ABSTRACT

The international environment of electricity energy has changed dramatically since the beginning of the 90's. The introduction of competition to electricity generation and commercialization has been the main focus of many restructuring experiences of the electrical sector. The main goal has been to achieve better economic efficiency than the past centralized and often monopolistic environment. The open access and a fair regulated tariff for transmission assets have been the keystones in the development of the electricity market.

Many methodologies have been proposed to price transmission networks in order to send reasonable economic signs to the electricity market players. These methods such as the MW-mile, bus marginal cost, and others, usually incorporate the spatial nature of transmission systems giving the generation and consumer agents the opportunity to place their generation and load units at the most appropriated sites. To the agents that are already placed are offered the opportunity to influence on the transmission expansion plan in order to minimize the wheeling charges.

As far as generation goes, especially for thermal units, locating the assets where their production will be valued at best is of uttermost importance for the companies' future return on investment. Besides the transmission fare and the plant investment cost, an important portion of the total cost is the fuel cost. For natural gas plants, the fuel cost can be split into two parts: the production cost and the transportation cost. The gas transportation is usually performed by gas pipelines, which have similar characteristics with the electricity transmission network. Therefore, fuel supply conditions, as well as generation and transmission capacity constraints, have to be taken simultaneously into account in the investment decision making process. Synergies between electricity and natural gas systems have to be identified and economically quantified so that integrated decisions could bring in an edge to the investment company. In the long-term phase, the decisions are highly inter-dependent on gas and electricity sub-systems, which justifies an integrated analysis. Therefore, economic regulation of electricity transmission and gas transportation must be performed together and it will be shown in this thesis.

Pricing each of gas and electric networks has been well studied individually but there are few studies dealing with the combined approach. This thesis describes and applies wheeling methodologies, proposed initially for transmission network, in combination with the gas pipeline network. Transmission wheeling charge methods usually consider load flow equations, i.e., the static behavior of electrical systems. Therefore, a coherent method of pricing gas network must also use steady-state equations for the gas flow through pipelines. More emphasis is devoted to gas equations and simulation methods.

Studies case considering the Brazilian system demonstrate the importance of the wheeling charge regulation for both the gas and electricity systems. The economic regulation of grids is crucial when investment and operational costs of natural gas thermal units are under analysis. For such units the natural gas is the input and the electricity is the output of the production process.