DR19.02 – Pomona Mosaic Battery Control and Optimization

OPPORTUNITY

WHAT IS THE PURPOSE OF THIS PROJECT?

This project was designed to conduct research related to the design, interconnection, installation, commissioning, system performance, customer objectives and grid impacts of the installed energy storage system and solar photovoltaic array at Mosaic Gardens at Pomona. The lessons learned and best practices were captured and delivered as knowledge transfer to key constituents within various departments in Southern California Edison. The primary objective of this project was to demonstrate how customer storage can be leveraged and to quantify impacts to both customers and grid stakeholders.

Figure 1: Photos of BESS and PV Systems

Background

This project was conducted at an apartment complex operated by Linc Housing in Pomona, California. The building is a three-story low-income residential development consisting of forty-six apartment units on an infill lot. The targeted tenants are low-income qualified, with half the units designated for those who are identified as displaced or without shelter. The units are projected to reduce energy usage by as much as 1,350 kWh compared to a current unit built to code.

Customer energy resource adoption trends are forecasted to increase substantially in the Southern California Edison (SCE) service territory in the coming years. Under current energy and climate policy changes and reliability challenges, incentives in California and other areas are now paving the way for rapid storage adoption. SCE's research interests in customer-owned storage are emerging and broad, and as customers increase their adoption of solar-plus-storage systems at the multi-family level, SCE seeks to understand how these systems can:

- Create incremental grid value in locations with demonstrated needs, such as areas with reliability-related service interruptions or distribution circuits experiencing high loads.

- Create incremental customer value above the typical use case for PV-paired battery systems. Efforts may help to unlock additional customer value streams, such as increased customer satisfaction or incremental customer revenue streams from grid deferral.
- Provide “stacked value” benefit streams with solar plus storage and how those can impact customer perceptions, customer education, and awareness of the use and benefits of PV-paired battery systems for future models of DR programs.

TECHNOLOGY

WHAT IS THE TECHNOLOGY?

This project incorporates four 15 kWh battery energy storage systems totaling 60 kW with two solar arrays having a total power capacity of 34 kW AC. Three smart inverters, each capable of outputting 11.4 kW AC, are installed at the site. The solar and storage systems are DC-coupled, with two of the three inverters each connected to two of the four battery cabinets. See Figure 2 below for a system diagram.

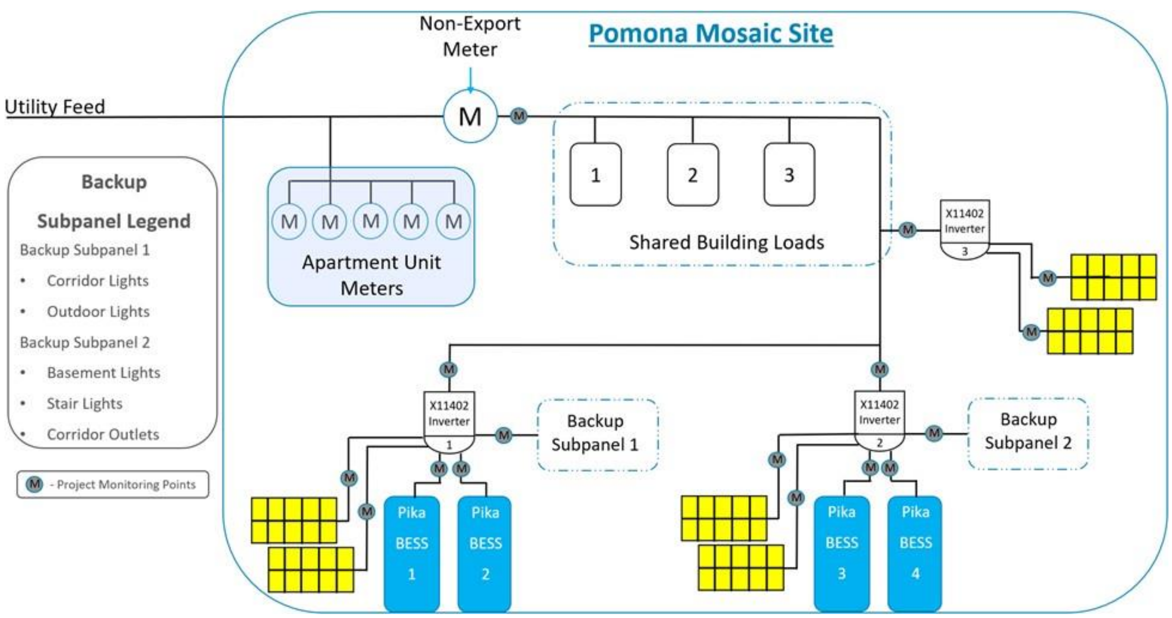

Figure 2: Diagram of Electrical System

Two monitoring systems provided data collection for the project. One inverter is a solar-only inverter operated consistently in Grid Tie mode. The battery inverters are able to operate in many more modes, including—but not limited to—Priority and Clean Backup, Self-Supply, and Time-of-Use modes.

Energy storage was added to the site, with a rooftop photovoltaic solar system. The project pairs four battery energy storage systems totaling 60 kW with two solar arrays providing a total power capacity of 34 kW. Two 11.4 kW smart inverters connect with the batteries and the PV systems, while a third inverter operates in solar-only mode. The solar-plus-storage systems allow operation in a variety of modes to serve both customer and grid needs.

APPROACH

WHAT WAS THE EVALUATION APPROACH?

Tests were conducted over the course of a year, using the different control modes and collecting data from test instruments. Power consumption and production will be recorded on a time and tariff rate basis. On weekdays, the system is expected to charge up during the morning hours, starting around when the PV begins to generate. Assuming a typical, sunny Southern California day, the 60 kWh battery connected to an inverter rated for a maximum charge power at around 20 kW should be able to charge the battery system in approximately 4 hours, starting from first sunlight (this accounts for the ramp-up of solar generation in the morning hours). The actual system topology of the site is two sets of 11.4 kW rated battery-connected inverters that are each connected to two 15 kWh battery cabinets, though the simplified, high-level configuration and calculation holds. With the battery system fully charged at that time, any remaining rooftop generation produced would be used to power other community loads. During weekends, the Clean Backup operating mode will have the battery recharge from solar PV production. The battery will remain at full charge throughout the duration of the weekend unless a utility outage occurs. Of course, throughout the course of the weekend, some energy will be lost in the form of self-discharge losses, which should be relatively small, but nonetheless measurable.

FINDING

WHAT WERE THE MAJOR FINDINGS?

Self-Supply Mode-

The battery energy storage system was placed in Self-Supply for over a month in 2021. The data and results showed that the system did operate as expected. It is important to note, that due to placement of the CTs, the battery energy storage system was tracking and responding to the loads on the backup-loads panels, rather than the entire building load. Figure 3 shows an average day's operation under Self-Supply.

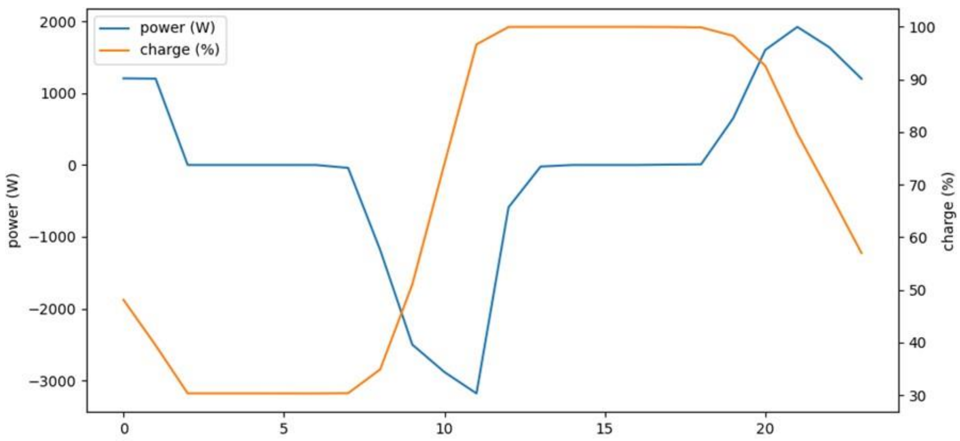

Figure 3: Operational Results

During daylight hours, the batteries are charged by excess solar generation in the morning and then remain idle at 100% SOC until evening hours. As the sun begins to set, the battery begins to discharge to support the loads of the building that can no longer be supplied exclusively from solar PV. After the sun sets, Self-Supply mode directs the batteries to discharge to match demand, based on measurements from system CTs. This load-following discharge continues until the batteries reach their SOC reserve limit in the middle of the night.

Time of Use Operation:

The data and results show that the system, for the most part, operated as expected. However, the system and TOU mode did not initially perform correctly. Only after additional troubleshooting with the manufacturer, product provider, and electrician installers was the system able to work as intended. Figure 2 shows an average TOU operation day. Because the battery is in Clean Backup for 19 hours of the day and only takes about 4 hours to charge from solar, the batteries are idle for 15+ hours of the day. Even after Self-Supply is activated, the battery will not immediately discharge when solar PV is producing enough power to serve the building load. After the sun sets, Self-Supply mode directs the batteries to discharge to match the demand of the home/facility based on measurements from system CTs. In the final hour, the batteries enter Sell mode and attempt to discharge at full capacity.

Conclusions and Challenges

The value obtained by operation in TOU or Self-Supply mode is heavily dependent on effective load monitoring. For example, Time-of-Use operation in a shared-housing application is unlikely to be able to monitor all loads on the system, so the full potential benefit may not be realizable. Similarly, in Self-Supply mode, having all building loads tracked by system CTs would allow greater utilization of stored energy from batteries and minimize the power taken from the grid. In either case, battery operation provides more economic value to the customer when batteries discharge as much as possible during on-peak periods.

Self-Supply Mode- likely to be beneficial to the grid, because it helps to mitigate and flatten peaks in demand by tracking and matching customer loads. Self-Supply is most beneficial to customers for whom PV export is compensated at less than the retail price of electricity.

Batteries used in backup mode tend to operate very little, and primarily to recharge batteries due to losses, because outages are relatively rare. Operating storage in clean backup mode has minimal effects on the grid, either positive or negative, because all charging is done by the solar PV system and all discharging occurs during outages. Priority-backup operation could pose some issues if many battery systems are using this mode: in the event of an outage, all of these systems would be attempting to charge as soon as possible after the outage. This could be a challenge to the grid in some instances.

Overall, for those utilities experiencing difficulty interconnecting and mitigating the impact of a PV system on the grid, Clean Backup may not be ideal. Self-Supply and Time-of-Use operations are likely to provide far more value to the grid. Fortunately, the vast majority of available energy storage systems are capable of operating in Self-Supply or Time-of-Use modes, while also providing backup to customers.

Although the energy storage system is less likely to have 100% SOC during an outage, when it is also operating in Self-Supply or Time-of-Use mode, it is benefiting the grid the most.

The full findings are based on the report “DR19.02 – Mosaic Garden Final Report” which is available at **www.dret-ca.com**.