomes more complex. Because of the fully loaded transmission line, LMP for Area 1 is set to $25/MWh and LMP for Area 2 is set to $35/MWh.[6]

Gen Company 1 produces 250MWh and is paid $25/MWh. Gen Company 2 produces 25MWh and is paid $35/MWh. The consumer buys all 275MWh at $35/MWh. The total generator's revenue ($7,125) is not equal to the total of the consumer's payment ($9,625), because the transmission congestion limited the use of a cheaper generating resource. In this case the consumer pays more than the generating units receive. The excess is the congestion cost or congestion revenue fund. The congestion costs are collected by the market operator and are given to holders of a FTR as a compensation for transmission congestion charges that arise when the transmission grid is congested.

Assuming that the consumer has a FTR for 250MW[7] with Area 1 as the source and Area 2 as the sink, the congestion rent will be 250MW * ($35/MWh – $25/MWh) = $2,500 for that hour. The consumer will pay to the ISO/RTO $9,625, but it will get back $2,500 as the FTR holder. In total, the consumer will pay $7,125 for its consumption. This value is equal to the total generator's revenue. The FTR allows the holder to have the same energy price at the point of withdrawal as the price at the point of injection.

[6] See *Energy Market Primer* for LMP calculation.
[7] The ISO/RTO cannot grant more FTRs than the transmission system is capable of supporting.

The congestion charge is calculated as $MWh_{delivered}$*(Day-ahead LMP congestion component $_{sink\ location}$ − Day-ahead LMP congestion component $_{source\ location}$) while the FTR credit is calculated as $MW_{awarded}$*(Day-ahead LMP congestion component $_{sink\ location}$ –Day-ahead LMP congestion component $_{source\ location}$). If the MWh delivered is equal to the FTR MW award and they are over the same path, customers have option to perfectly hedge the congestion charges.

FTR is traded separately from transmission service. The FTR will provide a benefit if the path is in the same direction as congestion (the LMP at sink is higher than the LMP at source). The FTR will provide liability if the path is in the opposite direction from congestion (the LMP at sink is lower than the LMP at source). FTRs are separate from energy delivery and can be on separate paths from the energy delivery.

Example 2 – FTR as benefit and as liability Gen Company 1 is located in Area 1, and a consumer is located in Area 2 (Exhibit 2). Gen Company 1 is selling 100 MWh to the customer over a transmission line with a power limit of 100 MW. Energy flow is from Area 1 to Area 2.

Exhibit 2 Simple electric energy system with congestions

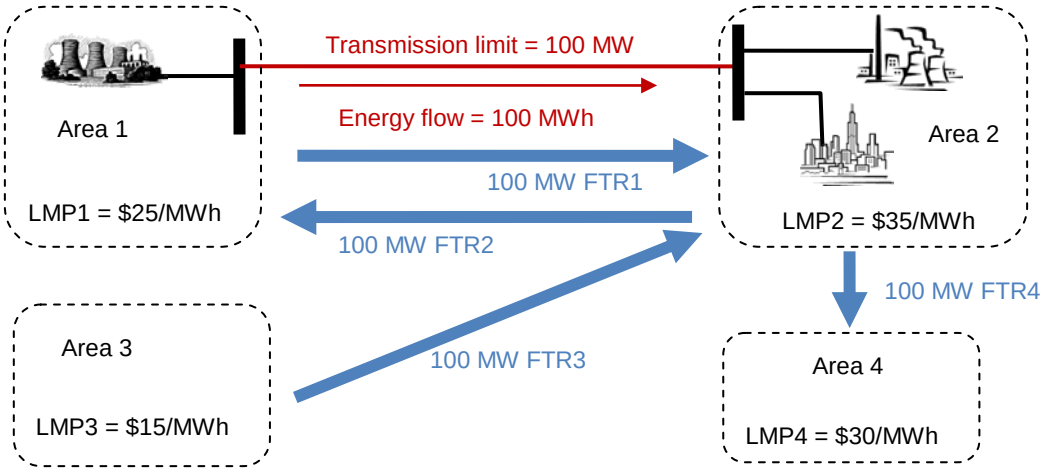


Image developed by NETL.

The customer has multiple options to hedge against the congestion. FTR1 and FTR2 are on the same path as energy flow. FTR1 is in the same direction and FTR2 is in the opposite direction as the energy flow. FTR3 and FTR4 are across different paths than the energy flow. Exhibit 3 summarizes the outcomes of these four FTR.

Exhibit 3 FTR outcomes

FRT	FTR Path	LMP_{sink} $/MWh	LMP_{source} $/MWh	MW	Congestion charge [$]	FTR credit [$]	Outcome
FTR1	Area 2-to- Area 1	35	25	100	1,000	1,000	Benefit – perfect hedging
FTR2	Area 1-to- Area 2	25	35	100	1,000	-1,000	Liability
FTR3	Area 2-to- Area 3	35	15	100	1,000	2,000	Benefit – over-hedging
FTR4	Area 2-to- Area 4	35	30	100	1,000	500	Benefit – under-hedging

FTRs are requested based on expected power flow and expected LMPs, since the FTRs are granted before the day-ahead market is conducted. This represents a risk to FTR holder because the FTRs with negative price paths create liability to them.

Market participants purchase FTRs by participating in a FTR auction. They submit the quantity (how many FTRs they desired to buy or offered for sale), price (buy bid and sell offer), FTR sink and FTR source to an ISO/RTO. The ISO/RTO stacks the bids up in a descending order and clears the market by maximizing the FTR bid-based value. The objective of a FTR auction is to get the highest bid for the FTR

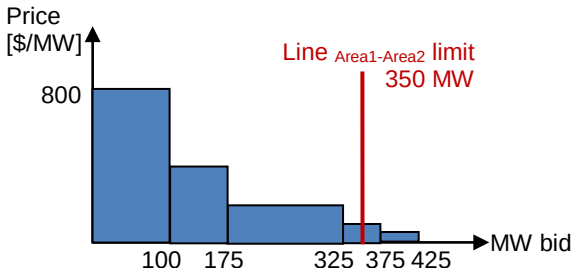
and to generate the most revenue to FTR holders. The ISO/RTO then runs a feasibility test to check simultaneous feasibility of the FTRs. The simultaneous feasibility test ensures that the limits of the transmission system are respected.

Example 3 – FTR auction and clearing mechanism An ISO/RTO receives FTR bids and offers from five market participants for 350 MW of transmission capacities between Area 1 and Area 2, shown in Exhibit 1. The ISO/RTO accepts all bids (Exhibit 4) and stacks them up in a descending order (Exhibit 5). The ISO/RTO checks the simultaneous feasibility of the FTRs by adding all FTRs and comparing to the line capacity. Total MW bid is equal to 425 MW and it over-exceeds the line capacity. The ISO/RTO will clear the market at 350 MW. The FTR clearing price in Area 1 will be equal \$0/MW and the FTR clearing price in Area 2 will be equal \$100/MW.

Exhibit 4 FTR bids

Market participant	FTR MW requested [MW]	FTR bid [$/MW]
MP1	100	800
MP2	75	400
MP3	150	200
MP4	50	100
MP5	50	50

Exhibit 5 FTR auction clearing



The ISO/RTO will grant FTRs to four participants with the highest bids: MP1 will be granted 100 MW, MP2 will be granted 75 MW, MP3 will be granted 100 MW, and MP4 will be granted 25 MW (out of 50 MW requested) at \$100/MW clearing price. The total FTR auction revenue is equal \$35,000. MP5 will not be granted any FTR since its bid is lower than the market clearing price. These four market participants will receive a share of the congestion cost collected at the day-ahead market.

The FTR revenue is distributed to auction revenue rights (ARR) holders. The ARR are allocated to network transmission customers and firm point-to-point transmission customers for the duration of one year. Only firm transmission customers can be granted ARR based on historical usage data. Market participants will request ARR and the ISO/RTO will approve them based on the simultaneous feasibility test conducted before the annual FTR auction.

Example 4 – Auction revenue rights allocation Three firm transmission customers (FTC) are using the transmission line between Area 1 and Area 2 (Exhibit 1). FTC1 load peak is 20 percent of the area peak, FTC2 load peak is 30 percent of the area peak and FTC3 is 50 percent of the area peak. All three FTC are ARR holders. The FTR revenue collected in the FTR auction in Example 3 will be distributed based on the load peak percent. FTC1 receives \$7,000, FTC2 receives \$10,500 and FTC3 receives \$17,500.

Often, the amount collected during the FTR auction is not equal to ARR targeted amounts. If the FTR revenue is insufficient, ARR credits are prorated proportionally to ARR values. If the FTR revenue exceeds ARR targeted amounts, the excess revenue is used to fund any shortfall in FTR target allocations. (ARR allocation is a multi-step process where during each step only percents of the total capacity is allocated. In some steps there will be insufficient revenue and some steps there will be excess revenue.)

Examples in this primer are simplified. The main objective of the primer is to explain the different terminology and processes at a very high level. Real power systems are much more complex and the FTR auction and the ARR allocation process are much more complicated than is presented in the examples. However, detailed explanations and processes are beyond the scope of this primer and can be found in ISOs/RTOs tutorials and manuals.

More details about the different markets can be found in the primers *Energy Market, Ancillary Services, Capacity Market, Comparison of Different ISO/RTO Capacity Market Structures* and *Power Markets*.