DR18.06 – Solar+: Enabling Clean Energy in Disadvantaged Communities with Integrated PV + Storage

OPPORTUNITY

WHAT IS THE PURPOSE OF THIS PROJECT?

The purpose of this project is to identify scalable community models to maximize the economic benefits of solar PV energy systems for low-income multifamily populations and to evaluate how these technologies could enable grid flexibility, environmental and other benefits that are beneficial to the entire rate base. Emphasis was placed on business models that supported the economic and environmental advancement of low income residents as California Investor Owned Utilities transition all residential customers, including those on affordable discount rates, to time of use (TOU) rates with time differentiation and peak pricing. The project developed a model in a residential building test site that could provide measurements of utility bill cost reduction and the larger rate base including balancing solar to avoid distribution upgrades and shave energy peaks. This reduces greenhouse gases (GHG) from the California electric system and managing bulk system capacity through demand response (DR).

Figure 1: Residential Building Site Layout

Background

This Mosaic Gardens at Willowbrook (Willowbrook) is an affordable multifamily housing property in Compton, California, a highly disadvantaged community (DAC) in Southern California. It was constructed in 2017 by Linc Housing, achieving LEED Silver certification, and it incorporates transit-oriented development concepts. While EPRI, Linc and its partners started development of the project shortly after Willowbrook's construction completion in 2017, construction of the solar + storage project scope only officially began in Fall

2020, once all necessary approvals were secured. The site layout is depicted in Figure 1 above. Today, Willowbrook provides 61 housing units to low-income families, with 31 units reserved for individuals or families transitioning from homelessness. The site was selected because it represented the target market of affordable multifamily housing, and the owner was motivated to investigate the benefits of solar + storage for their larger portfolio.

TECHNOLOGY

WHAT IS THE TECHNOLOGY?

In 2020 and 2021, the team successfully deployed and tested the resource integration demonstration comprised of the following technologies:

- 2 battery cells 60 kW / 2-hour, provided by EnergPort
- 2 60-kW bifacial solar photovoltaic (PV) arrays, provided by Canadian Solar
- DC-coupled PV and storage system, with Bi-directional inverters provided CE+T
- Inverter meeting CA Rule 21 Phase mandates for grid supportive functions
- A local controller coordinating PV, battery, and inverter, provided by GridScape
- Multi-Level Controls Integration through a Cloud-Based Open Demand Side Resources Integration Platform (OpenDSRIP), developed by EPRI and funded through another CEC grant (EPC 15-075), coordinating overall system controls
- This project utilizes a Community-Sharing Virtual Net Energy Metering (VNEM) model. The production and operation of the PV and battery will be distributed (allocated) across each of the residential unit meters and the Common Building meter
- The project will include common area lighting and air conditioning DC loads, directly coupled with the battery system

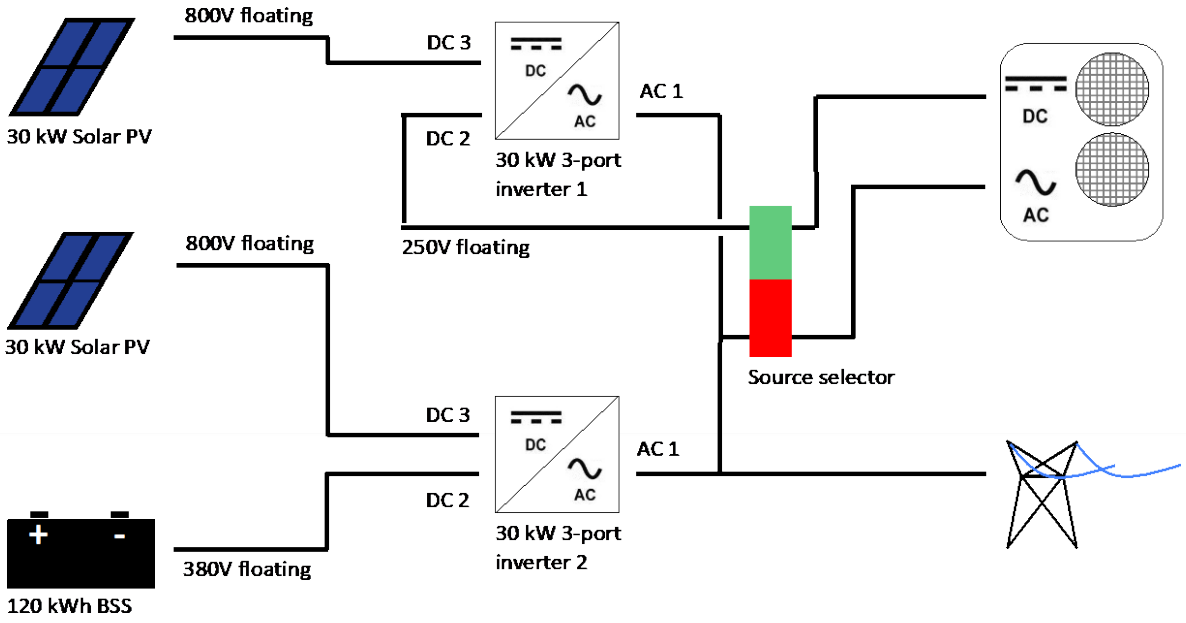

Figure 2: System Electrical Diagram

Most of the chosen innovations are emerging technologies, which were challenging to deploy due in part to limited product availability, lack of familiarity by permitting authorities and stakeholders, code limitations, and compatibility issues. Still, this resource integration project has garnered heightened attention not only for its energy efficiency and DR benefits, but as a realized demonstration of DC distribution and appliances that can be expanded with the provision of automatic transfer switch to offer low-income communities' resiliency. It could provide backup power and a resiliency center during local outages to support critical loads like medical devices and air conditioning.

APPROACH

WHAT WAS THE EVALUATION APPROACH?

EPRI collected data at 1-second, 1-minute, or 15-minute intervals (depending on metric and sensor device) and reported back to EPRI's server to provide technical support for deployed systems. An example of data collected can be seen below in Figure 3, where a basic timeline of charging, discharging, and TOU rate changes are quantified. The study analyzed metrics using a measurements-based, statistical approach for the following:

- Battery and PV functionality
- Solar energy performance
- PQ implications: study of common power quality factors
- Comparison of energy utilization pre- versus post- treatment
- Load shed DR performance
- EPRI evaluated multiple battery control scenarios

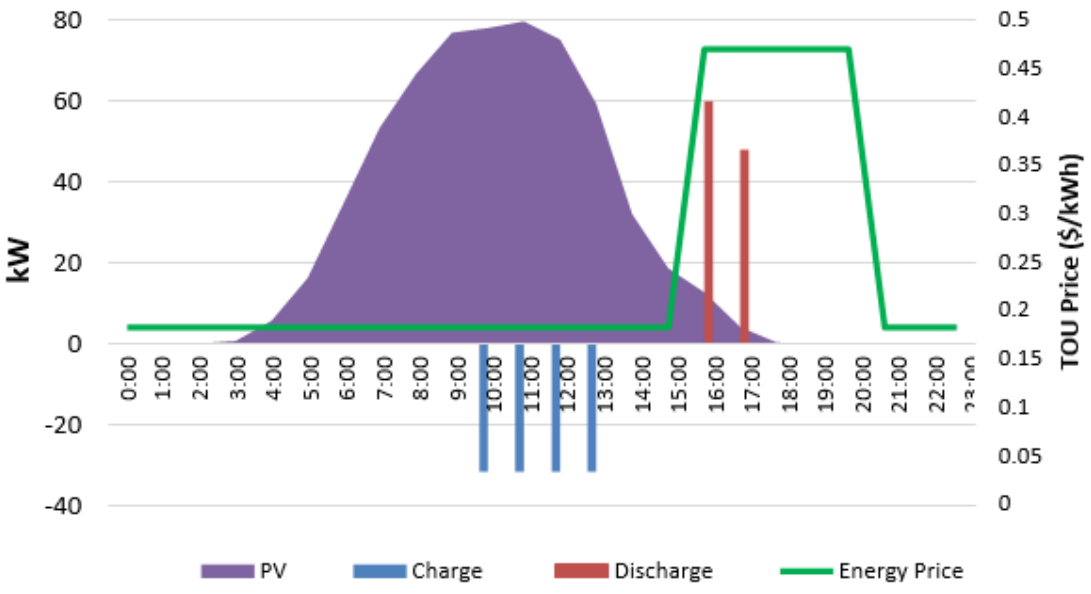

Figure 3: Energy and Rate Chart per Hour

FINDINGS

WHAT WERE THE MAJOR FINDINGS?

Although much data was collected and many metrics analyzed, the key finding was confirming this alternate business model would manage grid users more effectively in community-scale and support overall grid health. The project successfully confirmed the cost effectiveness of community-scale BTM PV + Storage resources for the rate payers as well as the utility grid. Especially when these solutions are distributed across other multiple locations within a utility's distribution feeder.

LOWERED COSTS - The project is projected to demonstrate energy savings of 137 MWh to the grid on an annual basis just from the solar generation. If another 10 percent savings is added through reduction in losses, this represents saving 151 MWh per year from this project alone. The energy and demand savings translate to lower utility costs to serve ratepayers, and ultimately results in lower costs allocated to ratepayers. Extending the results of this project to California's deed-restricted affordable multifamily households shows potential for a bill reduction of $253 million for California's low-income households. (~10 percent of California multifamily households are deed-restricted affordable multifamily)

GREATER RELIABILITY - This project demonstrates an integrated solar, storage, and end-use load platform to test control scenarios that can support greater grid reliability while supporting intermittent renewable energy resources. This project can reduce evening demand by 8.6 percent during TOU peak periods, which will contribute to increased grid reliability, ultimately benefiting all California ratepayers. The project team worked closely with the local utility, SCE, to study the distribution grid impacts (i.e., voltage, thermal, protection) that these DERs can potentially mitigate.

ECONOMIC DEVELOPMENT - This project created new jobs equivalent to eight person-years (five funded by the grant, three funded by match share). This can be scaled to significant job growth if similar retrofit work is conducted statewide for the target sector. The reduction in energy bills and DR participation payments also leaves tenants with greater disposable income, which is particularly impactful for low-income populations, which constitute nearly 20 percent of all California ratepayers.

ENVIRONMENTAL SAFETY - This project has the potential to reduce greenhouse gas (GHG) emissions due to the installation of renewable energy and energy efficient technologies. Extending the results of this project to California low-income multifamily households shows a potential for energy use reduction of 1,182 GWh per year, which translates to statewide CO2 reduction of ~83,331 metric tons per year for California's low-income populations. (20 percent of California's ratepayers are low-income; 75 percent of low-income are multifamily)

Conclusions and Challenges

Overall, the results at Willowbrook illustrate benefits that include lowered costs for the property residents as well as greater load flexibility and environmental benefits for the utility and larger rate base. The demonstration also offers technology implementation pathways and lessons learned for more effective project, program, and policy targeting the low-income multifamily sector in California with integrated resource deployments.