Abstract--In September of 2000, the Chilean Energy Commission published a draft of a new electricity services law. One of the main changes was the replacement of the Chilean electricity pool by two new organizations, the Power Exchange and the Independent System Operator. Based on the experience of the electricity markets of California, England/Wales, Scandinavia, Colombia and Spain, and considering the characteristics of the Chilean market, an analysis is done in this paper on the consequences of such change and the effect on prices and dispatch. Topics such as market power, horizontal concentration, transmission constraints, the withdrawal of the capacity payment, must be carefully analyzed in a market design, considering the effects these issues may have in the competitiveness of the sector and the search for efficiency.

Keywords—Market Power, Power Exchange, Independent System Operator.

I. INTRODUCTION

During the second half of the 90's, the deregulation process of the electricity markets evolved toward new organizational models. Power exchanges developed, integrating aspects of the pools and the private bilateral contracts, two of the traditional structures of deregulated markets. Chile has not been absent from this process and in a recently proposed new law; major changes are considered in the pricing and dispatch mechanisms. A Power Exchange (PX) or Market Maker and an Independent System Operator (ISO) would manage the tasks previously performed by the Chilean Pool (Centro de Despacho Económico de Carga - CDEC).

Independent of the organizational form the electricity markets adopt, it is possible to recognize three essential functions that allow them to operate: the Physical operation, responsible for the grid operation in terms of reliability and stability; the Economic operation, whose purpose is manage energy markets and supplying the system demand at minimum cost, and the Commercial operation, as a result of the two others, in charge of the settlement and conciliations of the obligations contracted in the market.

II. THE POWER EXCHANGE AND THE INDEPENDENT SYSTEM OPERATOR’S MODEL (PX-ISO)

Unlike centralized models, in which only one institution assumes the three main functions of the market, the PX-ISO model contemplates an explicit separation between the market and physical functions. As a result of this dichotomy the PX becomes the energy market operator and the ISO is in charge of the physical operation of the grid.

The separation of functions is supported by the assumption that the principles behind the market and the grid operation are quite different. While the markets operated by the PX are based on economic principles, the ISO must operate according to physical and safety requirements.

A. The Power Exchange

The PX is an institution created by the regulatory framework and its main objective is to employ and run competitive auctions of energy, on non-discriminatory basis, supplying the electricity demand at market prices. The PX assumes as counterpart in each purchase and sale operation, and for this reason it usually manages the settlement process, establishing guarantees and processes of conciliation to smooth differences among the agents. Normally the PX is not authorized to make purchases and/or sales on its own behalf, since it has access to privileged information that can be used for its own benefit.

1) How does a PX work?

The PX is a virtual forum where the agents concur to trade blocks of energy according to their requirements. The PX receives daily and hourly supply bids from the generators. With these bids it builds a merit list, sorting the prices supplied from least to most expensive until the generation match up the aggregate demand curve, obtaining as result of this operation the Market Clearing Price. The work of the PX is the accomplishment of periodic auctions for the different markets it operates. The most frequent ones are a day-ahead and hour-ahead markets that contemplate the deliveries of energy for the following day and during the same day, respectively. Additionally the PX usually manages the bids in the real time and ancillary services markets. However, the decision to purchase, in this case, is made by the ISO, and the job of the PX is purely administrative.

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What at first began with the operation of physical markets, has been evolving towards more sophisticated markets, with the developing of financial instruments like forward contracts and options, allowing mid and long term transactions.

B. Independent System Operator

The operation of the grid requires of certain synchronization among the agents. In this case the ISO is accountable for the coordination and the operation of the transmission system. The ISO determines the additional generation and the ancillary services required to make the necessary adjustments to guarantee the real time balance between generation and load, while maintaining the stability of the system. The scope or jurisdiction of the ISO is circumscribed almost exclusively to the real time operation. Nevertheless, in some cases it can have some degree of authority in the planning and the expansion of the system. The ISO has also another task, which is the validation of the PX operations, since these are not always physically feasible. If this is the case, the ISO must make the corresponding adjustments.

C. PX Analysis

Like other models, the PX - ISO model pretends to give a solution to the organization of electricity markets. Nevertheless, the PX has advantages and shortcomings. The main advantages of the PX are the transparency and efficiency in the commercialization of the energy, in particular the open character of the auctions and the low transaction costs. From the market point of view, the PX is able to provide a clear signal to all the agents, assigning the real value to each one of the services traded in the market. This does not always happen with the optimization system by pools, which can sometimes be perceived as arbitrary and non-transparent.

Particularly its detractors see the separation of the PX markets with the system’s physical operations, as a disadvantage or weakness of the model, because it constitutes an additional difficulty in terms of coordination and transference of information between the PX and the ISO. The periodic auctions allow daily price fluctuations. This and the system’s pricing model are likely to produce a high volatile and unpredictable price pattern and make the model susceptible to monopolist behavior, also known as market power, usually executed by generators who take advantage of contingencies and grid transmission’s constrains to raise the market price away from competitive levels.

D. Market Power

Since the deregulation processes are more and more frequent, the market power (MP) has become one of the major concerns for authorities, regulators and researchers who look into the risks of design flaws that may cause abuses of companies with privileged positions within industry.

Two of the most emblematic cases of MP are found in the England/Wales [6] and California [1] markets. Because these systems are predominantly thermal, only some aspects can be extrapolated to the main Chilean electricity system (SIC). Take for example, the presence of mechanisms with perverse incentives to make the system fail or take it to extreme situations, to “artificially” raise the energy prices. Another key feature is the necessity of implementing a flexible pricing
system to increase the consumer’s elasticity. Two markets are comparable to the Chilean market, due to the importance of the dam hydro power stations: Colombia and the Southwest of Brazil. In studies related to these markets [3] [2], the authors cite as the main causes of MP a small gap between the generation capacity and the demand for power where there are companies with important market shares. At the same time a new element is added to the agents decision-making, the strategic use of the water resources stored in the dominant companies’ reservoirs.

Depending on the dispatch method, the behavior of companies will be different. If the competition settles down by costs, with a centralized optimization, the MP of the dominant companies can be done by declaring certain generation units on maintenance, under certain periods of time, and so the demand’s surplus must be replaced with more expensive units, raising the system’s marginal cost [5]. On the other side, if the dispatch is decentralized then the strategic companies have two choices: either restrict the supply or raise the bids. The direct consequence of the MP is transference of well being from consumers to generators, who raises their profits above competitive levels.

III. THE POWER EXCHANGE IN THE CHILEAN MARKET

According to the proposed law change, the PX’s function will be to serve as a convergence mechanism between the mid and long term contracts, and the dispatch of generation units. To fulfill this commitment, the PX will run energy auctions in two markets, the day ahead and the day market, as well as receive the bids in real time and ancillary services markets. Another remarkable aspect is that the PX will be an independent organism from market agents, therefore eliminating the conflicts of interests that appear sometimes inside the actual pool (CDEC), which is managed by generators and transmission companies. The analyses of the real consequences that free bids auctions may have in the Chilean electricity markets are strongly dependent of the following topics:

A. Regulatory Framework

The character of operations, which are going to take place in the PX markets, is an important aspect that is not absolutely clear at this time. In the original law draft, daily auctions were contemplated, with daily and hourly bids. However, according to later explanations, at least in a transient period, the bids format would be on an annual basis, and considering the differences between hydraulic and thermal plants. The annual bids mechanism has two advantages, the fact that generators are allowed to freely make their bids, eliminates the disagreements about the calculation of the variable costs, which is a problem in the actual framework. At the same time, the MP is partially mitigated, since the bids cannot be changed during the current period, taking advantage of the network congestion or the sudden outage of generation units. Although, these type of bids seem to aim in the right direction, from the PX point of view, this format weakens its character, since it does not allow the periodic adjustment of the supply bids according to the evolution of the market and the agents expectations becoming a pool where instead of costs, half rigid prices are used.

In relation to the annual supply bids, the season of year when they are submitted is crucial. If the bids are done in the beginning, during or after the rainy season, it will have a direct impact over the amount of information the agents will have to commit their generation plants, since there will be a greater or smaller uncertainty on the resources available in the reservoirs. It seems then relevant that the supply bids must be done once the precipitation season has ended, and so the bidders will have a higher accuracy over the amount of water available.

B. Market Power

The biggest apprehension on this model is the market power, especially in Chile where the power generation is highly concentrated1, and the installed generation capacity does not exceed the demand with enough slack. This situation makes the PX – ISO model vulnerable to MP. This situation has been observed in markets with a smaller property concentration than the Chilean one. England/Wales and Colombia are good examples of this phenomenon.

The presence of a high hydroelectric component in the SIC, reaching approximately 60% of its installed capacity, introduces an additional factor that has to be included in the analysis: the strategic use of water resources. Endesa has a technology monopoly over the hydro resources, since it has rights over most of the Chilean rivers, while at the same time, it has an important market share. This kind of situation affects the potential competition and other benefits of this model, while at the same time, it places requirements and demands over the regulatory framework.

To have an idea about how much the prices could increase with free annual supply bids, some simulations have been done modifying the GOL model [4], and the results indicate that if each power station tries to maximize its own income, the energy price would rise a 17% on the average. Now, if the power stations owned by the same company cooperate and maximize the profits of the holding, the increase would be a 27%. Those results have to be taken with care, as the models utilized have several shortcomings and constrains.

In case of the second Chilean system, the SING system, the risk of facing MP is much smaller due the excess of installed capacity and the presence of industrial and mining consumers. These consumers are allowed to buy energy in the wholesale market. This means they bargain the energy prices with the generators without any intermediations. Almost 90% of the

1 In the SIC system three firms have a total market share of 93% (Endesa 55%, AES Gener 22%, Colbun 16%). In the SING system there are only four major firms: Tractebel 30%, AES Gener 28%, Endesa 22% and Southern Energy 20%.
demand belongs to the “big consumer” category. This means there is equilibrium between the supply and the demand. However, the challenge in this system is the development of a pricing system capable of assuring the continuity and reliability of the service. The explicit payment for ancillary services must aim to avoid episodes like the blackouts and the loosening of loads, occurred at the end of the 90s.

C. Transmission Constrains

Transmission constrains are surely, one of the bigger challenges regulators must face in designing electricity markets, particularly, the network congestion occasioned when the ideal dispatch exceeds the grid capacities. Actually this not only means the separation of markets, but also produces a situation against the market competitiveness and adds another strategic issue to be managed by the agents, in most of the cases, the supply bidders. They can take advantage of this situation and raise the prices. The Chilean transmission networks have a radial topology, due to the shape of the country; this characteristic enhances the presence of bottlenecks in the grids. The stochastic nature of the hydro resources in the SIC, changes the amount of energy generated by each kind of technology and therefore, the power flow direction will depend where the injected energy comes from. A rainy season increases the contribution of the hydroelectric power stations, located mainly in the middle and the south of the country. Dry season demands the generation of more electricity at the thermal units. This singularity can give MP no just to hydroelectric plant, but also to thermal ones when the hydro resources are scarce.

D. Responsible use of the hydro resources

The midterm uncertainty over the rainfalls makes the use of hydro resources a sensible issue, because the optimal use of the water, from a social point of view, will not always be aligned with the private interests of the power plants owners. An irrational use of the hydro resources, altogether with other contingencies can originate situations of electrical supply failures, like it happened in 1998 and 1999. As reported in [2] the strategic agents are able to restrict the water transferences from wet periods to dry ones, strategically diminishing the energy available in the system and artificially increasing the prices.

E. Capacity payments withdrawal

The change of law proposes to eliminate the present capacity payments. Although it means a step forward in the total liberalization of the market, this payment is a signal to expand the generation system and specially important for the entrance of new agents, since incoming generators are not likely to have their production previously committed in contracts and they will face the volatility of the spot market. The capacity payment is a financial mechanism that assures money flow stability, resulting in a lower discount rate in the investment project evolutions and making a larger number of business enterprises profitable. A raise in the energy prices to internalize this effect must compensate the withdrawal of the capacity payment. In October 2001, the capacity payment stands for roughly 20% of the energy final price.

IV. CONCLUSIONS

The Chilean electrical services law draft brings up conceptually correct elements to improve the current model: the independence of the market operator from the other agents, a pricing mechanism based on free supply bids and not in costs, makes the market process more transparent by avoiding controversies and diminishing entrance barriers. The accomplishment of open auctions and the introduction of financial instruments will aid the creation of a more robust and liquid market, considering the possible interconnection of the SIC-SING-Argentinean system would open the market to a greater number of agents. The new regulatory framework must deal with requirements like clear market signals, stimulating the investment in generation and reserve capacity and suitably remunerating these services to avoid, if possible, all supply failures keeping a service with high standards.

The high horizontal concentration in generation in Chile, together with the small slack between the installed capacity and the demand in the SIC, establishes exigencies to the regulatory frame to avoid MP and speculation in the PX. This statement is based on the fact that electrical systems like England/Wales and Colombia have experienced this type of practices with much lower property concentrations than the Chilean system.

The use of annual supplies bids, at least transitorily, aims to mitigate MP, although it is questionable, since this format denaturalizes the PX. The simulations become a must in order to know the real impact of a major change in the dispatch methodology and the competition within the industry. The strategic use of water is a subject that must be analyzed since the private interests not always will be aligned with the efficient use of the resources from the social point of view.

The presence of large mining and industrial consumptions in the SING, make the relation between buyers and sellers more equal than in others systems, mitigating possible monopolistic practices. The challenge of the SING system is the development of mechanisms that allocate and remunerate properly the ancillary services, to improve the services quality. Although questionable, the capacity payment’s withdrawal is a step forward in the market liberalization; a raise in the final energy price compensating the downward should be expected.

In the future it would be advisable to have a regulatory commission independent of governmental authorities, designing long-term power policies in consensus with the market’s agents.
V. REFERENCES


VI. BIOGRAPHIES

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