



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

Senior Design Project Description

Company Name	Duke Energy Foundation - CAPER	Date Submitted	April 4, 2018
Project Title	Hybrid Energy Storage (CAPER_STOR)	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	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.

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. However, this chemistry has some drawbacks when compared to ultra-capacitor technology.



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Students will be asked to cost effectively design a hybrid 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 2017
- Per Phase Watt and VAR 5 minute measurements from the existing DG recloser solar generation for 2017
- Per Phase Watt and VAR 5 minute measurements from the existing voltage regulators, source and load sides for 2017

Expected Deliverables/Results:

Spring 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 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

Fall 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 3 selected PV profiles (highly intermittent, overcast and clear)

Disposition of Deliverables at the End of the Project:

Deliver to CAPER representative

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

- Strong interest in the Power Generation field
- Knowledge of Mat Lab and Open DSS Software
- Ability to travel to status meetings that will be held off-campus. Presence is required at



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ALL off-campus meetings.

- CAPER has two conference meetings each year. One 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.** Travel costs will be covered by the team's project budget.
- Faculty mentor must also attend the student presentations at the CAPER conferences (Conference fee will be paid from Project budget).