International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 03 Issue: 01 | Jan-2016 www.irjet.net p-ISSN: 2395-0072

Transmission congestion management effects on reducing cost of bilateral market and increasing traders profits

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Abstract - ***The power system restructured by separating generation, transmission and distribution of open access to the transmission network, so the network has to be considered as a basic infrastructure. congestion occurs when transmission line and transformers are overloaded. Congestion may reduce the system's security and increase costs, thus providing a way to manage congestion of transmission system is the most important issues in the design. In this paper, first, study and simulate the power system in different case of congestion, then to search and secure solutions for consumers and producers against the transfer fee paid. Following a bilateral market analysis and providing solutions in addition to harm reduction (debt), the risk of transmission congestion covered and in the next section compares the use of congestion management tools by traders and market makers will result that dealers net profit If you use these tools to more producers.***

Key Words: *Locational Marginal Pricing (LMP), Congestion, Financial derivatives, Transmission Right*

1. INTRODUCTION

In studies of power systems, transmission network infrastructure as a fundamental restructuring[1] because the system, transmission network is the place where to consumer is the energy generated and when the transmission network is Congestion[1], consumers , may be received with high efficiency of the manufacturers are in trouble[2].

After deregulation of electricity markets, price volatility has increased. Therefore, hedging instruments play an important role in the most well-functioning markets. one of the most important tools for managing risk prices using financial derivative instruments. These tools in separating the financial risk and coverage against risks, to act efficiently and effectively. as well as tools such as transmission rights can be congestion risk and price risk prevent[3].

William W. Hogan proposes the concept of a contract network and first introduced the financial transmission rights [4], which provides a mechanism to control the financial risks of congestion-induced price variations, and an OPF is conducted by the system operator in congestion management and setting congestion cost. In [5] [6], Ma introduces the practical implementation of PJM financial transmission rights auction market, and analyzes the various aspects of the financial transmission rights auction mechanism.

2. CONCEPTS

2.1 Financial Derivatives

In the electricity market, market risk, price risk, particularly over other suppliers and demanders threatening risks because of the extreme volatility of prices. Search for consumers and electricity manufacturers to find ways to reducing costs and stabilized of cash flow, derivative instruments were introduced to the industry to price risk to those who able to handle it and will profit from this position, transition answer[7].

2.2 Transmission Rights

For easy and optimized communication between network components and the use of maximum capacity, should create a mechanism to overload and congestion of the network and greater efficiency functioning of rationing can not guarantee it. For this action we use transmission rights.

2.2.1 Financial transmission rights

The basic types of transmission rights are:

[1] Transmission network congestion can be in the form of transmission, the more defined Ranges permitted operation.

I. Financial transmission rights (FTRs) obligation [8, 9]: right to collect payment from (or an obligation to pay) the price difference associated with transmission congestion between destination and origin for a specified contract quantity[10].

II. Financial transmission rights (FTRs) option: right to collect payment from the price difference associated with transmission congestion between destination and origin for a specified contract quantity. If the price difference is negative the payoff is zero.

III. Flowgate rights (FGRs): constraint-by-constraint hedge that gives the right to collect payments based on the shadow price associated with a particular transmission constraint.

IV. Physical transmission rights (PTRs): right or priority to physical transmission for a specified amount between two defined locations.

The mathematical formulation for the payoff for the FTR is:

$$FTR = Q_{ij}(P_j - P_i) \qquad (1)$$

where *Pj* is the bus price at location *j*, *Pi* is the bus price at location *i* and *Qij* is the directed quantity specified in the FTR from point *i* to point *j*.

3. SIMULATION OF PRICE RISK MANAGEMENT WITH DERIVATIVES CONGESTIOTED

Two bus network software PowerWorld according to Figure 1 is simulated. In this system, all power producers and consumers under the instructions of the grid operator, the power injected into the network, or from the harvesting.

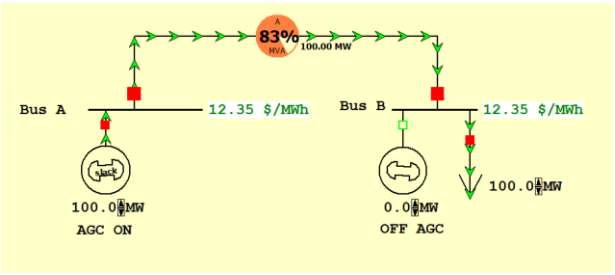

Fig -1: Economic dispatch two bus network

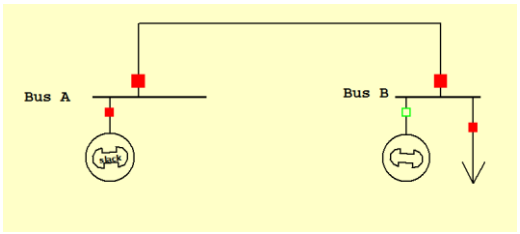

Fig -2: Two bus network. simulation without congestion

Supposition of the problem: The contract for delivery of 100 MW in the constant price of 12.35$/ MWh regulated and as long as there is no congestion between the two nodes, prices for producers and consumers is (Figure 2). In particular, if the price LMP is equal to 11.05 $/MWh, the contract between the two nodes can be obtained as follows.

- The first mode

Bus Generator 1 (Company 1) the power 100MW at a price of 11.05 $ / MW sold, That amount is given below: $100 \times 11.05 = 1105\$$

Therefore, the bus 2 (Company 2) 100MW to sized above amount of the company 1 buys. To settle the contract CFD are as follows:

$$100 \times (12.35 - 11.05) = 130\$$$

In other words, the above amount the consumer must pay to the seller. and if so LMP prices higher than 12.35 $/MW, the consumer must pay the difference to the producer.

- The second mode

If the price of the Company 1, 15 $/MW and at 2 to 8.55 $/MW (ie network transmission capacity is limited). The calculation is as follows.

Step 1:

Company 2 value 100 MW at prices 8.55$/MW sells. and amount front of the consumer receives:

$$100 \times 8.55 = 855\$$$

While the according to the contract, it was agreed that this company will receive the amount of contrast: $100 \times 12.35 = 1235\$$. But the the amount $1235 - 855 = 380\$$ deficit is expected that the company was 1, the amount paid to settle the contract.

Step 2:

Company 1, 100 MW prices 15$/MW buys and pays $100\times15=1500\$$. According to the contract, it was agreed that only pay the amount of 1235$, while this company also expects to settle the contract of the company 2, amount of $1500-1235=265\$$ received.

Obviously these is not compatible expectations. Therefore in case of congestion in the transmission system, CFD contracts that contain delivery just energy, lose their efficiency. Thus parties to the transaction to protect itself against fluctuations price of derivative contracts and increasing energy efficiency in addition to production or consumption, for transmission system's ability to deliver this energy contracts that use the FTR contracts.

According to the description and formulas provided in the FTR, can caused by congestion dispute price in the previous example, be achieved as follows.

$$15-8.55=6.45\$$$

4. TRANSMISSION CONGESTION MANAGEMENT

Transmission congestion management plays an important role in the deregulated power market. Introducing of Financial Transmission Right (FTR) is a significant trend in transmission congestion management and is also the center of debates. As a financial instrument for hedging risk, FTR provides a totally new approach for congestion management through hedging congestion charges for bidders, which doesn't influence the dispatch of real power system.

4.1 Congestion Management in the Bilateral Model

The bilateral model means that the generators and load service entities (LSEs) sign the contracts separately without a central entity such as a Pool Operator or a Power Exchange. However, some schedules are not feasible due to some constraints of the power system, so it is essential to check, adjust, and curtail the primary schedules[11].

The first mode:

At this point, we assume, producers (generators) and consumers (load) a bilateral contract on the amount of Q12 without intermediaries with Pc prices have signed. So that the P1 and P2 respectively Price at bus generator and load. The impact of generator paying a congestion fee in the bilateral market without an FTR seen in table 1.

Table -1: Consequences for the generator paying a congestion fee in the bilateral market without an FTR.

	Bilateral market	Congestion fee	Total cash flow
Generator is paid:	*Q12PC*	*−Q12(P2 – P1)*	*Q12PC – Q12(P2 – P1)*
Load pays:	*Q12PC*		*Q12PC*

By buying an FTR the generator will be compensated for the congestion fee as shown in Table 2. The FTR makes it possible to fix the price of transmission. The arrangement will be profitable if *pFTR* < *P*2 - *P*1 which is the same condition as in the preceding cases.

Table -2: Consequences for the generator with an FTR.

	Bilateral market	Congestion fee	FTR	Total cash flow
Generator is paid:	*Q12PC*	*−Q12(P2 – P1)*	*Q12(P2 – P1)* *−Q12 PFTR*	*Q12PC – Q12 PFTR*
Load pays:	*Q12PC*			*Q12PC*

The second mode:

In the next example, the trader pays the congestion fee, because it has agreed to buy 12 *Q* at bus 1 at a price *f1* and sell the power at bus 2 at a price *f2*. The trade is illustrated in Table 3.

Table -3: Without an FTR

	Bilateral market	Congestion fee	Total cash flow
Generator is paid:	*Q12(f1 – P1)*		*Q12(f1 – P1)*
Load pays:	*Q12(f2 – P2)*		*Q12(f2 – P2)*
The profit of the trader:	*Q12(f2 – f1)*	*–Q12(P2 – P1)*	*–Q12(P2 – P1)+ Q12(f2 – f1)*

Table -4: With an FTR

	Bilateral market	Congestion fee	FTR	Total cash flow
Generator is paid:	*Q12(f1 – P1)*			*Q12(f1 – P1)*
Load pays:	*Q12(f2 – P2)*			*Q12(f2 – P2)*
The profit of the trader with an FTR:	*Q12(f2 – f1)*	*–Q12(P2 – P1)*	*Q12(P2 – P1)* *–Q12 PFTR*	*Q12(f2 – f1) – Q12 PFTR*

As shown the trader is perfectly hedged against locational price differences by purchasing an FTR. This is profitable for the trader as long as the contract price is less than the difference in bus prices between the two locations.

5. CONCLUSIONS

In this paper, we studid financial derivative instruments and meaning of financial transmission rights (FTR) to cover market price risk and transfer density were evaluated. First, the impact financial derivative instruments to reduce market price by a 2-bus network in different modes (with congestion and absence of network congestion) was simulated. and it was observed that Contracts For Difference (CFD) can be used as a barrier against transmission congestion. In the next section a trader (the interface between the seller and the buyer) buys the contract FTR. And it was observed that if the contract price is less than the price difference between the two bus net profit more than when the generator trader buys the contract.

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