Understanding Financial Transmission Rights

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Financial Transmission Rights (FTRs), also known as Fixed Transmission Rights (FTRs), Transmission Congestion Contracts (TCCs) or Congestion Revenue Rights (CRRs), replace physical transmission rights in centralized electricity markets. The FTR gives the holder the financial equivalent of physical network capacity. Ignoring losses, the effect of the FTR is to guarantee the holder that, for a predetermined amount of energy, the holder’s price of energy at the point of withdrawal will be the same as the price at the point of injection. The FTR payoff is the difference in congestion between points of injection (e.g., a remote generator) and withdrawal (e.g., a load center). FTRs are bought and sold in centralized electricity markets for periods ranging from a month to several years.

A physical transmission right gives the holder the right to use a particular transmission line, or set of lines, to transfer energy from one location to another. A financial right, in contrast, gives the holder in one location the right to buy energy at the price of another location. Consider Figure 1 for example. A physical transmission right would give load at the East bus the right to use the transmission line connecting the East bus with the West bus to transport energy at a rate of up to 100 MW. A financial right would give load at the East bus a guarantee that the price of the West bus will be applied to 100 MWh per hour of energy consumed at the East bus, regardless of how the transmission line is used. The difference is negligible on the simple system shown in Figure 1 but it is significant with real systems that are much more complex.

Figure 1 - Example System

The flow of energy over the individual lines of a transmission system is governed by physical laws which have little regard for ownership, contractual agreements, or property rights. Physical transmission rights work well for radial systems where a unique path can be identified between any two points. The concept of physical rights tied to transmission ownership breaks down in real systems which are not radial. Real systems have loops and no unique path can be identified between every pair of points. When multiple paths exist between two points, energy will flow over all paths simultaneously. Thus physical rights can be more of a fantasy than a reality. Financial rights, on the other hand, will always work.

We will use a simple system to illustrate the use of the FTR as a hedging instrument to provide price certainty. Since the FTR is a financial instrument, we must examine the settlement of energy bought and sold to understand the value of the FTR. Initially our system consists of Green Load at the East Bus and Green Generator at the West Bus. East and West Buses are connected by a transmission owned by Green Load. The initial system is illustrated in Figure 2. LMP, the locational marginal price of energy, is used in these examples. LMP is the normalized (per MW) cost of supplying the next small increment of load at a particular location while minimizing the total production cost of energy. Relevant characteristics of load, generation, and transmission are summarized below:
Green Generator
Size: 110 MW
Marginal Cost: $40/MWh

Green Load
Size: 95 MW

West-East Transmission
Capacity: 100 MW

LMP at the West Bus is $40. A small increment of additional load at the West Bus would best be supplied by Green Generator at a cost of $40/MWh. Similarly, LMP at the East Bus is $40. Green Generator would also be the best (only) choice to supply a small increment of additional load at the East Bus.

![Initial System Diagram](image)

Settlement of the initial system is straightforward and is summarized in Table 1. Green Load pays $3,800 for energy; Green Generator collects $3,800 for energy. Everything balances and everyone is happy.

<table>
<thead>
<tr>
<th>Payment to Generator</th>
<th>Payment from Load</th>
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<tbody>
<tr>
<td>LMP</td>
<td>MW</td>
</tr>
<tr>
<td>Green Gen</td>
<td>$40</td>
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<td>Green Load</td>
<td>$40</td>
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Table 1 - Settlement of Initial System

Now suppose the system expands with the addition of Red Load and Red Generator at the East Bus. Characteristics of these additions are summarized below:

Red Generator
Size: 10 MW
Marginal Cost: $80/MWh

Red Load
Size: 10 MW

The expanded system and the least cost method of serving load in the expanded system are shown in Figure 3. LMP at the West Bus is set by Green Generator – additional load at the West Bus is best served by Green Generator at a cost of $40/MWh. LMP at the East Bus is set by Red Generator – additional load at the East Bus must be served by Red Generator at a cost of $80/MWh. Therefore, there is a significant price difference between West and East Buses.
The energy settlement of the expanded system is shown in Table 2. Note three things. First, the minimum energy production cost is attained when Green Generator supplies energy to both Green Load and Red Load. Second, the LMP for Green Load has doubled from $40/MWh to $80/MWh, even though Green Load has caused no changes and owns more than enough transmission capacity to supply its entire load from the cheaper Green Generator. Third, significantly more money ($4,000) is collected from load than is paid to the generators. The excess is called congestion rent and is the funding mechanism for FTRs and the basis for making Green Load financially whole.

<table>
<thead>
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<th>Payment from Load</th>
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<tbody>
<tr>
<td></td>
<td>LMP</td>
<td>MW</td>
<td>$/h</td>
</tr>
<tr>
<td>Green Gen</td>
<td>$40</td>
<td>100</td>
<td>$4,000</td>
</tr>
<tr>
<td>Red Gen</td>
<td>$80</td>
<td>5</td>
<td>$400</td>
</tr>
<tr>
<td>Total</td>
<td>$4,400</td>
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Table 2 - Settlement of Expanded System

In lieu of its physical rights to the West-East Transmission, Green Load is given an FTR for 100 MW. In accepting the FTR, Green Load can no longer control access to the West-East Transmission, but collects the congestion rent instead. The impact on Green Load of the higher LMP is completely reversed by applying 95 MW of the FTR to its own energy costs. Green Load pays $7,600/h for energy but the 95 MW of FTR generates $3,800/h in congestion rent and the net payment for energy is unchanged from the initial system. The FTR has made Green Load financially indifferent to network usage. Green Load’s net expenditure for energy in the expanded (congested) system is the same as in the initial (uncongested) system even though the price of energy at the Green Load location has increased. The FTR provides Green Load with price certainty.

The remaining 5 MW of FTR generates $200/h in congestion rent and can be thought of as a real-time payment from Red Load for the use of the West-East Transmission. Red Load may prefer to buy the remaining 5 MW of FTR from Green Load for a period of time. This can be thought of as Red Load prepaying for use of the West-East Transmission for that period of time.

Real power systems are much more complex than the simple example above. However, in real systems the FTR still protects the former holders of physical transmission rights from the new price patterns and volatility inherent in an LMP system. The FTR allows the system to be operated in a least-cost manner which may involve new patterns of transmission usage and congestion. Meanwhile, the former holders of physical transmission rights are made financially indifferent to the change.

The interest in FTRs extends beyond organizations that must make wholesale purchases of electric energy. As seen above, some may value the FTR as a congestion hedge to provide price certainty in lieu of physical transmission rights. To others the FTR is viewed purely as an investment opportunity. Regardless of how it is viewed or valued, the FTR was designed as an alternative to physical transmission rights. The easiest way to understand FTRs is in this context.