Heila Technologies: Tariff Price Calculation for Use in Micro-Grid Optimization Algorithms

Abstract
During the course of my internship, I worked on different aspects of the Optimization & Control pathway for Heila’s technology. The aspects I worked on were data pre-processing, price calculator, bill calculator, and post-processing functions.

Introduction
The diagram below helps to give an idea of the larger Optimization & Control functions of Heila. The aspects that occur in the cloud are indicated by a cloud icon, while those that occur on the EDGE node are indicated by the chip icon. A key part of my work was making sure that the aspects I worked on that would be done on the EDGE (namely the price calculator) would be able to run quickly and not use unnecessary storage on the EDGE.

Background Research
I spent time looking at rate structures in use by PG&E as well as those used by clients that Heila is working with. These rate structures included both demand and energy charges. Energy charges are based on the amount of energy consumed over a period of time (measured in kWh). However demand charges, used primarily for commercial and industrial customers, are measured in kW and are based on the power consumed at a single point in time. Rate structures may include only energy charges, or may include both energy and demand charges. Possible rate structures include TOU rates (time of use: different costs for energy at different hours), tiered rates (different costs for energy at different tiers of use), TOU-tiered rates (a combination of TOU and tiered), or flat rates.

In addition to looking at the rate schedules, I also read existing Heila white papers. This helped me to understand the overall scope of the technology as well as the potential use-cases for an automatic plotting function that I worked on later on.

Methods
On the pre-processing side, I worked to create an automatic plotting function, as I mentioned previously. This function allows for Heila’s graphs to be neater, more standardized, and easier to create for future presentations and white papers. This came in handy as I worked on providing graphs for an investor presentation in early August. I also cleaned data for several of the projects that Heila is currently working on.

Discoveries
Incorporating all of the aspects of the diagram in Figure 1, we were able to produce optimization simulation results for projects that Heila is currently working on. Using the post-processing bill calculator, we were then able to see how much the customer saved on a monthly utility bill without using Heila’s tools, with prescient (perfect) data, and with forecasted data.

Additionally, the plots below show the scheduled costs (determined by the price calculator) and how the optimization algorithms caused the micro-grid to react.

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Figure 1: Optimization and Control pipeline

Figure 2: The demand and energy time-of-use rates on a weekday and weekend, for one of Heila’s clients.

For the price calculator and bill calculator, my work built off of the existing work done by those working for LBNL on their EcoBlock project, a project that Heila is also contributing to. My role involved testing the existing price calculator and bill calculator and altering it to work more smoothly within Heila’s framework. I removed dependencies, for example in the price calculator, that would take up too much space on the node. I also created functions that would allow one to directly edit the tariff structures we used. I also worked on making sure the outputs of the bill calculator were useful for future analysis. I made changes to allow for more tiers to be used and more types of tariff structures to be used. I also made template tariff structures for Heila to use as projects with new tariffs were used in the future. Outside of my work on this, I helped to run simulations of the the optimization algorithms, as shown in the Discoveries section.

Figure 3: Bill saving for prescient, predicted, and counterfactual load data. Client 1 on the left and Client 2 on the right.

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Figures 4 and 5: Figure 4 shows a simulation for three days (March, 4, 5, and 6, 2020), using perfect or prescient load data. Figure 5 shows a simulation for two days (December 1 and 2, 2019) using predicted data rather than perfect data.