DR18.05 – Residential Energy Storage Study (RESS)

OPPORTUNITY

WHAT IS THE PURPOSE OF THIS PROJECT?

Residential Battery Energy Storage Systems (BESSs) have become a popular solution marketed by the storage industry for electric grid resilience in California, mostly due to power grid interruptions originating from fires and high wind events. The purpose of the study was to explore the capabilities of monitoring, automation, and control of four Behind-the-Meter (BTM) residential BESS systems, providing real-time grid congestion support and demonstrating price responsiveness with live market values. A major goal was to study how Southern California Edison (SCE) might share this Application Programming Interface (API) control of the BESS with more users. This innovative project wasn't without its challenges as described the Findings section of this report. The overall project intent was to align the BESS with grid pricing signals (proxy for grid congestion) and for autonomous real-time response, thus expanding the value of API control via pricing signals.

Background

The RESS project builds on the Retail Automated Transactive Energy System (RATES) project, which set out to test whether it was possible to stabilize participant bills and utility revenue streams via special utility rate programs. Of interest in this new project were LG RESU lithium-ion (Li-Ion) batteries and controllers purchased by SCE through previous projects. The battery systems were installed and commissioned at three homes in the Moorpark, Thousand Oaks, and Westlake Village areas, seen below in **Figure 1**. Another BESS was installed at the SCE Energy Education Center (EEC), located in Irwindale, CA.

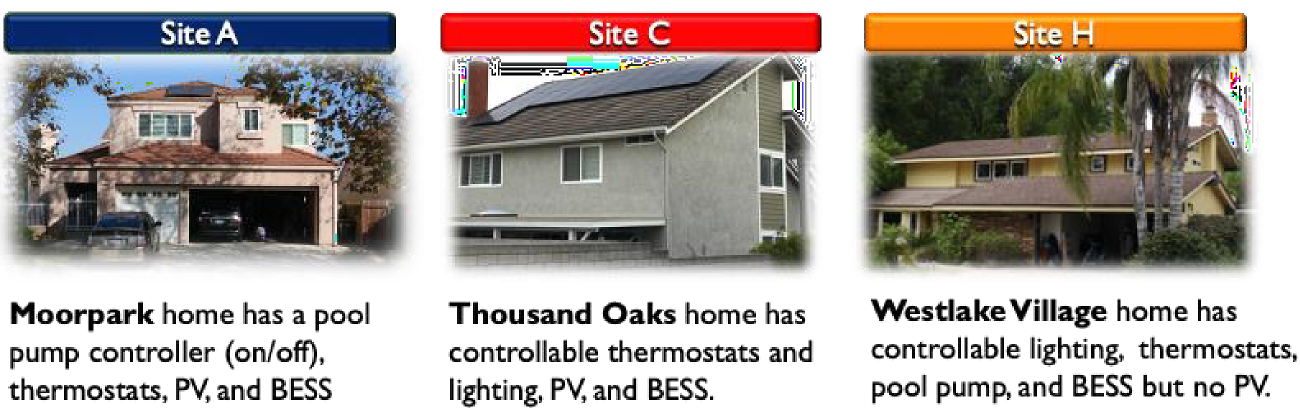

Figure 1: Residential Testing Locations

The flexibility of batteries to charge and discharge on short notice helps the overall health of the power grid. Automated, controlled battery dispatch can stabilize the distribution system as more variable solar generation comes online. This project explored the feasibility of various retail tariffs with highly-dynamic pricing while using the energy storage equipped with finely-controlled dispatch capabilities. The approach can potentially offer a better customer value and power grid operational support on a massive scale.

TECHNOLOGY

WHAT IS THE TECHNOLOGY?

To control the batteries and facilitate participation in the Demand Response (DR) program, SolarEdge was integrated with third-party software interfaces through a dedicated grid services API controller, which enabled automated control and data logging. SolarEdge's StorEdge series specialized power inverters were used to manage and monitor Photovoltaic (PV) arrays and provide the fundamental BESS framework. Inverters are devices that regulate electricity flow and convert Direct Current (DC) power into Alternating Current (AC) power.

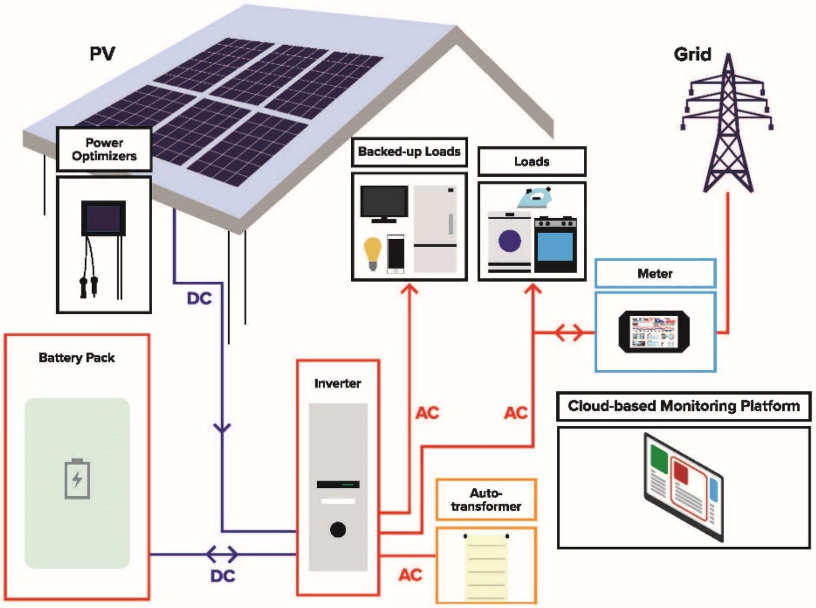

Figure 2: Typical BESS Power Distribution Design

Rooftop solar PV arrays generate DC power, and optimizers maintain constant voltage to balance the PV module's production. Connected to the inverter was the SolarEdge 5kW auto transformer which was designed to work with the inverter as a transfer switch for battery storage. The auto transformer is required for the inverter to operate properly and isolate power to the main electric panel when the grid is down. It should be noted that due to neighborhood covenants, Site H in Westlake was not equipped with solar panels. Along with the other two residential sites, the installation at SCE's Irwindale SEE exhibit included solar panels. SCE's exhibit offers the public as well as building professionals, an opportunity to view a functioning BESS up close, and to assess API control without disturbing customers.

APPROACH

WHAT WAS THE EVALUATION APPROACH?

The BESS charge and discharge setpoints were established and evaluated along with scheduled commands for BESS charge and discharge. A retail energy time shift is viable when BESS can be used to reduce electric bills through judicious energy dispatch. Each site's equipment displayed a dashboard consisting of the kilowatts (kW) of energy exported, imported, consumed, and produced as measurements of the study.

FINDING

WHAT WERE THE MAJOR FINDINGS?

The importance of this project to SCE and California is underscored by the state's outsized role in advancing residential BESS. According to the Energy Information Association (EIA), battery storage costs fell by 72% between 2015 and 2019, a 27% per year rate of decline, and yet, this implementation project revealed there are still improvements to be made. PV overproduction was successfully sent back to the grid after the battery was charged. During mid-peak hours (4 – 9 p.m.) the battery discharged to serve the home's load, to minimize grid consumption, which can be seen in **Figure 3** below showing the dashboard of BESS Site A.

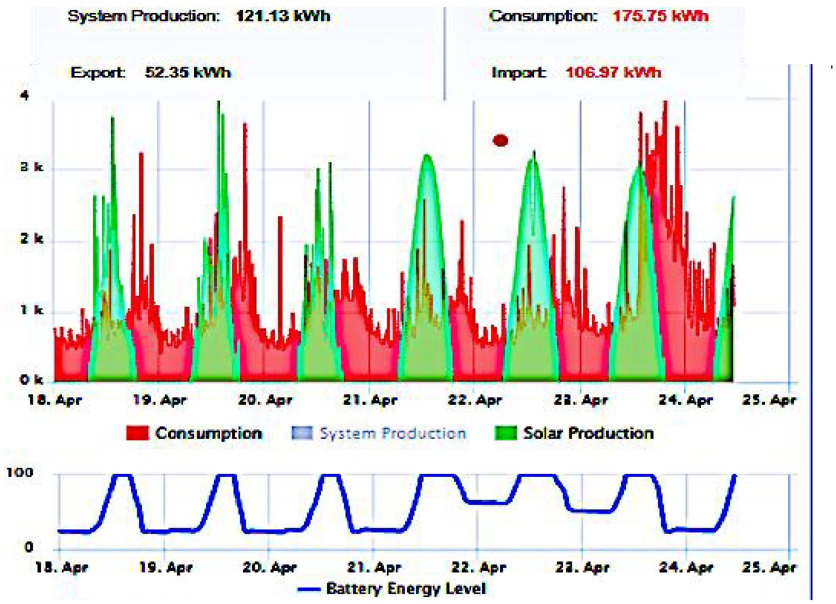

Figure 3: BESS System Performance Dashboard

A BESS minimum charge of 30% was maintained at each site to ensure optimum battery life. Overall the BESS at all four sites responded well to scheduling based around the TOU-D-Prime tariff. The dashboard at Site A was also able to display daily, monthly, and lifetime energy consumption, along with the current power production and consumption pictured below as **Figure 4**

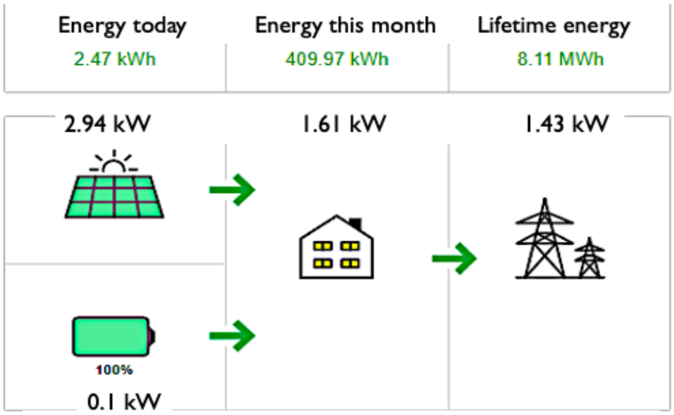

Figure 4: BESS System Dashboard

Conclusions and Challenges

The project encountered, among other problems, delivery constraints, installed equipment that did not perform properly, gaps in training (among permit inspectors, electricians, and installers), equipment design issues, and undocumented manufacturer firmware changes. Support for BESS equipment control was not as comprehensive as advertised and did not allow full manual control of the system. COVID restrictions limited building access to perform engineering work, but this was eventually resolved. Delays occurred due to contracting and equipment procurement issues. At the outset, batteries and inverters were sold out, resulting in a five-month delay.

One positive, important outcome is the SCE TOU-D-Prime rate tariff was identified as an effective mechanism for maximizing customer savings. This was achieved through an alignment of BESS scheduling with tariffs and was found to be feasible with or without PV generation. The team encountered numerous challenges, some of which could be resolved, and others that require future attention

There are several market intervention strategies which could create the incentive for residential customers by using economic signals and technology incentives such as: load increase programs, TOU rates, critical peak pricing, flexible ramp products, and proxy demand response source. The project successfully demonstrated monitoring and scheduled controls could be used on four BTM residential BESSs for grid support and price responsiveness. It also intended to identify problems with installations, commissioning, and technology integration. Significant project delays were encountered because of factors outside these project task areas.

Although all three residential installations involved its share of complications, the project demonstrated BESS capabilities while identifying more economic improvements to future systems. It is hopeful that the lessons learned from this study may support the future development of BESS systems as an emerging technology. The full report, linked below, includes further details of the project procedures and results .

The full findings are based on the report "DR18.05 – Residential Energy Storage Study" which is available at: www.dret-ca.com.