Modeling the Impact of Solar and Ocean Energy Integration on the Reliability and Resiliency of the Eastern North Carolina power grid system

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INTRODUCTION

- Beaufort county North Carolina has a population of 47,079 people with a household size averaging 2.5 people per house [1]
- Beaufort county consists of four solar farms and one power generation plant [2]
- Beaufort county is provided power to by both Dominion Power and Duke Energy[3].
- Little information is provided to show how solar farms affect the existing grid.
- By modeling this area its believed that by increasing the number of solar farms within the system it creates a more stable energy generated from the solar farms.

MATERIALS & METHODS

- The area of focus is the customers served by Tideland EMC in Beaufort County, NC.
- The power grid in the area was mapped out using grid information from Tide land EMC and GPS distance data [3].
- Used population maps and average household size in conjunction with monthly customer usage to determine the load of the area[4]-[6].
- Irradiance data from a local PV generation site was used to create a irradiance of the area was used to determine the generation profile of Eastern North Carolina [7].
- Simulink was used to model the load and generation data of the area. This data can be analyzed to determine the power generation of the PV sites in the area.

RESULTS

Beaufort county residents are served by Tideland EMC. Tideland purchases power from Duke energy and Dominion Power [3].

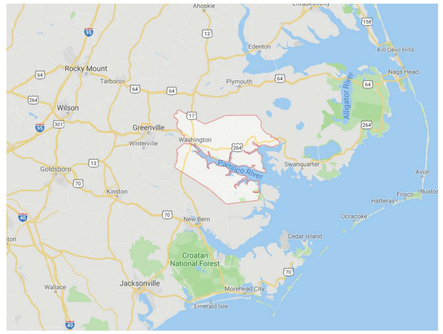

Figure 1. Image of Beaufort county, NC from Google Earth

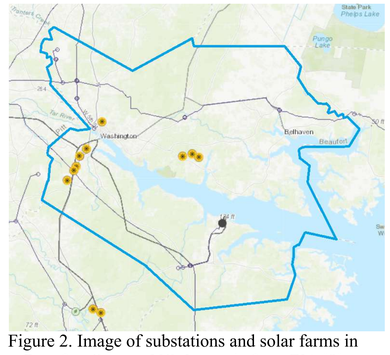

Figure 2. Image of substations and solar farms in Beaufort County, NC. Image is from EIA [2]

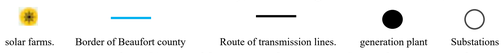

Figure 1. shows Beaufort county in relation to North Carolina. Figure 2. shows the route of the transmission lines that server Tideland EMC and the locations of substations and power generation sites. Dominion power serves the substations to the north of the Pamlico sound and Duke energy serves the substations south of the Pamlico sound.

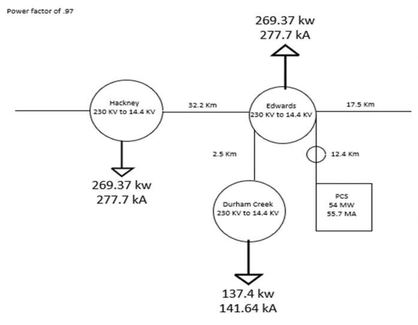

Figure 3. A simplified schematic of the southside substations and PV generation sights

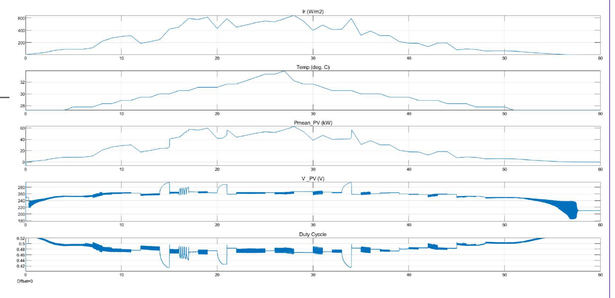

Figure 4. The power generation results from the MATLAB model

Figure 3. shows how the area was broken down into a simpler circuit make it easier to model. Breaking the area down by each substation so that the initial model only contained a source, load and generation site the models can then be combined to show the entire area. Figure 4. shows how the power generated based on the irradiance and load curve. The results show that the voltage has a inverse relationship to the duty cycle and that the power generated has a direct relationship to the irradiance the panel receives.

DISCUSSION

- Using a working computer model can help understand existing solar farms and future power generation sites impact the power grid.
- Using comparable data from local PV generation sights, to determine the amount of irradiance that Eastern North Carolina receives, and population density data.
- The model simulate the power output of the PV sites in addition to simulating a dynamic load that affects the power grid from users.
- Developing the model further would allow a better understanding of additional power generation not only in solar, but also wind and wave generation.
- Model could be used to better understand the sustainability of microgrids during storm damage [8],[9].

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