Behind the Meter: Implementing Distributed Energy Technologies to Balance Energy Load in Virginia
(Technical Report)

An Actor-Network Analysis of the 2011 Texas Power Grid Failure
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Socio-technical Synthesis: Distributed Energy Technologies for Grid Reliability

My technical work and STS research both address the electric power grid, looking specifically at how energy eventually reaches consumers from the original point of generation. However, the two projects differ in their time perspective and location. My STS research looked to the past by analyzing how the Texas power grid failed during an unusual, severe winter storm in 2011, while my technical work looked to the future by investigating the implementation of distributed energy technologies on balancing load on Virginia's power grid.

My technical project investigated implementing distributed energy technologies, specifically heat recovery chillers and thermal energy storage tanks, to balance load on the grid at both an institutional and statewide scale. These load-shifting technologies are critical to reducing peak energy consumption which is important for ensuring the reliability of the electric grid, accounting for the variability of renewable energy generation, reducing annual institutional electricity pricing (which is based on the previous year's peak energy demand), and managing the effects that climate change might have on our power grid. Using the University of Virginia's Fontaine Research Park as an institutional case study, my capstone team designed a predictive model to forecast when peak energy demand will occur to inform Facilities and Management of the potential installing a thermal energy storage tank might have on reducing peak load. We then extended the scope of our research to the entire Commonwealth of Virginia to simulate the ways in which these types of interventions might play out for the whole state.

My STS research focused on how the power grid failed to provide reliable energy to its customers. Actor-network theory analysis brought my STS research to conclude that the Electric Reliability Commission of Texas (ERCOT), the independent system operator for the electric grid in Texas, was responsible for the power grid failure by failing to adjust actor roles in the network. While ERCOT was ultimately responsible for the network failure, my research also found many other adversary actors, mainly weather and failing generators.

The knowledge gained from working on these two research projects simultaneously added value to each. The winter storm that hit Texas in 2011 was unusual at the time. Unfortunately, more unusual weather events will occur as climate change worsens. My STS research on the Texas power grid failure highlighted how important working on the future of load-shifting technologies is to ensuring electricity reliability. The failure of the past created urgency in my technical work. Similarly, my technical work identified other actors, the heat recovery chillers and thermal energy storage tanks, that ERCOT could have recruited in the network to better ensure the integrity of the Texas power grid. In summary, working on my technical project and STS research together allowed me to use experiences from the past to motivate work for the future.