Dynamic Pricing in Electric Power Markets Affected by Distributed Energy Generation using Agent-Based Modeling

Gasser G. Ali[1] and Islam H. El-adaway[2]

[1]Ph.D Candidate, Department of Civil, Architectural, and Environmental Engineering, Missouri University of Science and Technology, Rolla, MO 65409. E-mail: gasser.ali@mst.edu
[2]Hurst-McCarthy Hurst-McCarthy Professor of Construction Engineering and Management, Professor of Civil Engineering, and Founding Director of Missouri Consortium for Construction Innovation, Dept. of Civil, Architectural, and Environmental Engineering and Dept. of Engineering Management and Systems Engineering, Missouri University of Science and Technology, Rolla, MO 65409, E-mail: eladaway@mst.edu

ABSTRACT

The power infrastructure in the US is facing many challenges concerning capacity, reliability, and sustainability. Some of those challenges are associated with the integration of Distributed Energy Resources (DER) into the conventional grid system. DER may offer reliable and cost-effective distributed small-scale generation near or at end-consumers. However, it also creates new challenges for utilities and generating companies due to the uncertainties in estimating demands. Accordingly, the goal of this research is to investigate dynamic pricing in electric power markets considering the effect of the increasing penetration of DER. To achieve that goal, a complex System-of-Systems model that combines Agent-Based Modeling and Machine Learning is presented in this research. The model relies on Reinforcement Learning to enable dynamic pricing of electrical power in response to the shifts in demand resulting from the adoption of DER. Results of the emergent behavior of the complex SoS verify the interrelated causality between prices of electrical power and the penetration rate of DER, which is also called the Death Spiral. Ultimately, the presented framework should assist researchers and practitioners in the fields of electric power infrastructure and DER in investigating the pricing dynamics of agents in the electric power markets considering the effect of the penetration of DER.