The integration of distributed energy resources (DERs), e.g., rooftop photovoltaics installations, electric energy storage devices, and flexible loads, is becoming prevalent. This integration poses numerous operational challenges on the lower-voltage systems to which the DERs are connected, but also creates new opportunities for provision of grid services. In the first part of the talk, we discuss one such operational challenge – ensuring proper voltage regulation in the distribution network to which DERs are connected. To address this problem, we propose a Volt/VAR control architecture that relies on the proper coordination of conventional voltage regulation devices, e.g., tap changing under load (TCUL) transformers and switched capacitors, and DERs with reactive power provision capability.

In the second part of the talk, we discuss one such opportunity – utilizing DERs to provide regulation services to the bulk power grid. To leverage this opportunity, we propose a scheme for coordinating the response of the DERs so that the power injected into the distribution network (to which the DERs are connected) follow some regulation signal provided by the bulk power system operator. Throughout the talk we assume limited knowledge of the particular power system models and develop data-driven methods to learn them. We then utilize these models to design appropriate controls for determining the set-points of DERs (and other assets, e.g., TCULs) in an optimal or nearly-optimal fashion.