As the technology behind renewable energy sources becomes more advanced and cost-effective, these sources have become an ever-increasing portion of the generation profile of power systems across the country. While the shift away from non-renewable resources is generally considered to be beneficial, the fact remains that renewable sources present unique challenges associated with their individual generation profiles. Because of the high variability of renewable resources, the stability of the system can degrade. Generators assigned to regulate frequency, keeping it close to the desired 60 Hz, are forced to ramp up and down quickly in order to supplement the rise and fall of the variable resources, causing transient frequency deviations, power swings, major interface transfer variations and other significant issues.

This research aims to measure the impact of renewable resource penetration level on power system stability. Currently, the generally accepted amount of regulation (non-renewable, rapidly-dispatchable reserve, used as a back-up to base generation on a short time scale to avoid stability issues) is 1% of peak load. Because of the high variability associated with renewables, including wind (the focus of this thesis), this value is expected to need an increase of at least a few percentage points. The primary objective is to quantify the amount of regulation necessary to maintain marginal stability as a function of the penetration level of wind generation.

Once this functional relationship is established for the base case, the influence of additional controllable parameters will be considered to determine if the measured regulation level can be decreased while maintaining the same desired stability for a given wind penetration percentage. The increased cost of additional regulation is of fundamental concern; modulating these additional controllable parameters may ease this burden.