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This paper came forth as a result of our research in a consulting project undertaken by *Expectativa*, upon request of *Hidroeléctrica Piedra del Aguila SA*, a 1400 MW private generation company located in the Comahue region in Argentina. We have enriched our ideas in many discussions with our client, in particular in meetings with Horacio Turri, Ignacio Alarcón and Bruce Laxdal, as well as with several other private generators from Comahue. We also want to acknowledge remarks from Ingo Vogelsang, Albert Ma and Michael Riordan from Boston University; Gustavo Husson from the Secretary of Energy and Communications in Argentina; and Enrique Neder, Marcelo Schoeters, Santiago Cúneo and Carlos Valquez, who provided us with useful comments in several workshops held at *Expectativa*.

Abstract

The financing of new investment in electricity transmission has always been a complex issue because of the presence of economies of scale, network externalities and lumpiness of investment. In a system where generation is competitive, this complexity is exacerbated by the need to make open access dispatch compatible with the allocation of ownership rights in the network, so as to prevent free-rider problems that may deter or unnecessary delay new investment. Uncertainty about the expected benefits of the project also adds to the difficulty in finding optimal solutions to transmission regulation, in particular when regulation precludes the introduction of financial instruments that help allocate the risks associated to the investment decision.

The objective of this paper is to propose a market-based mechanism to finance competitive investments in electricity transmission, in a system where generation is fully competitive and the network is subject to an open access principle. In our basic scenario, there are ownership rights on the existing network that are fully allocated to a private company called GridCo. New lines are built and run by *independent transmission operators* (ITOs) profit-maximizing entities which recover their investment through the sale of *transmission capacity rights* (TCRs) in an auction procedure. TCRs are a financial instrument that gives the holder a right to own a share of the incremental capacity of the region, over the life span of the new investment. TCRs are granted on the incremental capacity over the region whose nodes can inject/receive more power as a result of the new investment. The auction serves to allocate TCRs among interested parties who will either exercise the rights for their own participation in the incremental capacity and/or receive a regulated fair return in the form of a rental payment from those who actually participate in the incremental capacity.

The mechanism aims to address the free-rider problems that arise in open access networks. The rule that determines the participation of grid users in the incremental capacity, and the parameters used in the calculation of the rental price appear to be of critical importance, and both issues are candidates for further research in this direction.

I. Introduction

Scholars and policy-makers who are currently studying and implementing transmission policies in deregulated electricity environments face several challenges: transmission pricing, congestion rents, network externalities, lumpiness of investment, economies of scale, open access, free-rider problems, coordination, and the allocation of decentralized ownership rights are among the principal topics in the agenda.

The financing of new investment in electricity transmission has always been a complex issue because of the presence of economies of scale, network externalities and lumpiness of investment. In a system where generation is competitive, this complexity is exacerbated by the need to make open acces dispatch compatible with the allocation of ownership rights in the network, so as to prevent free-rider problems that may deter or unnecessary delay new investment. Uncertainty about the expected benefits of the project also adds to the difficulty in finding optimal solutions to transmission regulation, in particular when regulation precludes the introduction of financial instruments that help allocate the risks associated to the investment decision.

The objective of this paper is to propose a market-based mechanism to finance competitive investments in electricity transmission, in a system where generation is fully competitive and the network is subject to an open access principle. We want to conciliate the apparent contradiction between open access and network ownership rights. In our basic scenario, there are ownership rights on the existing network that are fully allocated to a private company called GridCo. The proposed mechanism contains, therefore, a market-based incentive scheme designed to finance the building of new lines under alternative ownership. Although the mechanism draws heavily on the market initiative, the role of regulation will not be nil, as the guidelines and procedures for the concourse of competitive private participation will be initially set up by the regulatory authority (henceforth the regulator).

New lines are built and run by *independent transmission operators* (ITOs), profit-maximizing entities which recover their investment through the sale of ownership rights and generate operating profits through the O&M of the new facilities. Candidates for ITOs have to submit competitive bids for a BOM contract (build, operate and maintain) which is awarded by the regulator. ITOs are subject to operating supervision by GridCo, for network coordination purposes.

Despite ITOs involvement in the construction of new lines, the final responsibility for financing the investment, with its associated risks, does not belong to ITOs. Rather, capital costs are financed by those willing to purchase ownership rights, which we named *transmission capacity rights* (TCRs), at a price to be determined by an auction procedure. This procedure serves to allocate TCRs among interested parties who either exercise the rights for their own participation in the incremental capacity and/or receive a regulated "fair" return in the form of a rental payment from those who actually participate in the incremental capacity. In this way, the mechanism aims to address free-rider problems associated with the apparent dilemma between the open access principle in a competitive environment and the existence of ownership rights. In the scheme, there is no need for coordination among agents, in the sense stated in Baldick and Kahn (1993), as the mechanism provides a market solution for the allocation of risks among network users and other agents that are willing to finance the investment. The rule that determines the participation of grid users in the incremental capacity, and the parameters used in the calculation of the rental price will be of critical importance and will therefore be the main concern of the regulator.

TCRs are allocated on the incremental capacity over the region whose nodes can inject/receive more power as a result of the new investment. How to determine the domain of this region is not an easy task, and its definition relies on a purely technical concept related to power flows. In a similar fashion, the rule for determining the participation of grid users in the incremental capacity will be based on the share of the power injected/received over the total power of the region. This is a practical rule, not necessarily optimal, which should be compatible with the regulation that governs the existing lines of GridCo, which is explained below.

TCRs can thus be seen as a financial instrument that gives the holder a right to own, a share of the incremental capacity of the region, over the life span of the new investment.

Other authors have used the concept of transmission rights for network investment. Hogan (1992), in a seminal paper, introduced the concept of *contract network* options, which were designed to give long-term capacity rights to an electric transmission network. More recently, Bushnell and Stoft (1995a, 1995b) also discussed the introduction of *transmission congestion contracts* which grant property rights to investors. However, in all cases the revenue that is collected through these contracts is raised as the difference in nodal prices, which basically includes transmission losses and congestion charges[1]. In our mechanism, revenues from TCRs act like a fixed component in a two-part tariff system, since TCRs exclusive purpose is to be an instrument for capital cost recovery.

The motivation of this work rest on the structure and organization of the electricity market in Argentina, whose degree of deregulation and sophistication is fairly high. Much of the basis for our underlying mechanism draws from the actual

[1] In Bushnell and Stoft (1995b) this revenue is called *Link Based Rights (LBRs)*.

organization of the Argentine market, and our proposed mechanism of auctioning TCRs could well serve as a contribution to further improve the behavior of this market.

The rest of the paper is organized in three sections. Section II presents and briefly explains the regulatory framework assumed for our unbundled electricity market, emphasizing the role of each actor in the transmission activity. Section III introduces the mechanism for transmission investment, discussing the potential outcomes of the auctioning procedure. Finally, in Section IV we attempt to draw some policy-oriented conclusions.

II. Regulatory Framework of the Market

II.1 PoolCo and GridCo

In our scenario, the generation segment of the market is fully competitive, whereas transmission and distribution are subject to regulation on prices and service quality. The open access principle applies to the main high-voltage network and to all distribution networks, and dispatch is centrally administer by PoolCo, a non-profit organization which is also in charge of accounting settlement of the system.

PoolCo's main objective function is to optimize system dispatch by minimizing short-run costs of generating electricity, and also by complying with the complementary technical and economic rules set by the regulator.

GridCo, on the other hand, is a private company that has been granted a monopoly concession to maintain and operate the existing high-voltage network.

GridCo's regulation is rooted in four basic premises:

a. Monopoly rights to operate existing network.
b. Prohibition to sell or buy energy.
c. Open access principle.
d. Regulation on prices and quality.

Although the GridCo has exclusivity rights to operate the high-voltage network, it is banned from selling or buying electricity in the marketplace. The rationale for this measure is to avoid indirect forms of vertical integration that may prevent competition in generation, to sidestep discriminating actions by the grid operator, and to prevent cross-subsidies between activities. The controlling group of GridCo is also banned from holding a majority stake in generation, distribution or industrial user companies.

GridCo is required to provide transmission access to all parties (open access principle) when capacity is available. If capacity constraints arise, GridCo can not discriminate through rationing devices, since it is PoolCo's faculty to decide which generator is called upon for dispatch. This decision is based on an unconstrained dispatch merit list, which sorts producers by their bid prices, which in turn are capped by their recognized fuel costs plus a fixed percentage. The dispatch mechanism makes rationing for transmission capacity optimal for the system as a whole, as it guarantees that the lowest-cost generators have access priority.

GridCo's revenue is regulated and is mainly formed by access charges; fixed charges that are calculated based on the kW usage of some components of the network; and variable charges that take into account line losses and line reliability. The revenue formula is:

$$R = A + F (V^* - V) + V (e, p)$$

where R is total revenue, A represents access charges, F is the name for fixed charges, V is the variable charge, e is electricity flow and p stands for electricity and power capacity prices. V* is the stabilized variable charge, which we referred below. These three revenue components (access, fixed and variable charges) remunerate the existing network capacity[2] .

Access charges are unit charges for each interconnection point with the grid, and are intended to remunerate the costs associated to transformation stations at these points. The level of access charges is set as a dollar rate per hour.

Fixed charges on network components include a fixed dollar rate paid on transformers and a per-hour value based on line distance and usage. Fixed charges can be seen as "complementary charges" that are needed to cover the required network revenue in systems that work under spot pricing with spatial discrimination. In the terminology of Schweppe et. al. (1988), these are the so-called *revenue reconciliation charges*.

Variable charges are the short run transmission costs that include line losses, which are calculated as the difference between energy transported, evaluated at nodal spot prices for each of the two nodes involved; and line reliability, also referred to as network quality of supply, which is paid through the spatial difference on nodal power capacity charges[3] .

To dampen the adverse effects of spot price volatility on GridCo's revenue, variable charges are estimated *ex-ante* at what is called V*, the stabilized variable

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[2] Other charges would involve some of the secondary transmission services which are afforded directly by the grid users. This is the case of reactive power support, load-frequency control, and operating reserve management.

[3] Notice that we have differentiated between energy and capacity remuneration. Ruff, L. (1994) considers that there should not be a distinction between energy and capacity when prices are allowed to raise to market-clearing rationing levels.

charges. Differences between actual and stabilized variable charges are passed through to network users as part of the complementary charges.

Grid users have to pay congestion charges whenever there is a transmission constraint in any particular line or region. For grid users, the congestion cost is reflected and paid for through differences in nodal spot prices. Congestion charges, however, do not accrue to GridCo, but rather are collected by the regulator and deposited in special accounts whose purpose is to help finance capacity expansions in the region where the congestion costs were originated. Congestion charges thus generates a "congestion rent" that is appropriated by the regulator instead of the GridCo. Notice that this condition completely dilutes GridCo's incentive to restrict transmission capacity to generate more revenue. The mechanism on how these congestion rents are allocated for future investments will be discussed in the next section.

GridCo is also subject to quality incentive regulation. Notice that the variable charges set in the pricing regime send correct price signals to grid users, but have a perverse effect on GridCo's behavior. Indeed, the higher the losses and the lower the reliability of the line the higher the GridCo's revenue. To counteract this negative signal on transmission quality, GridCo has a special incentive to maintain full availability over the whole network. GridCo pays penalty charges whenever lines are unavailable[4], and receives bonuses when its availability performance is outstanding. Penalties for lack of availability are set on a per-line basis and their level increases with the duration and frequency of line outage, voltage, and the overrun costs caused in the system due to the transmission failure. Line availability is not the only regulated quality indicator. Among other quality requirements, it stands out the control on voltage levels, which should not exceed a pre-established range, on reactive power equipment, on transformation stations, and on other operative and configuration issues.

GridCo's costs are therefore mainly composed of O&M costs, though they also include potential penalties on line unavailability. GridCo's cost variations, on the other hand, are mainly dependent on the amount of penalties and the associated maintenance costs aimed to avoid penalties. As revenues are relatively fixed by means of the stabilization condition, GridCo's main profit maximizing efforts are then focused on the cost side: the minimization of penalties.

The reader should also notice that GridCo does not have any explicit pecuniary incentive to expand capacity, as GridCo is precluded from the obligation to undertake new investment, neither it is provided a special remuneration to cover long run incremental costs. On the contrary, new investment is left to the private initiative of ITOs, subject to pre-established regulatory rules for capacity expansion. These rules can

[4] Whatever the reason, except for planned maintenance operations.

be left entirely in the hands of the regulator or they can be designed to allow the market to decide the timing and the cost allocation of the investment. The core mechanism that is presented in section III fits with the latter proposition.

II.2 ITOs

The GridCo does not have the obligation nor the privilege to invest in new capacity. There is open competition for new investment in electricity transmission, where the winner of a competitive process is awarded a BOM contract, becoming an independent transmission operator (ITO).

ITO's revenue and cost components and structure resemble those of GridCo's. There are access, fixed, and variable charges associated with the new investment. Like the GridCo, ITOs are subject to regulation on service quality, and have similar incentives to minimize penalties on line unavailability.

To facilitate and enhance network coordination at the high-voltage level, GridCo is responsible for the whole compatibility of the system, and for the supervision of BOM contracts granted to ITOs. ITOs have to compensate GridCo with a small supervision fee, which can be viewed as a payment for a network coordination role[5].

The main difference between an ITO and GridCo is that the former needs to have a revenue component to allow for capital cost recovery.

III. A Market-based Mechanism for New Transmission Investments

Electricity and transmission prices should send the correct signals to investors to allocate investment in transmission efficiently with respect to timing, location, and magnitude. Spot prices of electricity are node prices that incorporate the short-term spatial aspect of the problem. Therefore, the coupling of transmission prices to generation costs does not distort the spatial signals in the short run. However, in our mechanism transmission prices are not designed to cover long run average costs or long run incremental costs. Consequently, GridCo is not subject to the obligation of network expansion. With no obligation to undertake expansion projects, and with transmission prices essentially short-term in nature, there seems to be a dichotomy between the incentives for efficient operation and for optimal expansion of the network, and the issue on how to finance additional capacity appears to be unresolved[6].

In a competitive electricity market, network users who eventually have to finance a new line are concerned with the proper allocation of capital costs. In our mechanism,

[5] This coordination and technical compatibility role does not need to be exercised by GridCo. Torres (1995) suggests that PoolCo can be in charge of this role, in order to level off the competition field between GridCo and ITOs.

[6] The dichotomy, however, is not total as funds collected through congestion rents are used to help finance new investments.

network users are composed by generators, distributors, and large industrial users, all of whom are entitled to shop for electricity in the wholesale market. Capital costs have to be directly afforded by network users who will later pass these costs to end users through the price of electricity. In a market that combines a competitive segment in generation with a regulated environment in transmission and distribution, however, passing costs along to end users is not necessarily a straightforward exercise. Regulation at the different levels may impede (partially or totally) the pass-through of investment costs to end users. The allocation of capital costs among network users, therefore, becomes crucial in the investment decision making process.

The first-hand market solution to the investment problem would be to let interested parties to undertake new projects on the basis of voluntary agreements. However, the presence of network externalities and the difficulty to conciliate ownership rights with the open access principle show that voluntary agreements are not enough to solve the transmission investment riddle.

For investments whose magnitude implies the use of common facilities to several transmission users, there is the need to develop an alternative mechanism that, within a particular regulatory framework, can conciliate ownership rights with open access and that can allocate investment costs and rights among those who are able and willing to finance the project in an efficient and equitable manner.

In principle, an equitable distribution of investment costs should be associated with the expected economic benefits brought about by the project. However, quantifying expected benefits is difficult since agents will not necessarily be willing to reveal this information[7]. A "benevolent" regulator could not determine a fair allocation either, since it has incomplete information. Our proposal should therefore be understood as a mechanism that makes private agents reveal their preferences through the auctioning of TCRs.

III.1 Auction Procedure

The degree of competition in the auction is one major concern in the design of this procedure. A non-competitive auction may result because there might not be a large number of buyers. The base case, defined as one where the auction is competitive, is developed, and then complementary rules are introduced to the base case for the case of an auction that is not fully competitive.

III.1.1 The competitive auction

[7] Green, Kohlberb and Laffonte (1975) and Groves (1977), among others, addressed the problem of truthful revelations. They proposed a solution to make individuals reveal their preferences, though the proposals do not assure that the revenue needed would be collected.

The mechanism for expanding transmission capacity can be explained as a sequence of actions that consists of the following:

a. A private enterprise interested in the building, operation and maintenance of a new line files an application to the regulator. The application contains the details of a BOM contract, which includes a description of the nature of the project (size, length, path, etc.), the value of the contract (expressed as the investment cost minus the net present value of expected future profits derived from the O&M of the new line), which we call K, the construction time and the expected life span of the line.

b. The regulator evaluates the proposal. The proposal should meet the "golden rule" requirement that the net present value of the total cost of investment plus the O&M costs of the system with the project is less than the net present value of O&M costs of the system without the project.

c. Competition for the value of the BOM contract (K): Once the project presented by the initiating enterprise passes the "golden rule", the regulator makes a call for open bidding for the value of K[8]. A competitive value for K, called k, is established as a result of the open competition for the BOM contract. The bid winner is pre-awarded the BOM contract, and the definite award is subject to the financial feasibility of the project, which will be determined in a further step, the auctioning of TCRs.

d. The regulator announces the amount of funds collected through past congestion rents in the area, called S, which is allocated to help finance the project. The needed revenue collection (R) through the auctioning of TCRs will then be $R = k - S$, or simply $R = K^*$, where $K^* = k - S$.

e. The auction for TCRs determines unitary (per MW) prices for TCRs, discriminated by hour band (peak, shoulder and valley). The second-price auction is subject to the overall condition that $R = K^*$ for the sum of the three hour bands. In the auction the potential buyers declare desired block quantities (1 TCR = 1 MW of incremental capacity) and prices for each quantity blocks. In a first round of bidding, prices are found for each hour band, and the fulfillment of the $R = K^*$ condition is verified. If $R \geq K^*$, the rules for setting equilibrium prices are simple and the procedure can be completed[9]. Otherwise, if $R < K^*$, the process can be concluded as it will be inferred that the market was not able to raise the funds needed for the investment. Alternatively,

[8] As a reward for presenting the initiave, the enterprise who promoted the project can be given the privilege to go to *ballotage* if competing bids are within a reasonable close range of the value of K (5-15%).

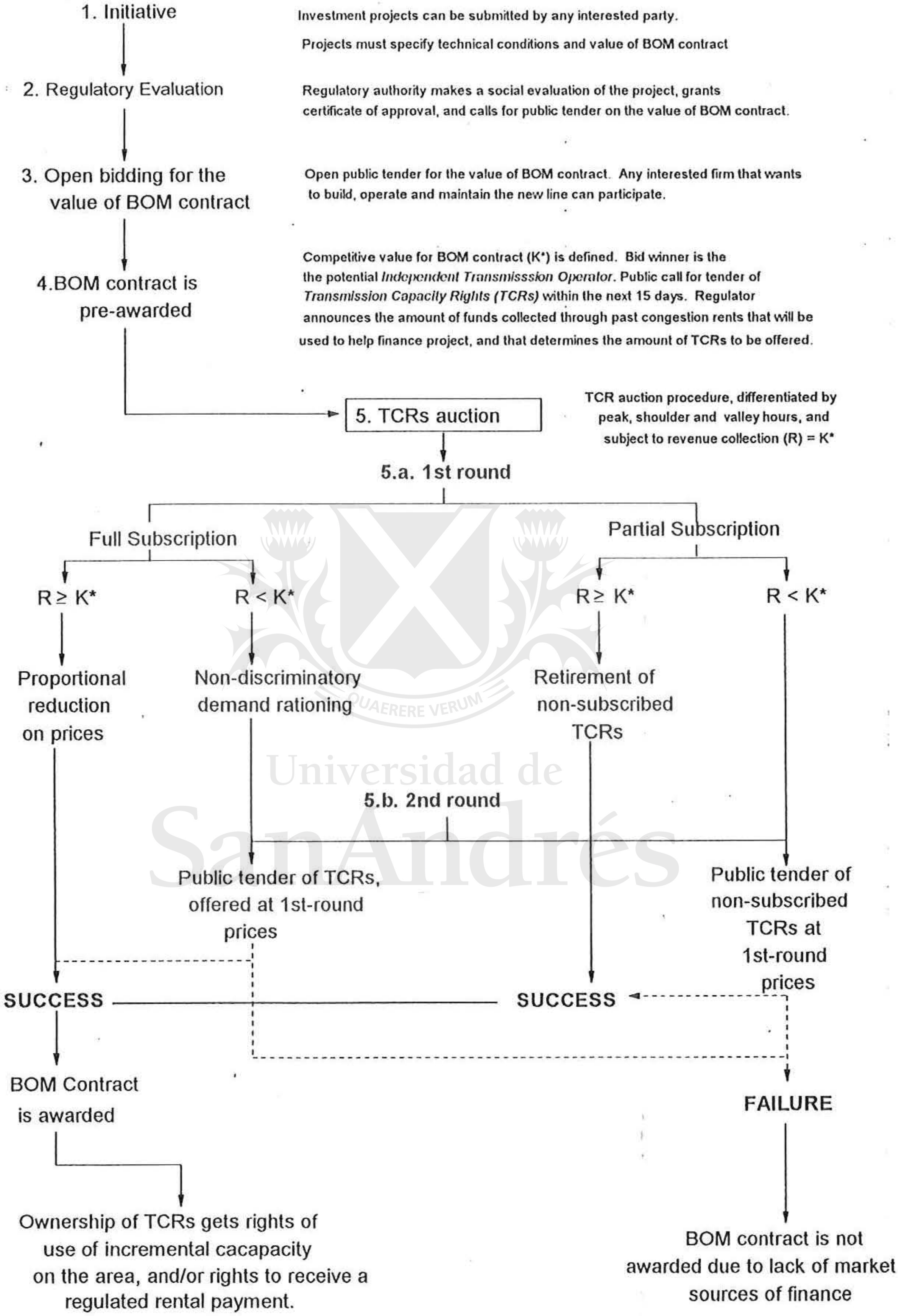
[9] Equilibrium prices in this context mean those prices that makes $R = K^*$. When $R \geq K^*$ prices for each hour band can be adjusted by the factor K^*/R.

the process can continue with a second round of bidding, where unsold quantities are offered at first-round prices.

f. The regulator gives the final award to the bid winner of the BOM contract, which will become the new ITO, and the project is undertaken. TCRs are payable to the ITO upon the conclusion of the works, so that the ITO bears the financial risks during construction time. PoolCo sets up a *clearinghouse* to settle TCRs accounts of network users.

The procedure is also illustrated in the figure below, with more details on the various outcomes that may emerge from the first round of TCRs auctioning.

Market-Based Methodology for Electricity Transmission Investment


1. Initiative
Investment projects can be submitted by any interested party.
Projects must specify technical conditions and value of BOM contract
2. Regulatory Evaluation
Regulatory authority makes a social evaluation of the project, grants certificate of approval, and calls for public tender on the value of BOM contract.
3. Open bidding for the value of BOM contract
Open public tender for the value of BOM contract. Any interested firm that wants to build, operate and maintain the new line can participate.
4.BOM contract is pre-awarded
Competitive value for BOM contract (K*) is defined. Bid winner is the the potential *Independent Transmisssion Operator*. Public call for tender of *Transmission Capacity Rights (TCRs)* within the next 15 days. Regulator announces the amount of funds collected through past congestion rents that will be used to help finance project, and that determines the amount of TCRs to be offered.
5. TCRs auction
TCR auction procedure, differentiated by peak, shoulder and valley hours, and subject to revenue collection (R) = K*
5.a. 1st round
Full Subscription
Partial Subscription
R ≥ K*
R < K*
R ≥ K*
R < K*
Proportional reduction on prices
Non-discriminatory demand rationing
Retirement of non-subscribed TCRs
5.b. 2nd round
Public tender of TCRs, offered at 1st-round prices
Public tender of non-subscribed TCRs at 1st-round prices
SUCCESS
SUCCESS
FAILURE
BOM Contract is awarded
Ownership of TCRs gets rights of use of incremental cacapacity on the area, and/or rights to receive a regulated rental payment.
BOM contract is not awarded due to lack of market sources of finance

III.1.1 The non-competitive auction

If there is not a large number of potential buyers, then the auctioning of TCRs can take place in two stages. In the first stage, only network users from the area where the project increments transmission capacity can participate, by declaring desired block quantities (1 TCR = 1 MW of incremental capacity) and prices for each quantity blocks. The exclusion of other bidders at this stage is proposed as a regulatory measure to avoid potential strategic bidding behavior. At the first stage prices are set for each hour band, and the fulfillment of the $R = K^*$ condition is verified. If $R \geq$ **¡Error!No se encuentra la fuente de la referencia.** K^*, the rules for setting the prices are once again simple and there is no need for a second round or a second stage, as the funds needed to finance the project are sufficient. If $R <$**¡Error!No se encuentra la fuente de la referencia.** K^*, however, cut prices are once again fixed, but this time there is the need to make a new call for bidding, in order to collect enough funds to cover K^*. The second stage then consists of a new call for tender, which is now open to any interested party, though bidders are only allowed to make quantity offers at the fixed prices set in the first stage. If as a result of this second stage $R \geq K^*$, then the procedure is completed, otherwise it should be interpreted that the project was not attractive enough to the market.

III.2 TCRs Settlement and Properties:

III.2.1 Participation of Network Users on the Incremental Capacity

Network users have to pay for the investment costs of new lines, in a similar fashion than automobile drivers who pay a toll for using a highway. Unlike automobile drivers, however, network users do not pay a fee related to the actual use (power flow path) of the new line. Instead, the network user contribution is a function of his participation on the incremental capacity of the electrical region where the investment is located. How to measure the user participation is therefore one of the key concepts in the mechanism. Ideally, the participation ought to be defined as the net economic benefits for each user over the total economic benefits of the project. Since benefits are not necessarily revealed by users and the regulator's available information is incomplete as to attempt to equitably allocate costs on this basis, there is the need to use a proxy definition for network user participation.

Network user participation determines the responsibility for the payment of TCRs' rental charges. Let us define network user participation at a particular hour as:

$$\alpha_i = \frac{P_i}{P} \qquad \text{for user i,}$$

where P represents power generation/load capacity in the electric region where the transmission investment is located. The coefficient α_i is multiplied by the incremental capacity to obtain the amount of TCRs that the user is responsible for in the payment of rental charges.

In some circumstances there might be excess incremental capacity (i.e. off peak hours). To avoid potential discrimination and exercise of monopoly power the regulated rental payments that accrue to TCRs holders are paid proportionally to each holder's share over the total TCRs granted for each particular hour band. When there is excess incremental capacity, thus, it is possible that a TCR holder may not accrue the full amount of his expected rental payment. This is the main risk associated to the purchase of TCRs.

It is important to note that the way in which α_i is determined affects the investment decision of TCRs potential buyers, both in terms of the quantity and the price at which each buyer is willing to demand.

III.2.2 Rental Payment

TCRs have the virtue of granting financial property rights over new lines, as opposed to physical ownership, in order to discourage free riding. To avoid exercise of monopoly power on these financial property rights, however, the compensation to be received by TCRs holders who do not exercise their own participation in the incremental capacity must be capped. How to set a fair regulated rental price (ρ) whose level is sufficient to compensate TCRs holders for their investment and, at the same time, does not distort short run and long run economic dispatch decisions? The "right" ρ can be determined as a function of the TCR auction price, just like an annuity on a fixed term bond. Mathematically, this is equal to:

$$\rho = \text{auction price} * \frac{i\ (1+i)^n}{(1+i)^n}$$

where i is the discount rate and n the life span of the investment.

In a world with identical intertemporal preferences, a network user should be indifferent between investing today in TCRs or paying the rental payment ρ in the future, if the implicit rate of return of ρ equals the discount rate of all network users. Said equilibrium and uniqueness on discount rates barely exists in the real world. Therefore, for public policy purposes, the choice of the rate of return of ρ is of crucial importance.

III.2.3 Use of Congestion Rents

In a region that has experienced transmission constraints, funds collected through congestion rents are available to finance the new investment, in addition to the funds that are raised through the auctioning of TCRs. How to allocate *S* (congestion rents) is not a trivial question since it may alter the investment decision of TCRs buyers. The allocation should be neutral with respect to the efficiency and equity considerations of the project. In our mechanism *S* is used to lower the final amount that needs to be financed through TCRs, from *k* to K*. The number of TCRs that are offered to the market can be adjusted by the ratio K*/*k*, which means that there will be a fraction *S/k* of the incremental capacity that does not grant transmission rights, and therefore does not accrue rental payments in the future. Recalling that there are economies of scale, the amount *S* is implicitly being used to finance the excess capacity associated to any transmission project[10].

III.2.4 TCRs Properties

The following distinct TCRs features deserved to be remarked:

1. The procedure is based and oriented in market decisions, as the demand for TCRs is voluntary and the regulator only determines the rules of the auction procedure.

2. TCRs', within a context of an open access system, confer property rights over the incremental capacity of the region during the life span of the investment. TCRs are like a financial instrument whose yield is a rent that is contingent to network users' participation on the incremental capacity.

3. The auction procedure allows the participation of outsiders to the industry who may want to share the risks of the investment by buying TCRs.

4. TCRs buyers are holders of an investment with some degree of liquidity, since TCRs can be traded in a secondary market.

5. As TCRs allow for peak pricing differentiation, it is likely that TCRs will cost more in peak hours than in off peak, as the expected benefits from using network capacity in peak hours is higher. In this way, those who are participating in the incremental capacity in peak hours will be contributing more to the financing of the line than those participating during non-peak hours.

[10] Notice that *S/K** can be greater than, equal to, or less than the percentage of excess transmission capacity.

6. TCRs avoid free-riders by incoming network users, since TCRs holders receive a rental payment as a compensation if incoming users prevail over them in the economic merit list of dispatch.

7. By using the accumulated congestion rents of the region (S) to help finance at least part of the excess capacity, the mechanism is implicitly dealing with the issue of economies of scale.

8. Externalities and loop flow problems are treated at two different stages. First, if negative externalities whose overall sum outweighs the benefits of the investment are detected, the regulator judges the project as detrimental and rejects it by command of the so-called "golden rule". Second, all other externalities (positive or negative) ought to be internalized in the auction strategy of each bidder. It is nonetheless possible that, in a non-competitive auction, a party who is excluded from participating in the first stage of the bid receives a negative externality, therefore not being able to internalize its expected net gain/losses through the auction procedure. This is an aspect that deserves a more detailed examination.

9. Changes in network reliability due to the construction of a new line will translate into changes in nodal factors. This is mainly a quality effect of the investment, whose expected benefit (positive or negative) should be internalized in the auction strategy decision made by each potential TCR buyer.

10. TCRs are related to capacity as opposed to being actual-path or contract-path related.

IV. Conclusions and Further Research

In a market where network investment decisions are left to private actors, the key answer to solve the transmission investment riddle will surely depend on the market structure, the regulatory framework and the specific incentives and price signals received by private agents.

{TO BE COMPLETED}

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