Financial Transmission Right effects on transmission expansion

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***Abstract* - The development of transmission network to reduce congestion and increase the exchange of securely power. Since, The analysis of incentives for electricity transmission expansion is not easy. We must looking for the best methods to increase transmission network. a solution in the development of transmission network, is investment correct economic. In this article, for the development of transmission network we use of hypotheses the long-term financial transmission right (LTFTR). This approach derives optimal transmission expansion through auctions of long term financial transmission rights by an independent system operator. This paper, first study structures for transmission investment, practical strengths and weaknesses structures. The second, we investigate FTRs Effect on Transmission investment and at the end LTFTRs in the case of simulation for development of transmission network are provided.**

Key Words: *: LTFTRs, Transmission investment*

1. INTRODUCTION

The analysis of incentives for electricity transmission expansion is not easy. Beyond economies of scale and cost sub-additivity externalities in electricity transmission are mainly due to “loop flows” that come up from complex network interactions[1, 2]. Loop flows imply that certain transmission investments might have negative externalities on the capacity of other (perhaps distant) transmission links[3]. Moreover, the addition of new transmission capacity can sometimes paradoxically decrease the total capacity of the network[4]. In the [2] studies the effects of an increase in transmission capacity in a three-node network model of two periods.

Transmission capacity is vital for the development of electricity markets. Shortages could prevent generators from selling electricity at high price locations and result in end users paying higher prices. The development of electricity transmission infrastructure requires adequate incentives to solve short-run congestion management, recuperate long-term fixed costs, and investment to expand the network[5]. There are three possible approaches for stimulating investments in transmission expansion: long-term FTRs, price caps, and market power analysis which all build on the equilibrium in the spot market[5].

This paper, first study structures for transmission investment, practical strengths and weaknesses structures. The second, we investigate FTRs Effect on Transmission investment and at the end LTFTRs in the case of simulation for development of transmission network are provided.

2. STRUCTURES FOR TRANSMISSION INVESTMENT

Among the hypotheses on structures for transmission investment, we have the long-run financial-transmission-right hypothesis, the incentive-regulation hypothesis, and the market-power hypothesis. The third approach seeks to derive optimal transmission expansion from the power-market structure of power generators, and takes into account the conjectures of each generator regarding other generators’ marginal costs due to the expansion[6, 7, 8].

The second approach for transmission expansion is a regulatory alternative that relies on a “Transco” that simultaneously runs system operation and owns the transmission network. The Transco is regulated through benchmark regulation or price regulation so as to provide it with incentives to invest in the development of the grid, while avoiding congestion. discuss mechanisms that compare the Transco performance with a measure of welfare loss due to its activities[9, 10, 11].

The first approach derives optimal transmission expansion through auctions of long term financial transmission rights by an independent system operator.

3. THE ANALYTICAL and PRAVTICAL STRENGTHS and WEAKNESSES of EACH APPROACHES

The merchant option relies on the auction of long-term financial transmission rights by an independent system operator. This approach appears promising because it confronts the problems implied by loop flows. However, we analyzed the technical difficulties in defining an operational long-term financial transmission rights auction since loop flows could produce a result opposite to the one sought by transmission investment. Additionally, this analysis is static and at odds with the dynamic nature of transmission investment. Moreover, the existence of market power and vertical integration might jeopardize the success of this method.

The second approach is provided by regulatory mechanisms for Transcos. The basic idea is to make a Transco confront the social cost of transmission congestion. One alternative is a two-part tariff cap that solves the opposite incentives to congest the existing transmission grid and to expand it in the long run. This approach broadens the analysis of the cost and demand functions for transmission services, which are not very well understood in the literature. However, to carry out this task, it must assume a monotonic increasing behavior of the transmission cost function. As shown[5], this assumption is not (in general) valid since an expansion in a certain transmission link can lead to a total decrease of the network capacity.

The third alternative approach defines optimal expansion of the transmission network according to the strategic behavior of generators, and considers conjectures made by each generator on other generators' marginal costs due to the expansion. It uses a real-option analysis to calculate the net present value of both transmission and generation projects. The main contribution of this approach is that it explicitly models the existing interdependence of generation investment and transmission investment. However, it also relies on a transportation model with no network loop flows.

4. MERCHANT TRANSMISSION INVESTMENT

Merchant transmission investment relies on market incentives. The investor pays for the transmission expansion. Incremental financial transmission rights provide a vehicle for unregulated, market-based transmission pricing. However, network interactions and economies-of scale have always supported an assumption in favor of central planning for transmission expansion.

4.1 Inefficient Transmission Investment.

In theory, inefficient investment in the transmission grid could be used to reduce capacity and enhance market power.

4.2 Incentives for Grid Owners.

There need to be incentives for maintenance and equipment replacement to preserve the existing capacity, and to cooperate with merchant transmission investments.

5. FTRs EFFECT on TRANSMISSION INVESTMENT

Investment in the transmission grid should create new economic capacity. The allocation of FTRs under a feasibility rule mitigates incentives for inefficient transmission investment.

5.1 Feasibility Test

The aggregate of all financial transmission rights defines a set of net power injections in the grid. The set of contracts is feasible if these injections and their associated power flows satisfy all the system constraints.

5.2 Feasibility Rule

The grid expansion investor selects a set of new financial transmission rights with the restriction that both the new and the old FTRs will be simultaneously feasible after the system expansion.

If PTP-FTR obligations initially match dispatch in the aggregate and new FTRs are allocated under the feasibility rule, then the increase in social welfare will be at least as large as the ex post value of new contracts[3].

If PTP-FTR obligations match dispatch individually, then the allocation of FTRs under the feasibility rule ensures that no one can benefit from a network investment that reduces social welfare[5].

6. LONG TERM FINANCIAL RIGHTS for TRANSMISSION EXPANSION

The third approach is a "merchant" one based on long-term financial transmission rights (LTFTR) auctions by an independent system operator (ISO).

6.1 **Nodal prices and financial transmission rights**

Differences in nodal prices, congestion transmission charges and network congestion can vary widely over time. Demand and supply availability can also intertemporally vary. Variations in prices then create a demand by risk-averse agents for instruments to hedge against price fluctuations. A short-run financial transmission right (FTR) is such an instrument. Transmission congestion rents are redistributed by the ISO to market agents through FTRs.
tracing the physical flow through a transmission network has proven to be impossible in practice [4]. Superiority of FTRs over physical rights has been analytically demonstrated as well[1]. discusses several financial transmission instruments such as rights, obligations and options[4].

6.2 **Long-term FTRs and transmission expansion**

Specifically, we are interested in studying optimal mechanisms to attract investment for the long-term expansion of the transmission network. short-term FTRs alone cannot resolve the problem of incentives for long-term transmission expansion. The approach of using FTRs to address the problem of long-term (LT) transmission expansion relies on a centralized ISO that allocates through an auction the necessary LT FTRs to protect the holders from future unexpected changes in congestion costs. LT transmission rights work in parallel with LT generation contracts[12].
Typically, the LT FTR allocation mechanism relies on the operation of a short-run spot market for energy and ancillary services by the ISO, and on a bid-based, security constrained, economic dispatch with nodal pricing.

6.3 **An investment protocol**

An investment protocol that best meets these criteria is not obvious. The hard part is defining the proxy awards.

6.3.1 An obvious rule that doesn't work

Every use of the current grid would be a proxy award. Under this rule, a non-zero incremental award of FTRs could require adding capacity to every link on every path in the meshed network. This would virtually preclude investment on anything other than radial lines.

6.3.2 A not-as-obvious rule that might work

The best use of the current grid along the same direction would be the proxy award. Motivated by the symmetry objective, treat "along" the same direction as allowing positive or negative increment, as opposed to being "in" the same direction.

Preset Proxy Preferences (P):

$$\hat{y} = T + \hat{t}\delta,$$

$$\hat{t} \in \arg\max\{tp\delta \; K(T + t\delta) \leq 0\}$$

Investor Preferences ($\boldsymbol{\beta(a\delta)}$):

$$\hat{y} = T + \hat{t}\delta,$$

$$\hat{t} \in \arg\min\{\max_{\theta \geq 0} \{\beta(\theta\delta) \uparrow K^{+}(T + t\delta + \theta\delta) \leq 0\}\}$$

Investment according to the preset proxy rule with preferences defined by prices "*p*" would be formulated as a type of auction model to maximize the investor preference in β (*a*δ) for award of "*a*" MWs of FTRs in direction δ . A similar formulation would apply for the alternative proposal using the investor preferences to define the best proxy award.

6.3.3 An FTR Expansion Model

Assume the preset proxy rule is used to derive prices that maximize the investor preferenceb(*a*d) for an award of *a* MWs of FTRs in direction δ.

$$\underset{a \geq 0, \delta, \hat{t}, \hat{y}, \|\delta\| = 1, \delta = 0}{Max} \qquad \beta(a\delta)$$

$$\begin{aligned}
&\text{S.t.}\\
&K^{+}(T + a\delta) \leq 0,\\
&K^{+}(\hat{y} + a\delta) \leq 0,\\
&\hat{y} = T + \hat{t}\delta,\\
&\hat{t} \in \arg\max\{tp\delta \; K(T + t\delta) \leq 0\}
\end{aligned}$$

In this model, the investor's preference is maximized subject to the simultaneous feasibility conditions, and the best use protocol. We add a constraint on the norm of the directional vector to preclude the trivial case δ = 0. We want to explore if such an auction model approach can produce acceptable proxy and incremental awards. We next analyze this issue within a framework that ignores losses, and utilizes a DC-load approximatio[4].

6.4 THREE-NODE NETWORK SIMULATION

6.4.1 Three-node network with expansion of one of the links

We can now consider a three-node network example from[4] where there are an expansion of line 1-3. The network and the feasible expansion FTR is illustrated in Figure 1.

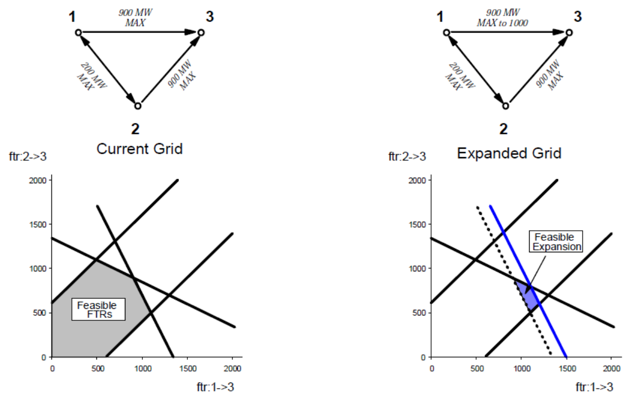

Fig -1: Three-node network and Feasible expansion FTR set.

The expansion problem for a three-node network with identical links and FTRs between buses 1-3 and 2-3 (we assume no mitigating FTRs) is formulated as:

$$\underset{a,\delta,\hat{t}}{Max}\ a(b_{13}\delta_{13}+b_{23}\delta_{23})$$

$$\frac{2}{3}(T_{13}+a\delta_{13})+\frac{1}{3}(T_{23}+a\delta_{23})\le C_{13}^{+}$$

The values of the decision variables are calculated as:

$$\delta_{13}=0.949 \qquad \delta_{23}=0.316$$
$$\hat{t}=180.71 \qquad a=135.5$$

The MW amount of awarded proxy FTRs in the direction 1-3 is $\hat{t}\delta_{13}=171.5$, and the amount of awarded incremental FTRs is $a\delta_{13}=128.6$. Similarly, the amount of proxy awards in direction 2-3 is $\hat{t}\delta_{23}=57.1$, and the amount of awarded incremental FTRs is $a\delta_{23}=42.9$.

The proxy FTRs help allocating incremental FTRs by preserving capacity in the pre-expansion network, which results in an allocation of incremental FTRs amounting to the new transmission capacity created[4].

6.4.2 Three-node network with two parallel links in one of the interfaces after the expansion

The network and feasible expansion FTR set are illustrated in figure 2.

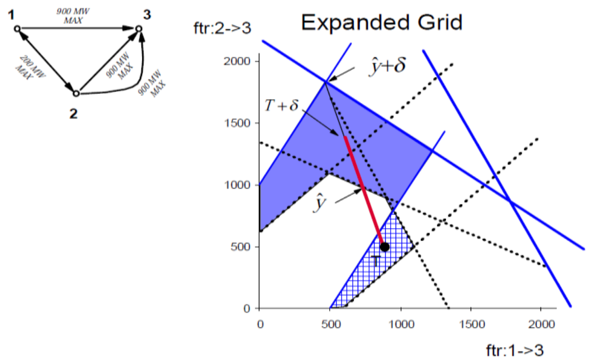

Fig -2: Three-node network and Feasible expansion FTR set.

The network expansion problem for identical links and FTRs between buses 1-3 and 2-3 is formulated as:

$$\underset{a,\delta,\hat{t}}{Max}\ a(b_{13}\delta_{13}+b_{23}\delta_{23})$$

$$0.6(T_{13}+a\delta_{13})+0.2(T_{23}+a\delta_{23})\le C_{13}$$

The values of the decision variables are calculated as:

$$\delta_{13}=-0.316 \qquad \delta_{23}=0.949$$
$$\hat{t}=442.72 \qquad a=1138.42$$

The MW amount of awarded proxy FTRs in the direction 1-3 is $\hat{t}\delta_{13}=-139.9$, and the amount of awarded incremental FTRs is $a\delta_{13}=-359.74$. Similarly, the amount of proxy awards in direction 2-3 is $\hat{t}\delta_{23}=420.14$, and the amount of awarded incremental FTRs is $a\delta_{23}=1081.36$.

6.4.3 Three-node network with two links

The network and the feasible expansion FTR set are illustrated in Figure 3.
The network expansion problem for identical links and FTRs between buses 1-3 and 2-3 is formulated as:

$$\underset{a,\delta,\hat{t}}{Max}\ a(b_{13}\delta_{13} + b_{23}\delta_{23})$$

$$\frac{2}{3}(T_{13} + a\delta_{13}) + \frac{1}{3}(T_{23} + a\delta_{23}) \le C_{13}^{+}$$

The values of the decision variables are calculated as:

$$\delta_{13} = 0.958 \qquad \delta_{23} = -0.287$$
$$\hat{t} = 835 \qquad a = 208$$

The MW amount of awarded proxy FTRs in the direction 1-3 is $\hat{t}\delta_{13} = 800$, and the amount of awarded incremental FTRs is $a\delta_{13} = 200$. The amount incremental 1-3 FTRs corresponds to the new transmission capacity on line 1-2 that the investor has created. There is also an allocation of proxy FTRs such that the full capacity of line 1- 3 is utilized. Similarly, the amount of proxy awards in direction 2-3 is $\hat{t}\delta_{23} = -240$, and the amount of awarded incremental FTRs is $a\delta_{23} = -60$. The amount of incremental 2-3 FTRs is minimized and corresponds to 20% of the reduction (300) in pre-existing FTRs. The incremental 2-3 awards are mitigating FTRs, and are necessary to restore feasibility. The investor is responsible for additional counterflows so that it pays back for the negative externalities it creates.

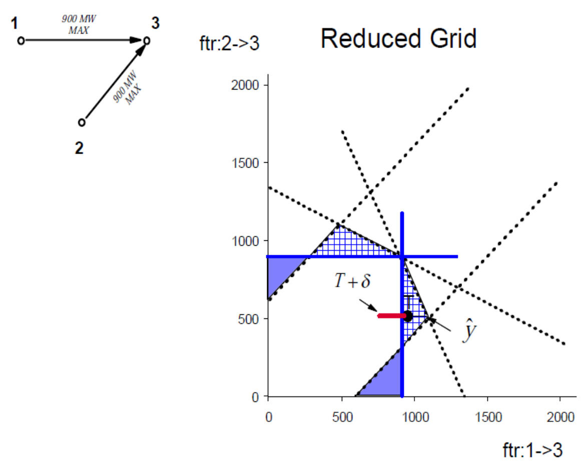

Fig -3 : Three-node network with two link and Feasible expansion FTR set.

7. CONCLUSIONS

A merchant mechanism is proposed to expand electricity transmission. Proxy awards (or reserved FTRs) are a fundamental part of this mechanism. They have been defined according to the best use of the current network along the same direction of the incremental expansion. The incremental FTR awards are allocated according to the investor preferences, and depend on the initial partial allocation of FTRs and network topology before and after expansion.
This article, for the development of transmission network we use of hypotheses the long-term financial transmission right (LTFTR) and we studied structures for transmission investment, practical strengths and weaknesses structures. also, we investigate FTRs Effect on Transmission investment and at the end LTFTRs in the case of simulation for development of transmission network are provided.

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