UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	Duke Energy	**Date Submitted**	July 11, 2018
Project Title	Meter and Device Placement for Duke Distribution Circuits (DUKE_METR3)	**Planned Starting Semester**	Fall 2018

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person. Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical		Electrical	3
Computer	1	Systems	
Other ( )			

Company and Project Overview:

About Duke Energy: We are one of the largest electric power holding companies in the United States, providing electricity to 7.6 million retail customers in six states. We have approximately 49,500 megawatts of electric generating capacity in the Carolinas, the Midwest and Florida – and natural gas distribution services serving more than 1.6 million customers in Ohio, Kentucky, Tennessee and the Carolinas. Our commercial business owns and operates diverse power generation assets in North America, including a portfolio of renewable energy assets. We are transforming our customers' experience, modernizing our energy grid, generating cleaner energy and expanding our natural gas infrastructure to create a smarter energy future for our customers.

Increased electrical energy usage and network intricacy has mandated a change in how electric utilities model and monitor their system. A transition from manual modeling using paper maps to electronic Geographic Information Systems (GIS) to keep accurate models of the transmission and distribution networks has been needed to keep up with this complexity. Telecommunication improvements and implementation of Smart devices have given the utilities increase in data from the devices and control of the devices using Supervisory Control and Data Acquisition (SCADA) software. The leveraging of GIS data and communication and control of devices on a distribution network has given rise to applications to help observe and operate the grid optimally called Distribution Management Systems (DMS). A relevant application of advanced DMS is their use in managing voltages in distribution feeders with high penetration of utility-scale distributed photovoltaic (PV) sources.

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Project Requirements:

This project will investigate applicability of using Integrated Volt/Var Control (IVVC) strategies to mitigate voltage variations caused by high PV penetration. The objective will be to define the monitoring and control devices needed, and where in the system they should be placed, in an attempt to minimize number of monitoring points (and data accumulation) while maximizing system visibility to achieve IVVC for voltage management. The goal would be to perform an engineering study based on sensitivity analysis of system node voltages with respect to changes in power flow to identify appropriate location of measurement and voltage regulating devices (e.g. voltage regulators, capacitor banks). A set of insights and guidelines on device placement should emerge from the analysis.

This project is a follow-on to the "Meter and Device Placement in Duke Circuit Model" project that was completed in May 2018.

Expected Deliverables/Results:

- Written report describing results of detailed engineering study on optimal device placement, including:
  - Evaluation of various device placement schemes based on their performance with IVVC applications provided in the DMS
  - Evaluation of effectiveness of the 4-3-2 rule to place normally-open and normally-closed devices (placing reclosers every 400 customers, or 3 miles, or 2 MW of lead) based on metrics of interest (to be selected) as sensing locations. Knowing that these rules of thumb are to be applied with Duke Energy's "Self Optimizing Grid" program, and that these devices are assumed to contain high quality sensors, is there a need to add additional sensors locations.
- Model of the test feeder and power flow analysis results including various penetrations of distributed generation

Disposition of Deliverables at the End of the Project:

No hardware to disposition.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

- Power Systems background
- Math and Control System background