Powering and Empowering a Community: Designing and Implementing a Microgrid for The Cape Eleuthera Island School

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GLOSSARY OF TERMS

ISLANDING Operating a renewable energy resource independent from the macrogrid.

MACROGRID An interconnected energy ecosystem including energy generation, distribution, and transmission networks.

MICROGRID A small network of electricity users with a local source of energy that is able to function independently of a macrogrid.

kWh A measure of energy equivalent to a power consumption of 1,000 watts/hr

HISTORICAL CONTEXT

With special permission, the Cape Eleuthera Island School (CEIS) first connected renewable energy generating equipment to the grid in 2005. Since then, the government and utility regulators have implemented an official national energy policy and interconnection standards, limiting commercial ratepayers to ≤ 50 kW of solar generation.

Currently, CEIS exceeds the permissible limit (50 kW), and is seeking inventive solutions to self-generate more energy and become and energy island*. Solar + storage has a relatively short payback period and provides the opportunity to set precedent for the Bahamas by demonstrating that a microgrid* is an effective way of obtaining energy.

1. 61.4 kW solar electric installed
2. 40% electricity generated
3. 306 solar modules

METHODS

To adhere to the goal of CEIS scientific research, there was a singular focus on the feasibility study of a microgrid* (Figure 1) at CEIS this Fall 2018 semester.

CEIS has been actively monitoring energy use since 2008, providing reliable energy production and consumption data for 10 years. Using energy data exported to a .csv file , and imported into HOMER models thanks to the efforts of Asante Energy.

HOMER models (Figures 2 & 3) are a way for us to conceptualize how different microgrid* configurations would perform on our campus, highlighting for us both time of day and time of year, energy export and import. Further, these models provide a baseline cost (Figure 4) for each of the considerations, allowing CEIS to developing funding proposals.

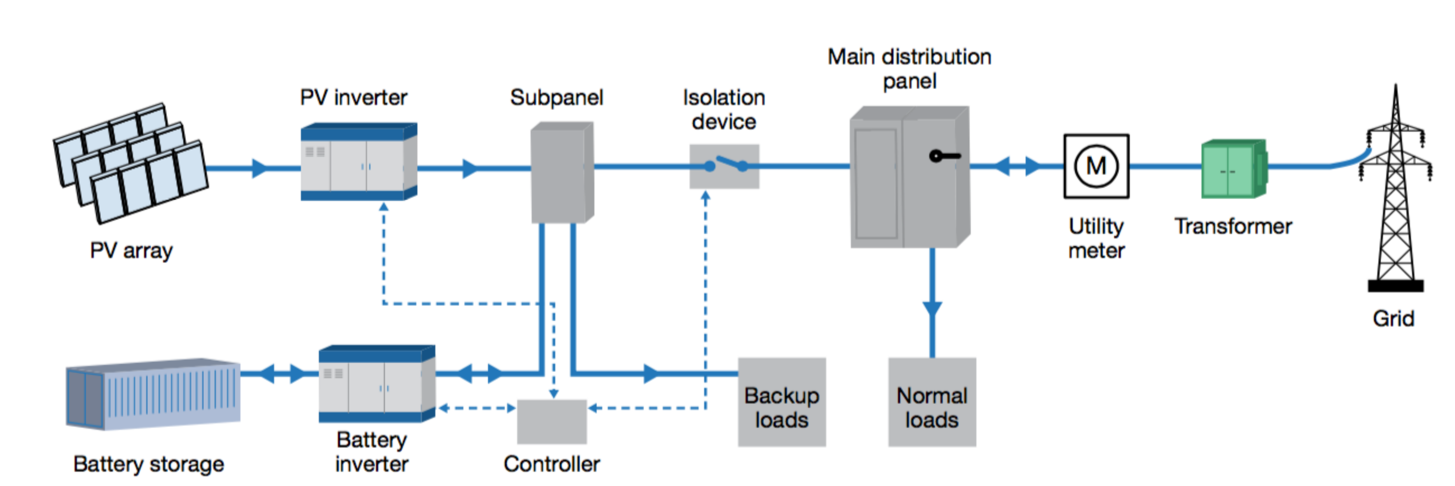


Figure 1: Schematic of example microgrid system (Colavito & Micheal, SolarPro, 2015)

RESEARCH QUESTION

How we do power The Cape Eleuthera Island School community, with new or existing renewable energy resources, while adhering to the guidelines of the current national energy policy?

SOLAR AS A SOLUTION

The cost of oil imports in the Bahamas, and therefore energy generation by the utility company, is fluctuating monthly. Due to this unpredictability, along with the the carbon cost of fossil-fuel power generation, imported energy from the grid is not a sustainable solution for CEIS.

The dollar per watt ($/W) ratio is lower than ever in 2018 for both module costs and installation cost. The global average for commercial arrays is $0.60/Wdc and $2.25/Wdc respectively. Module efficiency is higher than ever, and our location, with 5.8 peak sun hours (PSH) is ideal for optimal solar collection.

Shifting to a fully autonomous system of solar plus storage ensures resilience through not only economical storms, but environmental as well. Solar modules and solar racking systems can withstand increasing storm strengths when installed properly, powering our campus after the harshest of storms.

ENERGY AND FINANCIAL MODELS

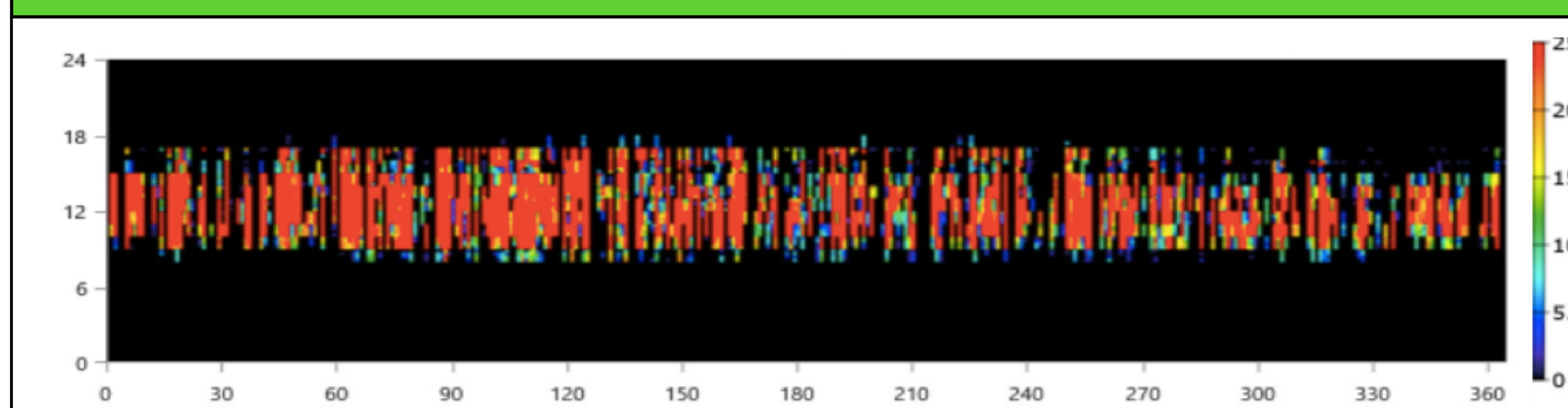


Figure 2: Energy exported to grid (kW)

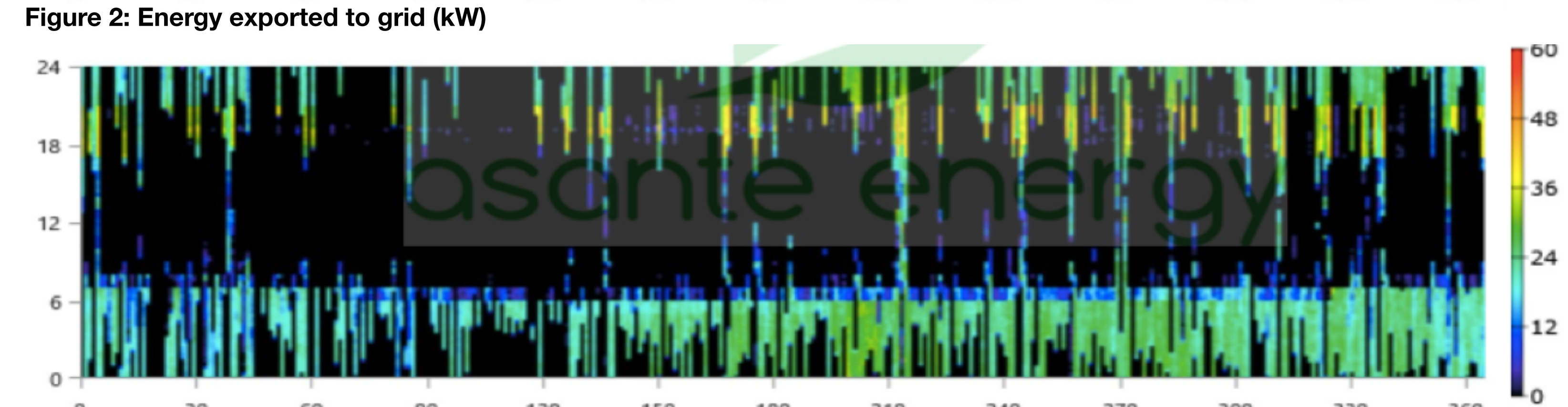


Figure 3: Energy imported from grid (kW)

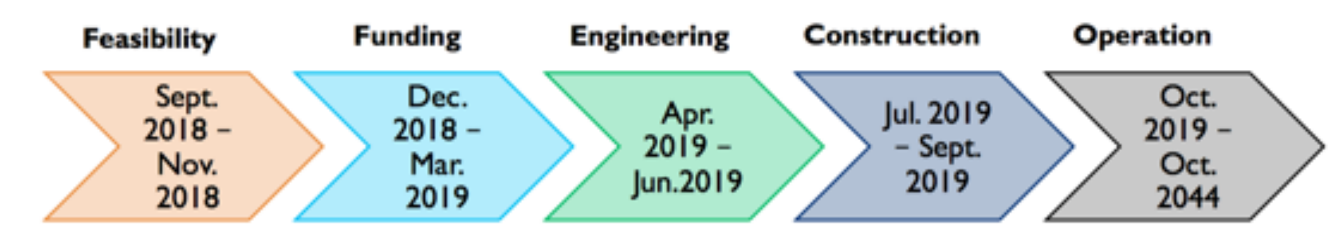
PROPOSED MICROGRID NET PRESENT COSTS

NAME	CAPITAL	OPERATING	REPLACEMENT	SALVAGE	TOTAL
Bahamas Power & Light	$ 0.00	$ 173,804.00	$ 0.00	$ 0.00	$ 173,804.00
Bergey Wind 10kW	$ 0.00	$ 2,586.00	$ 19,128.00	$ 10,780.00	$ 10,934.00
FG Wilson Generator 36kW	$ 0.00	$ 0.00	$ 0.00	$ 5,839.00	$ 5,839.00
Li-Ion Battery	$ 195,922.00	$ 44,584.00	$ 89,019.00	$ 8,851.00	$ 320,675.00
PV Module Array	$ 398,817.00	$ 5,324.00	$ 0.00	$ 0.00	$ 404,141.00
Microgrid System Converter	$ 12,508.00	$ 0.00	$ 5,307.00	$ 999.81	$ 16,816.00
Microgrid System	$ 607,248.00	$ 226,297.00	$ 113,455.00	$ 26,469.00	$ 920,531.00

Figure 4: Modeled net present costs for proposed microgrid

TIMELINE

CSD researchers this semester were primarily focused on *FEASIBILITY* in the timeline. This involved the analyzation of HOMER models, consultations with professionals Asante Energy and Saint Eustatius Utility Company, and siting locations for new solar generation. There are two options for this array; ground mounted and roof mounted arrays. Roof mounted arrays utilize already present space while ground mounted arrays can be oriented to optimize the solar resource and increases module efficiency. Additionally, the researchers put together a funding proposal to fund the project. The next steps until the microgrid is fully functional involves funding, engineering, construction, then operation.



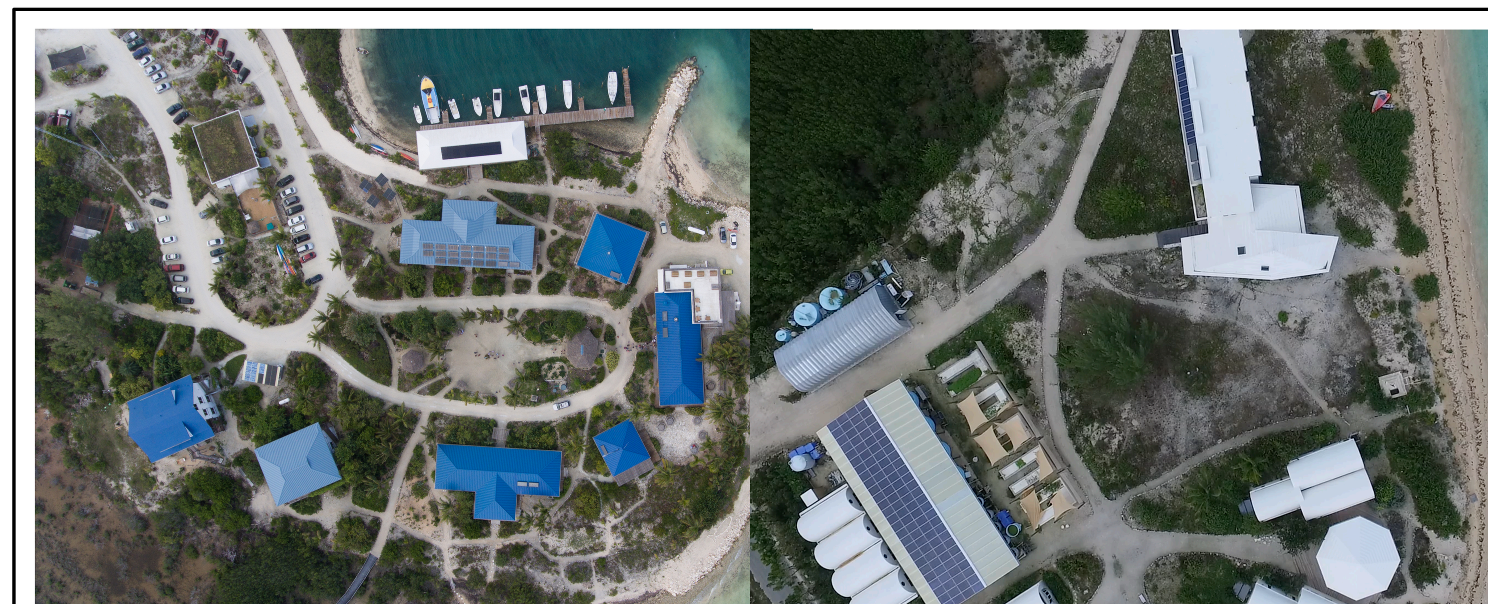


Figure 5: Existing grid-connected solar resources on CEIS campus.

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Michael Vance - President, Asante Energy
Fred Cuvalay - CEO, St. Eustatius Utility Company (STUCO)

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