UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*CAPER*	**Date Submitted**	*7/30/2020*
Project Title	*Battery Energy Storage Analysis* **(CAPER_BATT)**	**Planned Starting Semester**	Fall 2020

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical		Electrical	4
Computer		Systems	
Other ( )			

Company and Project Overview:

CAPER Overview
The Center for Advanced Power Engineering Research (CAPER) is a membership driven consortium among several universities and industry partners in the Southeast region of the US. The main mission of the center is to develop and demonstrate grid modernization technologies and enhance the educational experience for students in electric power engineering. With an aging infrastructure, rising demands for cleaner electricity and extreme weather conditions, the nation's utilities are working to meet these operational and planning challenges while maintaining a resilient and reliable grid. As a collaborative effort, CAPER will develop research and demonstrate advanced technologies to meet the operational and expansion needs under uncertainties with an increased penetration of distributed renewable generation. Its Industry Advisory Board (IAB), composed of numerous industry partners, meets twice per year with CAPER researchers and students to conduct business and to engage in discussions about the Center's research and education activities. The project results will be presented at the CAPER conference in each semester at the location to be determined by the CAPER Board. These two events are excellent networking and educational opportunities for the student team.

Project Requirements:

Declining solar costs and an increased focus on reducing the carbon footprint has led to rapid penetration of distributed solar facilities. In order to mitigate the intermittency inherent in these resources, energy storage is being deployed to allow utilities to efficiently and reliably operate their grids.

To date much of the installed energy storage has been lithium-ion based chemistries.

Students will be asked to cost effectively design a battery energy storage system that is capable of mitigating distribution circuit voltage sag, voltage flicker and solar intermittency.

Sizing and location of the system will need to be considered when calculating cost effectiveness of the system.

Duke Energy to Provide:

- CYME circuit models of Rankin Ave Ret 1208
- Per Phase Watt and VAR 5-minute measurements from the feeder circuit breaker for 2019
- Per Phase Watt and VAR 5-minute measurements from the existing DG recloser solar generation for 2019
- Per Phase Watt and VAR 5-minute measurements from the existing voltage regulators, source and load sides for 2019

Expected Deliverables/Results:

Fall Semester Deliverables:

- Research the following BES Management schemes for application on the circuit: PV firming, energy time shift & peak demand reduction
- Model given feeder in simulation software (CYME, OpenDSS, SINCAL or Matlab is recommended)
- Incorporate given load profiles, validate simulation of power flow and identify the baseline existing circuit issues
- Complete review of available distribution BES chemistries and technologies and select optimal technology for price/performances (Examples include: flow battery, lithium ion, lead acid, etc.)
- Model selected BES and PV system in steady state software
- Incorporate BES management scheme into circuit simulation

Spring Semester Deliverables:

- Evaluate performance of selected BES and management scheme for given circuit and load profile with consideration given to savings due to demand shift, PV firming, increasing hosting capacity, etc.
- Find optimal location of one or more of the BES systems to maximize value
- Emphasize differences in operational efficiency between the distribution feeder with and without your Solar+BESS system for year seasons and three selected PV profiles (highly intermittent, overcast and clear)

Disposition of Deliverables at the End of the Project:

Present results at the Spring 2021 CAPER conference that will be held in either NC or SC, location TBD. Deliver final report to technical supporter at the end of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If

none please state none):

- Strong interest in the Power Generation field
- Knowledge of Cyme , SINCAL and Open DSS Software
- Ability to travel to status meetings that will be held off-campus. Presence is required at ALL off-campus meetings.
- CAPER has two conference meetings each year. On in the Fall and one in the Spring. The locations of the conferences will be in NC or SC. Past meetings have been held at Clemson (either main or Charleston campus), NCSU or UNC Charlotte, but meeting locations may be anywhere in the Carolinas. The student team is required to present their results to the full CAPER organization each semester. ALL STUDENTS FROM THE TEAM MUST ATTEND AND PRESENT AT EACH OF THE TWO MEETINGS. THIS IS NOT OPTIONAL, ATTENDANCE AND PRESENTATION BY EACH STUDENT IS A REQUIREMENT OF THE PROJECT AND COURSE. FAILURE TO MEET THIS REQUIREMENT WILL ADVERSELY AFFECT THE INDIVIDUAL GRADES. Due to the Covid situation, conferences may be virtual attendance.
- Travel costs will be covered by the team's project budget.
- Faculty mentor must also attend the student presentations at the CAPER conferences