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"Valuación de Inversiones en Infraestructura Eléctrica y Comportamiento Estratégico"

ANEXO 18
PGT 5.1 – Formulación de modelos multi-agentes – Informe

Agent-based learning model for assessing strategic generation investments in electricity markets

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Abstract—The liberalization of electricity markets has significantly changed the perspective of the power generation business. Nowadays, generation companies pursue economic goals due their investment decisions are based on expectations of profitability and the risk of their alternatives. These expectations are difficult to predict because they depend upon various factors that are highly uncertain, including both exogenous uncertainties -such as variations of demand and endogenous uncertainties - such as the behavior of competing generation agents. This paper proposes a numerical tool that financially evaluates investment alternatives of generation companies based on a novel adaptive learning technique that links the generation agents' experiences under the current situation considering their expectations of profitability and risk. In this model, the Agent-based Computational Economics approach has been applied. This method represents generation agents through autonomous and heterogeneous entities pursuing economic goals and interacting through computer models.

Index Terms-- Investment, Similarity Learning, Strategic Behavior, Uncertainty.

I. INTRODUCTION

The liberalization of the electricity markets is essentially characterized by the explicit separation of the three segments of the electrical system (generation, transmission, and distribution), through schemes of open and non-discriminatory access, and the introduction of competitive mechanisms in the generation sector [1]. In this context, the electricity sector has a hybrid system that combines segments of natural monopoly structures such as transmission and distribution systems, with the competitive segment in the generation sector.

The types of competition are two. On one side, the perfect competition, which describes the situation of a market that their participants have *no power* to manipulate the price, which leads to the maximization of social welfare. In this type of competition, the participants' decisions do not affect the behavior of other market players. On the other side, the imperfect competition, that their participants can influence partially or totally the price. In this type of competition, the *oligopoly* is characterized by a small number of suppliers, and it is a very frequent instance in the power generation industry due to the important barriers to entry, the endured economies of scale by the generation technologies, the capital-intensive involved, government regulations, etc.

The market behavior with oligopolistic competition is much more complex to describe. Participants can implement both short-term and long-term strategies to exercise market power, in order to increase their profits above competitive levels while raising entry barriers to limit or prevent new players from entering the market.

Long-term strategies that generation companies can implement are defined by their investment decisions. Economists define *investment* as the act of incurring immediate costs with the expectation of future returns that exceed the incurred costs and the opportunity cost [2]. The most common factors to consider when assessing the profitability of an investment project are: (1) the expected return, *i.e.* the profitability of the project, (2) the risk level, that is, the likelihood deviation from the expected return, and (3) the time horizon, in other words, the lifetime of the investment.

In the following, the main characteristics exhibited by investments in power plants, which substantially influence the investment behavior, are summarized:

- Capital intensive. It concerns to a business process that involves considerable amounts of money to install a proper facility. For example, hundreds of millions of dollars are committed for combined cycle power plants and even billions of dollars to nuclear plants.
- One-step investments. This implies that a high share of total expenditures must be spent at the beginning of the project (construction time, environmental permits, etc.).

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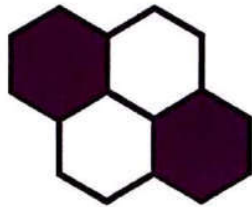
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