PECAN STREET

Case Study: Behind the Meter Storage and 4CP in Texas

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This paper summarizes the benefits of behind-the-meter (BTM) assets that can decrease a utility's net transmission cost through 4 Coincident Peaks (4CP) reduction. The report highlights the lessons learned for management and control of residential energy storage systems (ESSs). The data shown here is extracted directly from assets installed by Pecan Street Inc. in the Mueller neighborhood in Austin, TX. All data is available via Pecan Street's Dataport.

4CP and ERCOT

4CP is the method through which the Electric Reliability Council of Texas (ERCOT) assigns transmission system costs to distribution utilities. By assigning transmission costs as a percentage of peak load, the charge serves as an economic incentive to reduce peak demand. If an electric utility reduces its load during a 4CP event, it can reduce its share of transmission costs for the following year. Each 4CP event is determined by ERCOT as the 15-minute interval with the highest for peak load in June, July, August and September. Each event is the average 15-minute kW demand of an electric distribution provider at the time determined by ERCOT. For 2019, the 4CP events occurred:

- June 19 from 4:45p to 5:00p
- July 30 from 4:15p to 4:30
- August 12 from 4:45p to 5:00p
- September 9 from 4:15p to 4:30p

Austin SHINES

In 2016, Pecan Street joined Austin Energy as a partner of the Austin Sustainable and Holistic Integration of Energy Storage and Solar PV (SHINES) project. Awarded by the U.S. Department of Energy's Solar Energy Technology Office (SETO), SHINES deployed energy storage systems (ESSs) in utility, commercial and residential applications. Pecan Street acted as the residential aggregator for SHINES and deployed seven residential batteries and one V2G electric vehicle in the Mueller neighborhood in Austin, TX.

The project goal was to understand the costs and benefits of residential, commercial and utility scale battery systems. As part of the research, six battery control applications were evaluated for market value, reliability, and customer value. Under market value, the applications were utility peak load reduction, day-ahead energy arbitrage, and real-time price dispatch. For reliability, the program researched voltage support and distribution congestion management applications. Lastly, for commercial customer value, the monthly demand charge reduction application was analyzed.

This paper examines the impacts of the SHINES residential assets during 4CP events for Austin Energy. The assets installed behind the meter presented an ideal opportunity to reduce the utility's load during these intervals. When storage assets are correctly deployed during a 4CP event, the total load share ratio for Austin Energy could be reduced, reducing its transmission costs for the following year.

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System Configuration and 4CP Performance

As the residential aggregator for Austin SHINES, Pecan Street installed seven (7) two-hour, 5kW batteries and one (1) four-hour, 10kW bi-directional V2G electric vehicle (EV) along the Austin Energy feeder with the most solar generation for a total of 45kW of behind-the-meter capacity.

Historically, the majority of 4CP events have occurred between 3:45p and 5:00p[1]. As a result, two-hour systems are ideal to achieve the utility peak load reduction because the assets can discharge during that 75-minute window and have some flexibility in accuracy of deployment schedule. During a 4CP event, each kW is valued at approximately $60, equaling a $2,700 savings for Austin Energy if the SHINES systems are deployed correctly. Based on Austin Energy's white paper for the Austin SHINES project, reducing the utility's peak load would be the most significant driver for economic benefit in the ERCOT market.[2]

Table 1 provides the potential and actual load reduction and savings during 4CP events for the residential assets in the summer of 2019. For June and September, the residential systems responded to commands from the management platform (Doosan's DERO®) and reduced Austin Energy's utility peak by 30kW and 10kW, respectively. July, August and September provided significant lessons for future system deployment.

For July, the systems were not fully charged in time for the 4CP event. For August, Pecan Street removed the batteries from use by the aggregator because they were nearing the manufacturer specified maximum operating temperature due to the hot Texas summer weather. (Pecan Street did not run batteries when their internal operating temperature exceeded 108°F/42°C.)

Table 1 - Total and Deployed Capacity and Value Provided

	June 19	July 30	Aug 12	Sept 6
Total Residential Capacity [kW]	35	35	35	45
Residential Capacity Deployed [kW]	30	-13	0	10
Potential Cost Savings if Total Capacity is Deployed	$2,100	$2,100	$2,100	$2,700
Actual Savings Realized	$1,800	-$780	$0	$600

[1] ERCOT Four Coincident Peak Calculation (Accessed 2020). Available: http://www.ercot.com/mktinfo/data_agg/4cp

[2] Austin Energy. "Distributed Energy Resource (DER) Strategy, Next Steps, and Preliminary Findings from Austin SHINES DER Integration Project" (2019). Available: https://austinenergy.com/wcm/connect/2c82614f-f6a6-474c-8706-722e8c07cc4f/DERStrategyWhitepaper.pdf?MOD=AJPERES&CVID=mR5D14j

Stationary and Vehicle Battery Storage

The system installed and tested by Pecan Street included seven (7) two-hour, 5kW batteries affixed to the outside of homes within Pecan Street's volunteer research network in Austin, TX.

Also included was one (1) four-hour, 10kW bi-directional V2G electric vehicle (Nissan Leaf, shown below) located at Pecan Street's lab.

Together, the systems provided a maximum of 45kW of behind-the-meter capacity to Austin Energy.

June 19 4CP Event

The June 19 4CP event occurred from 4:45p to 5:00p. During this time, ERCOT reported that Austin Energy's load was 2,544.43 MW. The residential aggregator was connected and had six ESSs charged and available to reduce the peak load. This allowed Austin Energy to reduce its load by 30kW and save $1,800.

July 30 4CP Event

The July 30 4CP event occurred from 4:15p to 4:30p. Unfortunately, the ESSs were not fully charged at the time of the 4CP event and were unable to reduce Austin Energy's load. The control platform called for charge commands of the batteries, planning for a future peak or charging the assets again after meeting a peak sooner in the afternoon. As a result, charging the systems caused Austin Energy's total load to increase by 13kW. If the systems had been effectively charged earlier in the day, the total load reduction could have been 35 kW and would have saved Austin Energy $2,100. Instead, they cost the utility $780. This also indicates that simpler rules-based limits on preventing charging during likely 4CP times may provide effective protection against advanced controls charging at unfavorable times.

August 12 4CP Event

The August 12 4CP event occurred from 4:45p to 5:00p. Because of high temperatures, a majority of the storage assets were idled and removed from the aggregator so that they would not operate outside of the manufacturer specified temperature limits. As a result, there was no value added from the residential ESS assets. The peak load for August was not reduced or increased by the SHINES residential assets, as shown in Table 1.

September 9 4CP Event

The September 9 4CP event occurred from 4:15p to 4:30p. Again because of extreme outside temperatures, the outdoor systems were removed from the aggregator. The only ESS able to provide utility services and reduce the peak load was the 10kW electric vehicle battery, which was kept in a garage.

Pecan Street installed the battery systems on shaded outside walls of participating homes. After installation, but during the program, some of the participants trimmed trees that had provided shade. As a result, the battery aggregation system was programmed to not charge or discharge if their temperatures were above 108°F/42°C. The manufacturer specified maximum operating temperature was 45°C.

The vehicle, which is kept in a garage, was able to stay in the aggregator as an available resource. This suggests the need for installation standards that provide protection from the elements in order to have higher availability during weather extremes.

Discussion

Installations of ESS resources have increased dramatically over the past five years. As costs continue to decline, this trend is likely to increase; residential energy storage systems costs decreased by more than 15% per year from 2012-2017[3]. Pecan Street's work with the Austin SHINES project suggests that behind-the-meter storage assets can provide valuable grid services, such as peak load reduction when aggregated or with further reductions in price. These customer-owned assets can also be used, as demonstrated in this case study, to provide overall benefits to all customers through strategies such as 4CP mitigation.

As tested, the residential aggregator can provide value to the utility through reducing peak load during 4CP events. For the months of June, August and September, the residential assets reduced Austin Energy's peak load by 40 kW, a $2,400 savings (at $60/kW). For July, the systems increased Austin Energy's peak by 13kW, at a cost of $780. If the system's full capacity had been deployed for the four 4CP events, the savings produced by these four events would have covered the costs of two of the systems.

Proper planning, system operating limits and system design, however, are critical to realizing this full potential. Primary takeaways from the SHINES research and experimentation into the use of behind-the-meter energy storage systems for grid support include:

- Management platforms need to consider historical data for energy use peaks in order to understand how to deploy effective control schedules, as demonstrated in the July 4CP event. We know from historical data that most 4CP events occur within a two-hour period on weekdays. If the assets had been charged in the morning to be discharged during this window, they would have successfully reduced Austin Energy's 4CP load.

- Battery systems should always be installed in environments where they are protected from temperature extremes and can work properly within the operating temperatures specified by the manufacturer. This will allow ESSs to be dependable during 4CP events or any weather-driven peak event to provide grid services.

[3] Finkelstein, J et. al. "How residential energy storage could help support the power grid", March 20, 2019. McKinsey & Company. Available: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid#