



Laboratório Nacional de Energia e Geologia

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### Funding Source:



## MAN-REM: Multi-Agent Negotiation and Risk Management in Electricity Markets

### Motivation

Electricity markets (EMs) are systems for effecting the purchase and sale of electricity using supply and demand to set energy prices. Two key objectives of EMs are ensuring a secure and efficient operation and decreasing the cost of electricity utilization. To achieve these goals, three major models have been considered: pools, bilateral contracts, and hybrid models.

Ideally, opening up the electrical power industry to competition would be an important tool to improve efficiency and benefit energy customers. Competitive forces would drive companies to innovate and operate in more efficient and economic ways. Innovation would lead to lower prices and better uses of energy resources. However, the analysis of important European electricity markets (e.g., the Iberian Market involving Portugal and Spain) yields the main observation that they are still far from liberalized. Stated simply, tariffs do not reflect the pressure of competition. EM simulators can give important contributions to this problem and a number of prominent tools have been proposed in the literature. However, most energy management tools present limitations concerning the application field, i.e., they are tailored to specific market models and/or particular market operations.

Multi-agent systems (MAS) represent a relatively new and rapidly expanding area of research and development. MAS can deal with complex dynamic interactions and support both Artificial Intelligence (AI) techniques and numerical algorithms. In this way, a multi-agent approach in which software agents are capable of flexible autonomous action in order to meet their design objectives is an ideal fit to the naturally distributed domain of a deregulated energy market. Accordingly, this project addresses the challenge of using software agents to help manage the complexity of EMs. It intends to go a step forward in the development of EM simulators.



## Partners:



## Consultants:



## Time Frame:

April 2012 – Sept. 2015

## Goals and Plan

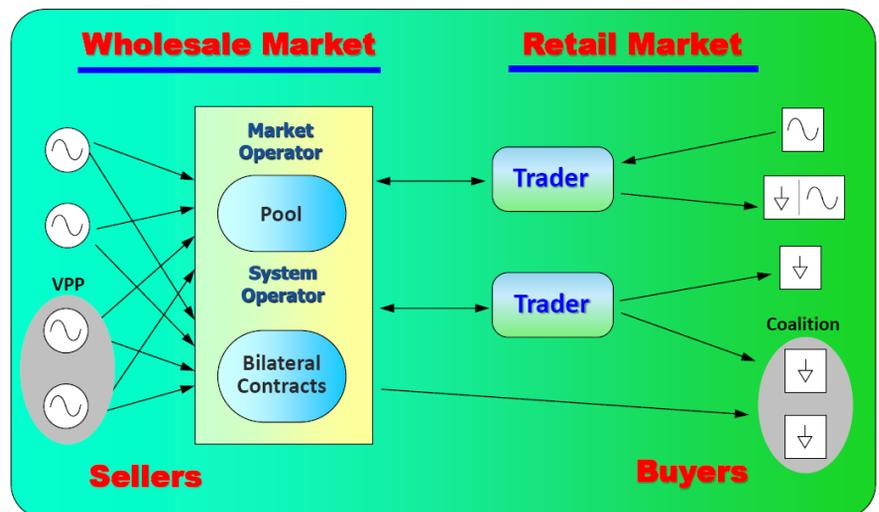
This project puts together the experience and expertise of a multi-disciplinary research team. Part of the team has been involved in the development of MASCEM, a multi-agent simulator for competitive electricity markets. MASCEM primarily focuses on pool negotiations and the strategic behavior of market participants. MASCEM strongest points are: (i) the use of sophisticated AI techniques for modeling market participants, (ii) a flexible and open approach supporting a diversity of models and tools for EM players, and (iii) a balanced approach of technical and economic issues.

This project shifts the focus of attention to bilateral contracts, customer coalitions, and risk management in contract negotiation. It both updates and extends MASCEM, accounting for a more integrated view of EMs. Specifically, the overall goal of this project is to develop an EM simulator enabling market participants to:

- negotiate the terms of forward bilateral contracts, consider dynamic pricing tariffs, reach (near) Pareto-optimal agreements, and unilaterally de-commit from contracts by paying de-commitment penalties;
- ally into beneficial coalitions – notably coalitions involving end-use customers – to achieve more powerful negotiation positions, and thus negotiate better tariffs;
- manage a portfolio of customers, taking into account trade-offs between the risk and return of bilateral contracts – notably contracts involving traders and customers.

Additionally, this project aims at integrating the EM simulator into the MASCEM system. The main expected result will be an improved energy management software tool able to simulate EMs in a complete and realistic way, thus overcoming most technical limitations of existing EM simulators.

Finally, this project will address the application of the energy management tool to the Iberian Market. The consideration of a real problem will provide additional challenges, making the tool more powerful towards ensuring the full benefits of deregulation. The research team will use the experience in EM simulation and the expertise in EMs and MAS to undertake the required progress of MAN-REM and to reach all the aforementioned goals and sub-goals.



**Electricity Market Participants**