UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*Duke Energy*	**Date Submitted**	*7/24/20*
Project Title	*Load Profiles of Customer Classes and Feeder Voltage Profile* **(DUKE_VOLT2)**	**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	3
Computer	1	Systems	1
Other ( )			

Company and Project Overview:

Duke Energy is one of the largest electric power holding companies in the United States, providing electricity to 7.6 million retail customers in six states. Duke Energy has 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.

Load profiles, also known as load schedules or load curves, define the typical power usage of a group of customers across the course of an average day. Typically, customers have been grouped according to their type - e.g. residential or commercial. Lacking detailed customer load data, utilities have determined load profiles based on assumptions and examples, but few assumptions and examples have included the effect of modern loads such as LED lights and electric vehicles, or Behind The Meter (BTM) resources such as solar generation and battery energy storage. Therefore, utilities need updated load profiles. Due to increased deployment of Advanced Metering Infrastructure (AMI), Duke Energy has access to detailed customer load data that can be used to evaluate the accuracy of existing load profiles and to develop more accurate ones.

Project Requirements:

The senior design team will analyze AMI data to determine how well the measured load data matches the DMS Load Schedules currently being used at Duke Energy. They will determine how accurately each customer category's load curve matches the DMS load schedule, and how well the aggregated load curves across a distribution circuit match the actual power usage on that circuit across the course of a typical day. The team may use the load curve analysis tools developed by last year's team.

Leveraging this knowledge, the team will construct a proposal to improve the DMS Load Schedules to better fit the measured load measurements from AMI. This may involve creating new customer categories based on the AMI data, or updating the load schedules for the existing customer categories, or any other method that will improve the accuracy of the DMS Load Schedules. Regardless, the total number of load schedules should be kept minimal and simplified. Reactive power curves based on the typical power factor per customer type will also be required. Additional data points can be used in this analysis including AMI voltage data or seasonal temperature data.

Once the proposal is approved, the team will implement their proposal, and create an automated tool which will repeat their work in the future with minimal engineering involvement. The tool should be designed to accept any substation CSV file along with any AMI dataset, and to output a DMS load schedule in the specified format. The program should also be able to handle seasonal AMI measurement data gaps and abnormalities that can arise. Time based analysis should be done carefully and fully documented since time-of-day & day-of-year is important to load schedules. Statistic techniques should be used to validate improvements to the seasonal load schedules.

The team will investigate the effect of BTM resources such as solar generation, electric vehicles, and/or battery energy storage on load profiles. Using this knowledge, the team will develop an automated way to detect the existence and impact of BTM resources. To account for these resources' contribution to the customer load profile, the team will generate updated load profiles for loads which include BTM resources. Alternately, the team may prove by research that specifies load curves for BTM resources is not valuable to grid operations and planning.

Additional customer categories should be determined from the given set of Residential, Small Commercial (single-phase), Medium Commercial (Multi-phase load less than 100KVA), Large Commercial (3-phase load greater than 100KVA), and Industrial categories. These insights should be applied on per season with real-power curves, calculated to the same nominal base, and include separate curves for native load & BTM generation.

Expected Deliverables/Results:

- A detailed report specifying how well each customer category's load curve matches the DMS load schedule, and how accurate the load schedules are for the given Duke Distribution Feeder.
- A script or tool which automatically generates DMS load schedules using AMI data. The program must be created using open sourced tools like Excel VBA, Python3+, Perl, Batch, R, etc.
- A manual on how to run the load schedule tool.
- A report summarizing the analysis process, the accuracy of the existing DMS load schedules, and the newly developed load schedules and their associated benefits.
- A similar report with a focus on load schedules affected by BTM resources.

Disposition of Deliverables at the End of the Project:

Output to be exhibited at the May 2021 expo then given to the Industry Supporter.

dware developed is the property of the Industry Supporter.

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

- Power and Energy Focus – Preferred.
- Programming and Data Analytics experience – Preferred.
- Power system analysis courses taken or in progress – Desired
- Statistics course taken – Desired
- Knowledge of DMS is a plus.
- For the Systems Engineering student:
    - SEGR 3110 (required)
    - SEGR 4141 (required: completed or 2020 Fall)
    - SEGR 4961 (preferred)