

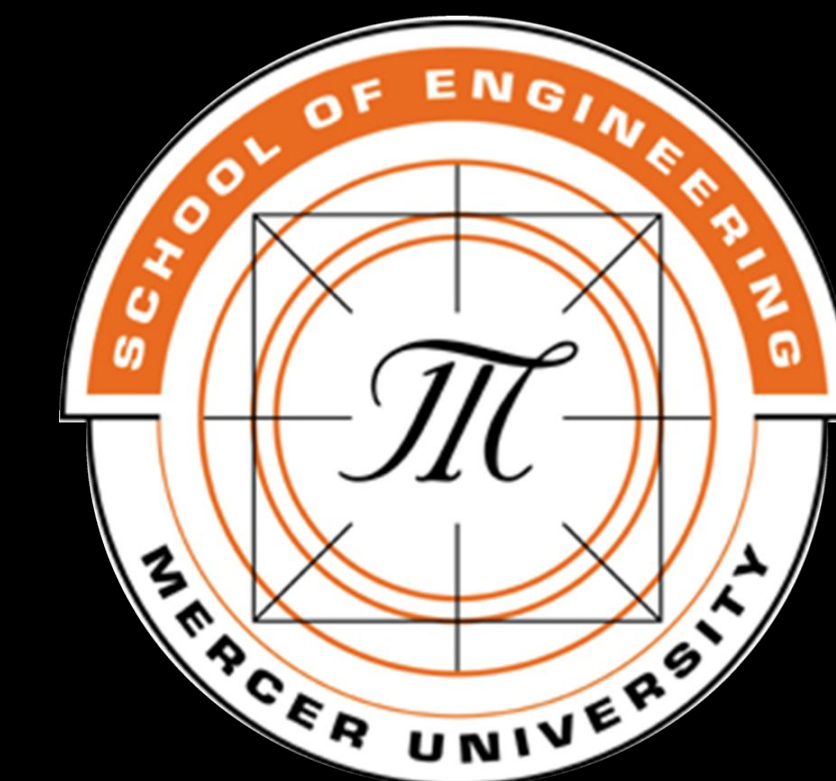


Optimizing Home Energy Efficiency and Solar Power

Alviez Chagan, Michelle Graham

Faculty Mentor: Dr. Michael MacCarthy, Director of Engineering for Development Program
(e4d.mercer.edu)

Mercer University - School of Engineering, Macon, Georgia



Abstract

Solar photo-voltaic (PV) installations and energy efficiency of materials and appliances used in homes can be costly and limit low income communities from participating in moving away from dependence on non-renewable resources. Habitat for Humanity homes are often very suitable for solar PV installations considering their long-term no interest loans, energy star certifications, and considerable vetting of homeowners for financial stability/independence. The solar PV installations would be financially beneficial to the home owners, helping them to save on monthly energy bills while also contributing to overall sustainability of their community and helping improve the research throughout the years with all the data collected. These solar PV installations and material/appliance evaluations will help promote energy-efficient practices and use of renewable energy systems in central Georgia and beyond. The solar PV systems that are installed on each home will be designed to be affordable, durable, and expandable. Installation will help Habitat contractors, staff, and university students to learn the process and repeat on other homes and in other communities, with a medium-term goal of developing a sustainable local market for cost-effective household solar PV installation in central Georgia.

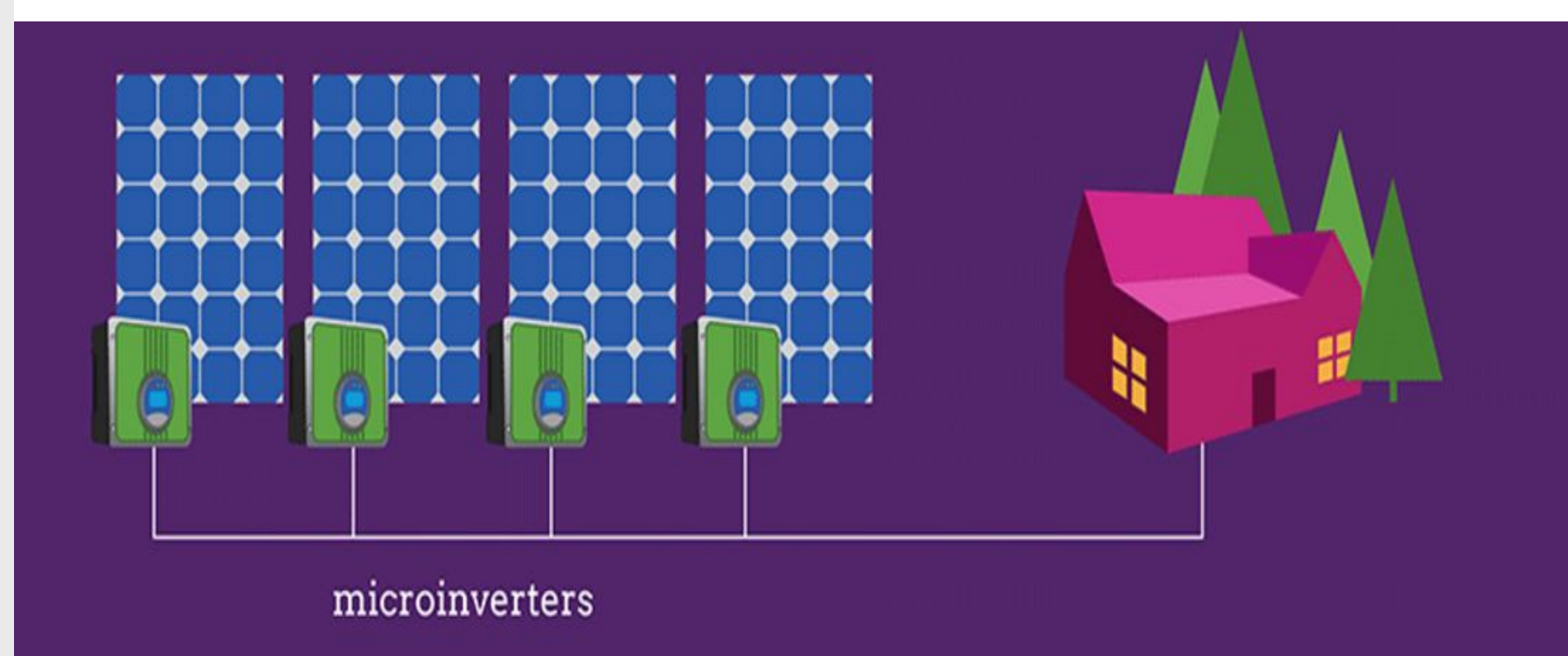


Background

Many households in the Middle Georgia area source their power from a coal-fired power plant, Plant Scherer. Plant Scherer, located in Juliette, Georgia, is one of the largest point-source greenhouse gas emitters in the United States. Because of this, homeowners in this region are in a unique position, as they have the opportunity to directly reduce emissions from this plant. One way that homeowners can do this is through the adoption of residential solar photovoltaic systems. While solar PV is a promising technology, many homeowners are dissuaded from adopting it due to high initial costs and long payback periods. Along with this, 25.7% of people in Macon, Georgia live below the poverty line, compared to a US average of 11.8% (US Census, 2018). Our research aims to create low-cost solar PV systems that are feasible for low-income homeowners. This technology would reduce electricity bills, increase home value, and decrease use of coal-fired power, empowering communities and protecting the environment.

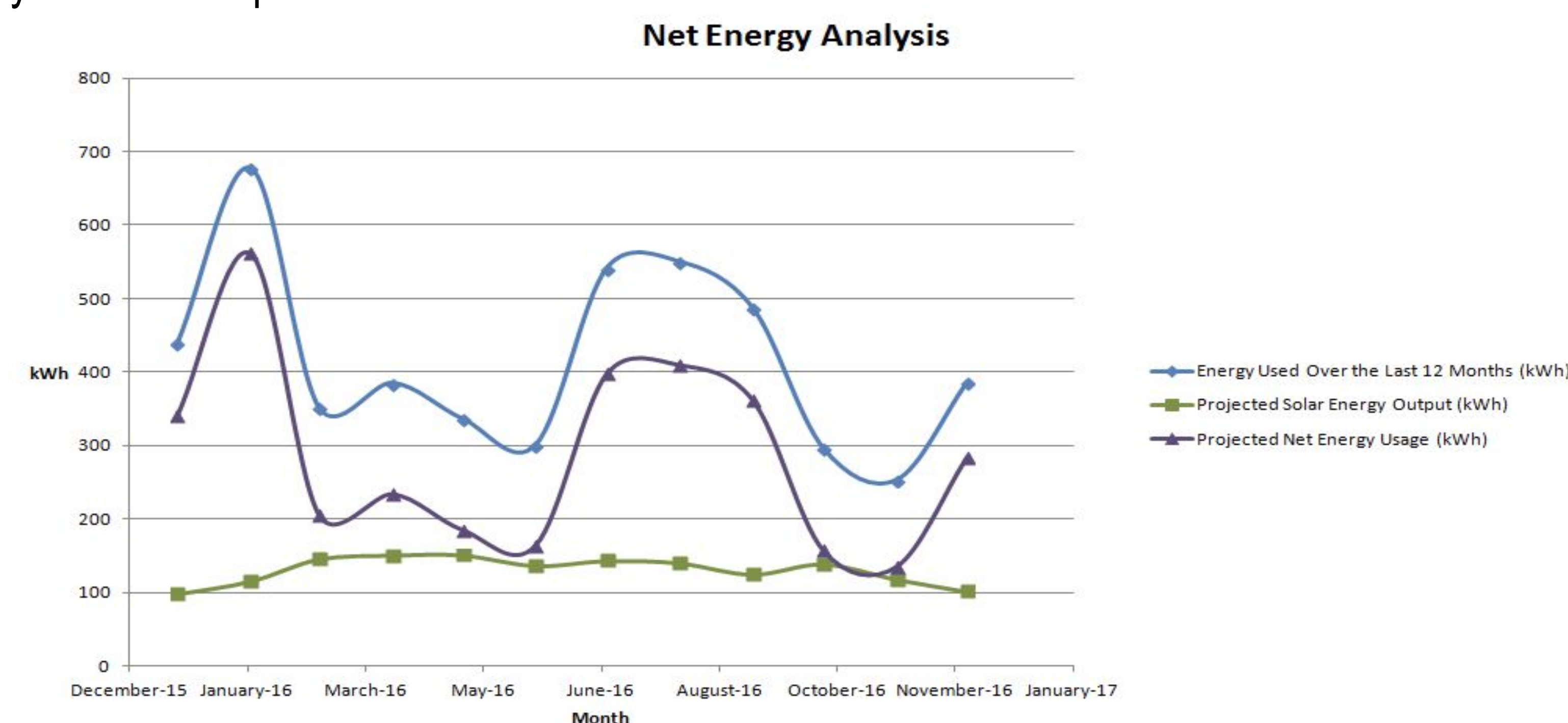
Research Summary

- 1.1 kW "pilot" system installed on a home in 2016
- System was comprised of two LG 280W panels and two Canadian Solar 270W panels
 - each panel was fitted with an Enphase microinverter
- System produces 5-7 kilowatt-hours per day (kWh/day)
- System is expandable up to 10 kW, meaning that savings and green energy production increase with each new installation



Results

- The 1.1 kW system cost around \$3520.15 which included materials, shipping, and labor
 - The previous 30% federal tax incentive brought the overall cost down to \$2440
- Saves 20-30% of the monthly energy used of a household this size
 - The energy cost savings of the system are estimated to surpass the system cost in less than 7 years
- Saves an average of 3190 lbs of carbon/year
- Once the system has paid itself off or the homeowner is financially capable, the system can be expanded (with the electrical components capable of supporting a 10kW system) to hold up to 10 kW of solar panels
- The system has required no maintenance since 2016

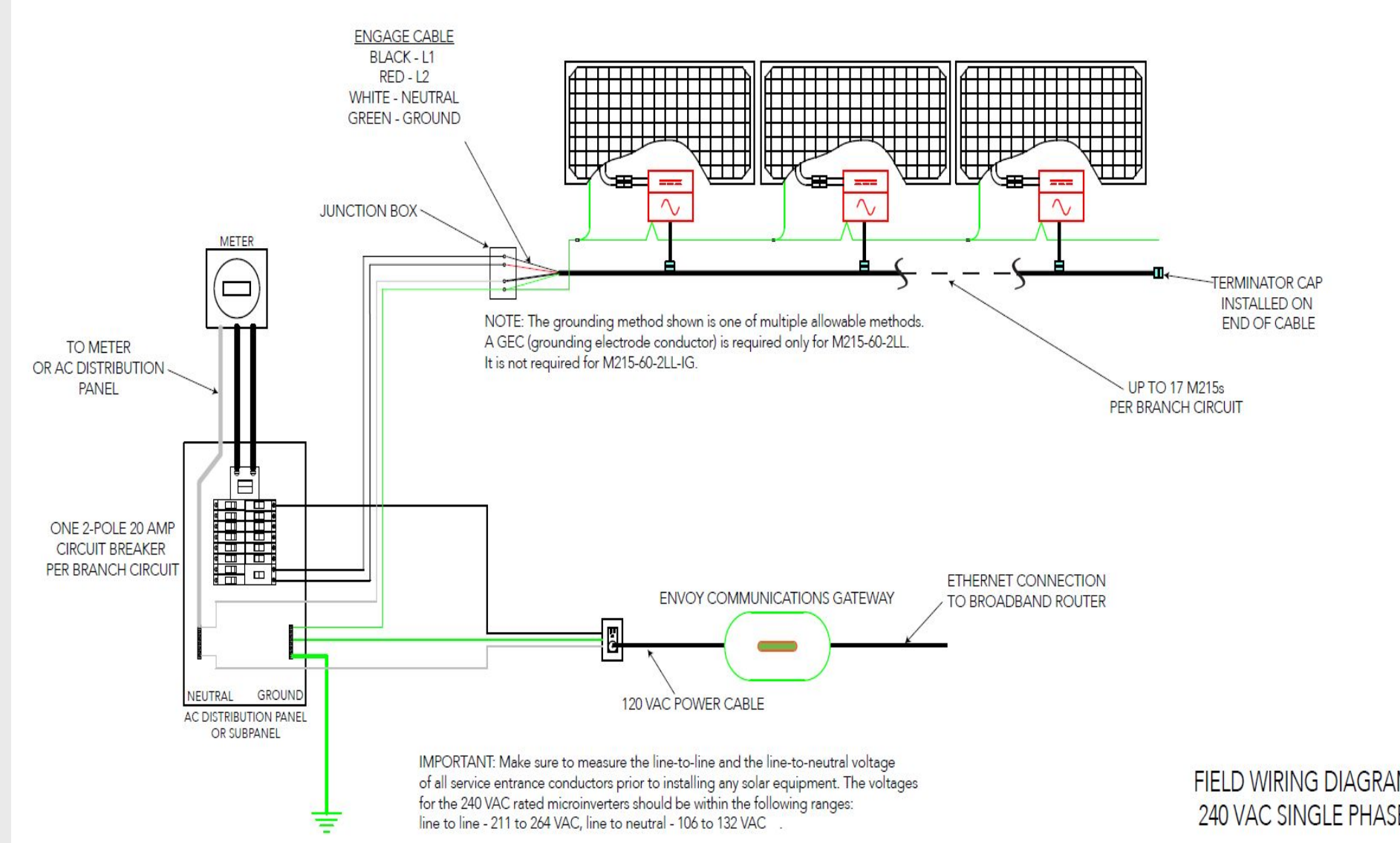


Ongoing Work

Currently, our research team is collaborating with Macon's chapter of Habitat for Humanity (HFH) to install another low-cost solar PV system in a newly built HFH home. We are using a similar configuration as the pilot system previously installed, but with several updated components and system improvements.

This system is expected to:

- Have a net cost of <\$2,000
- Start at 1.4 kW
- Produce ~1,700 kWh/year
- Save the homeowner ~\$200/year



Future Work

- Continued collaboration with HFH to install and monitor low-cost solar PV systems
- Air flow and heat transfer modeling within home, in order to better understand where energy losses occur and how they can be prevented
- Life-cycle analysis of home building materials, with a goal of being able to select the most sustainable materials for home construction

Acknowledgements & References

Dr. Michael MacCarthy, our faculty mentor, for his technical expertise, Gabriel Ramirez, for his initial work and contributions to the continuation of this project, and Mercer University's 'Research that Reaches Out' Quality Enhancement Plan for funding the project.

U.S. Census Bureau QuickFacts: Macon-Bibb County, Georgia. (2018). Retrieved from <https://www.census.gov/quickfacts/fact/table/maconbibbcountygeorgia/IPE120218#IPE120218>. Highest CO2 Emitting Power Plants in the World (Report). Washington, DC: Carbon Monitoring for Action (CARMA). Retrieved August 31, 2015, from: <http://carma.org/plant>