A MAS Simulation Model for Trusted Local Energy Markets*

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Abstract. Electricity is one of the pillars of modern society. From agricultural production to transportation and heath care. Almost every area requires or greatly benefits from the availability of electric energy. Maintaining the electric system and further developing and improving it is certainly a desirable goal. This work explores the idea of a Local Energy Market and the challenges in implementing such a market with a focus in Trust. A Multi-Agent System model is proposed to allow the simulation of Local Energy Markets and evaluation of Trust models.

Keywords: Local Energy Markets · Multi-Agent Systems · Trust

1 Local Energy Market

The traditional Energy landscape is changing, more and more electric production is shifting to Renewable Energy Sources (RES) such as photovoltaic panels and wind turbines. This shift to RES is an improvement towards more ecological and green energy, however the resulting energy production is unpredictable with high fluctuation, something that is problematic for the main energy grid. A possible solution to deal with this new paradigm is the implementation of Local Energy Markets (LeM) [2] as a supplementary market for local energy trading. The LeM is an energy market based on energy trading performed by local participants of three different categories [4]: (i) energy consumer; (ii) energy producer; and (iii) prosumer, a consumer which also owns energy generation [3]. The base of a LeM is a Smart Grid [1], an energy grid with a cyber-physical system based on smart meters and communications mechanisms. Several authors have proposed LeM models [1, 4, 2], however important aspects such as security and market trust have been neglected. This work takes a focus in the trust domain.

The proposed model for the LeM simulation is a Multi-Agent System (MAS). A MAS [5] is a software system based on agents, which are pieces of software that are autonomous, pro-active and capable of social interaction. MAS are well suited for distributed intelligence, integration between different systems and distribution of computation tasks, which makes them ideal for this simulation. In this case, the MAS is composed of 3 different kinds of agents: (i) a Market

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Interactions Manager (MIM) agent, that manages the energy trading; (ii) Participant agents, which submit proposals to buy or sell energy according to their needs; and (iii) Sensor agents, that represent the cyber-physical system by reporting data to their respective participant. The MAS model communication structure is represented in Figure 1. To support the market it is also proposed a trust model used by the MIM capable of evaluating the behavior of participants and detecting faulty or malicious activities. This model attributes a trust value to each participant which is continually revised with every participation in the market accordingly to the participants historical and contextual data, and forecasted values. The trust value ranges from $[0, 1]$, this value is lowered or increased depending if the participant values matches what is expected by the forecasting mechanisms. A high value $[h, 1]$ represents a trusted participant. A medium values $[m, h[$ represents a participant who is viewed with uncertainty and is warned about this fact. A low value $[l, m[$ represents a participant with problematic behavior. Lastly, there is critical value $[0, l[$, a participant with this value is immediately prohibited from participating in the market. In low and critical trust scenarios, both the participant and responsible market authorities are warned about the situation and need to take steps to resolve it.

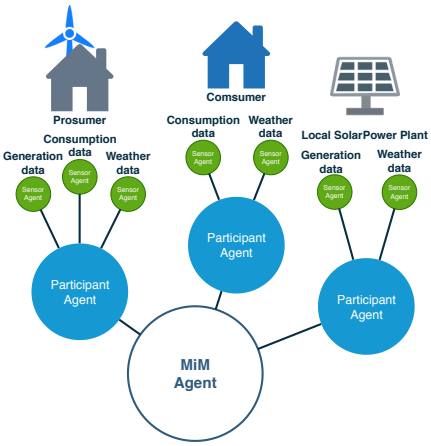

Fig. 1. Proposed MAS Model

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