Sociotechnical Synthesis
(Executive Summary)

Shifting Energy Use Dynamics: The Changing Energy Patterns of Large Institutions and Disadvantaged Communities

In 2019, the United Nations stated that one of its top priorities is to "Ensure access to affordable, reliable, sustainable, and modern energy for all"(Wu 2019). This goal is in response to the millions of people who do not have access to a consistent and constant energy supply. Because of this phenomenon, known as energy poverty, people sacrifice other needs such as comfort or necessary expenses in order to keep their electricity running. In some circumstances, renewable energy may be able to mitigate the economic strain of energy generation. Many options such as household rooftop solar and on-property wind energy generation can allow for individual households to generate their own electricity. In turn, this ability gives people the option to become more independent from the electricity grid.

On a larger scale than the individual household, some institutions are committing to carbon neutrality. In order to do this they will need to be in better control of their energy supply and operate more independently from the electrical grid. The technologies required to achieve this independence are referred to as distributed energy technologies. These technologies allow for institutional campuses to generate, store, and deploy energy at varying times of the day. A prime reason that institutions are employing this strategy is to utilize greater amounts of renewable energy and reduce their carbon footprint. Potential solutions include geothermal storage and generation, thermal energy storage tanks, rooftop solar, and deploying electric vehicles to act as electric batteries.

The University of Virginia is one of the institutions that is looking into distributed energy technologies in order to meet their commitment of achieving carbon neutrality by 2030. In order

to do this, they will have to completely restructure their energy consumption patterns. A major part of the technical project my team and I completed was looking into how the University can achieve this restructuring. Currently, the University has three electrical substations that take in energy supplied by Dominion Energy and distribute it out to the various facilities. Fontaine Research Park is a developing campus about a mile off of central grounds. It has its own metered substation that is Sherwood Substation, which allowed our team to hone in on what its energy development will look like in the near future. We analysed what effect distributed energy resources, specifically thermal energy storage, will have on the site. The technical project, "Behind the Meter: Implementing Distributed Energy Technologies to Balance Energy Load in Virginia", looked at how distributed energy resources will affect institutions, such as the University, and then also looked at a broader effect, the state of Virginia. This was done using linear predictive modelling that was coded in R using historical data from UVA proxy buildings. The findings from Fontaine were then scaled up to the state level to see if distributed energy resources could reduce the temporal variability of the energy grid if renewables became a larger part of the energy grid. The results were disappointing in that thermal energy storage systems did not have a large effect on the energy grid unless they were scaled to non feasibly large conditions.

To achieve our analyses for the technical project, we enlisted the help of UVA Facilities Management. Specifically, Jesse Warren, Ethan Heil, Edward Scott Martin, and Justin Callihan assisted us in understanding the energy operations at the University. In using the TEMOA analysis tools, Roger Zhu and Jeffery Bennet helped us to incorporate the distributed energy technologies we were focusing on into our models.

References

Wu, J., & Wu, T. (2019). Goal 7-ensure access to affordable, reliable, sustainable and modern energy for all. https://www.un.org/en/chronicle/article/goal-7-ensure-access-affordable-reliable-sustainable-and-modern-energy-all