Title: Learning-based optimization of distribution grids with renewables

Abstract
Electric distribution grids are challenged by the rampant integration of rooftop photovoltaics and other distributed energy resources (DER). This talk puts forth novel learning-based solutions for the planning and operation of grids with high DER integration. Regarding *planning*, DER interconnection studies can currently take months since they entail solving a large number of parameterized variations of the same optimization problem termed the optimal power flow (OPF). Leveraging the powerful toolbox of multiparametric programming, we can expedite probabilistic hosting capacity analyses (PHCA) by a factor of 10. For example, we were able to find the exact minimizers of 518,400 OPF instances by actually solving only 6,905 of them. Regarding *operation* of DERs and to address the challenge of optimally allocating DER resources in near real-time, we propose two physics-informed and communication-cognizant deep learning approaches: In the first one, a deep neural network (DNN) is trained to predict OPF solutions every time it is presented with new grid conditions. The novelty here is that the DNN is trained to match not only the minimizers, but also their sensitivities with respect to grid conditions, thus yielding a dramatic improvement on sample efficiency. The second approach consists of a decentralized control scheme, where each DER is modeled by a DNN and all such DNNs are jointly trained through an OPF formulation rather than the standard DNN learning procedures. Thanks to a flexible DNN architecture, the DERs can be partially driven by a common control signal depending on the available communication specifications.

Vassilis Kekatos is an Assistant Professor with the power systems group in the Bradley Dept. of ECE at Virginia Tech. He obtained his Ph.D. from the Univ. of Patras, Greece in 2007. He is a recipient of the US National Science Foundation CAREER Award in 2018 and the Marie Curie Fellowship during 2009-2012. He has been a postdoctoral research associate with the ECE Dept. at the Univ. of Minnesota, and a visiting researcher with the Univ. of Texas at Austin and the Ohio State Univ. His current research focus is on optimization and learning for future energy systems. He is currently serving in the editorial board of the *IEEE Trans. on Smart Grid*.