12-10-2020

Modeling Performance of Microgrid and Electric Vehicle Technology on the Utah State University Electric Distribution Network

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MODELING PERFORMANCE OF MICROGRID AND ELECTRIC VEHICLE TECHNOLOGY ON THE UTAH STATE UNIVERSITY ELECTRIC DISTRIBUTION NETWORK

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Background

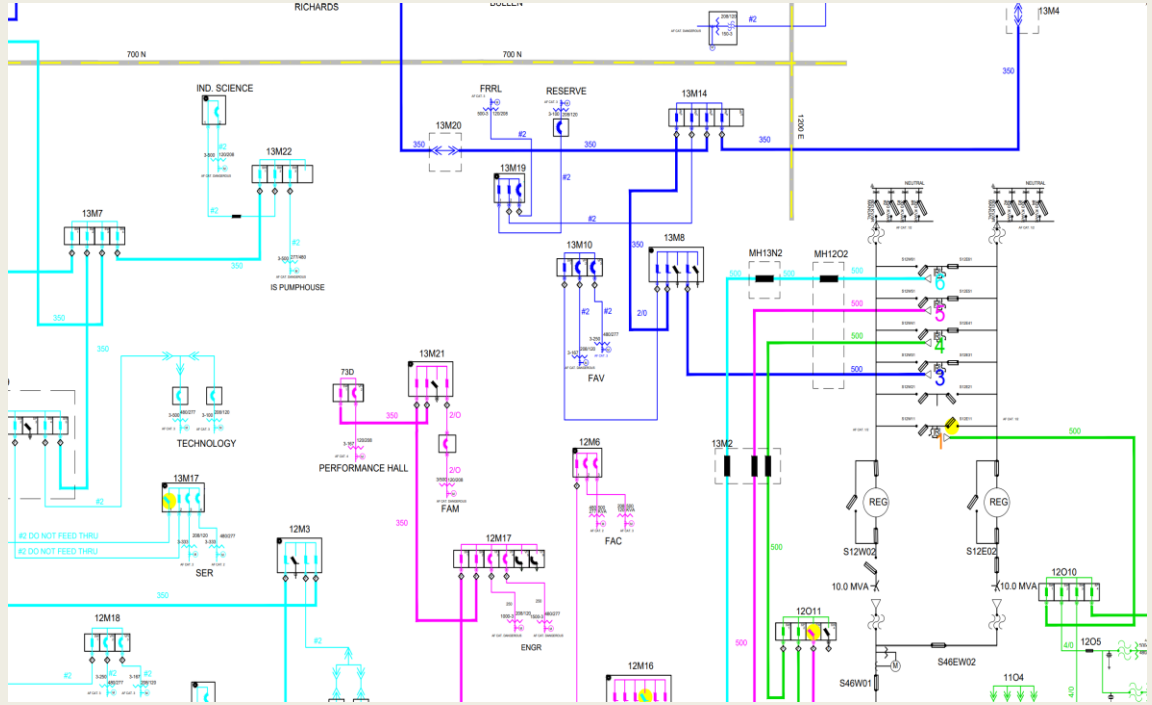
- The top priority of any electrical grid operator is to keep power always flowing, this supersedes consideration of cost or environmental impact
- As a result, deployment of electric vehicle charging is impeded by risk of overloading the network
- Grid simulation can determine the limits of a distribution network, and can help model the costs and benefits of solar power, battery storage, and EV charging

Project Goals

1. Develop a model of the USU Campus electrical distribution network
2. Simulate real loads on the network using real meter data
3. Simulate new loads and generation on the network
4. Analyze results of simulations and determine ideal levels of solar, storage and EV technology

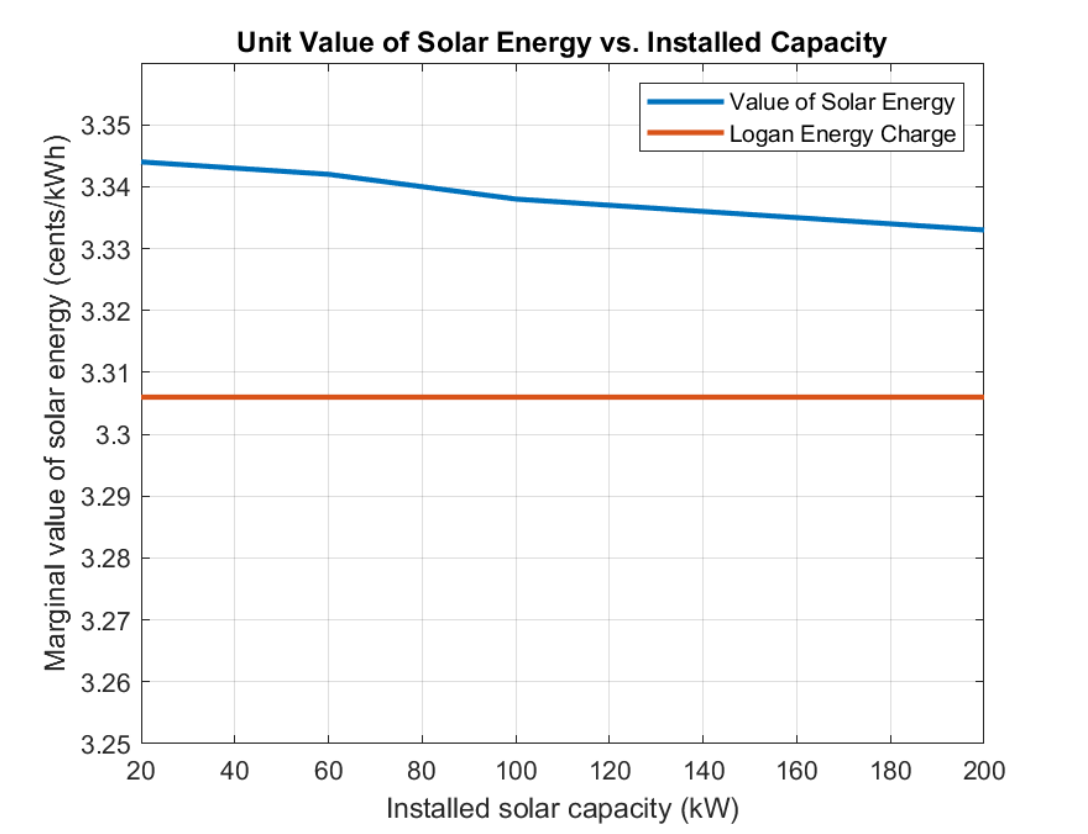
Model Construction

- The model was constructed using the OpenDSS simulator tool
- USU Facilities provided access to their one-line diagram, their cable and transformer databases, and the Logan electricity rates schedule
- The project focused on the southeast half of the campus network
- There are around 60 unique loads on the network
- Facilities provided nearly a year of meter data for around 50 of the loads



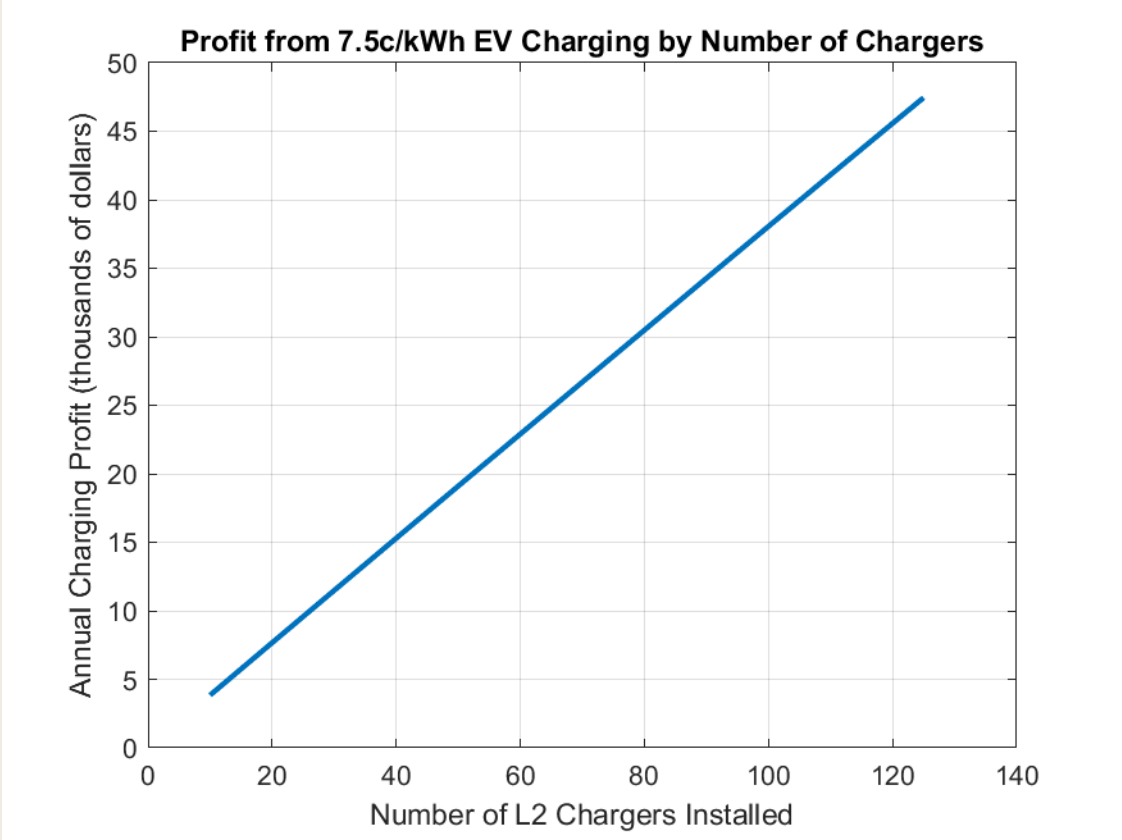
Solar Value Calculation

- USU's unique rates schedule requires time-of-use to be considered on top of total energy
- Simulations were performed for solar deployment from 20 kW to 800 kW
- In all cases, the value of each kWh was not much more than the Logan energy charge (about 1% more valuable)
- On the current rate schedule, solar power is not very economical, although real capacity factor could make a major difference
- Payoff in 43 years at 16% capacity factor
- Payoff in 24 years at 29% capacity factor



EV Charging Capacity and Costs

- Simulations show that with 200 kW on the roof, the new parking garage can support 125 chargers year-round with the grid's existing capacity
- By throttling charging speed during high-demand periods, at least 75 more chargers could be supported with existing infrastructure
- USU's rate schedule allows for low-cost charging
- Public charging could serve as a significant revenue stream for USU while providing low-cost charging for drivers



Battery Backup Capabilities

- Solar power and EV chargers do not create a financial case for installing battery storage, but battery storage can provide backup in the event of a blackout
- The average blackout in the US is about two hours
- USU currently operates diesel-powered backup generators to handle blackouts
- The south interconnection of campus uses 2750 kW on average. This requires 2750 kW of power capacity and 5500 kWh of energy storage to weather a blackout
- Tesla's Powerpack costs about $539/kWh, and traditional generators cost about $400/kW. A battery system would cost $2.965M, whereas the generators should cost $1.1M.
- Battery storage reaches price parity with diesel generators at $200/kWh

Conclusion

- Under USU's current rate structure, solar and storage provide little financial benefit at current prices, but could become worthy investments as costs decline
- Electric vehicle charging can be conducted very affordably using the available capacity on the network and could be deployed in higher numbers given some level of active management
- Opportunities for future research:
  - Determine optimal locations for chargers across campus
  - Show how altering USU's electrical capacity purchase can improve value of solar and storage technology
  - Apply simulation to show how a new load on a utility's network will affect purchase of wholesale electricity

Special Thanks

- USU Facilities, source of system specifications and meter data
- Dr. Regan Zane, faculty mentor
- USU Office of Research and College of Engineering, funding sources for the project

Questions?