

Expanding Residential DR: Two Years of Real-World Results from Batteries, Hot Water Heaters, and Pool Pumps -- Authors: Noah Fraser, Lilia Murphy

Most residential Demand Response (DR) programs are built around controlling thermostats to reduce cooling or heating loads during peak energy demand periods. With the industries push to roll DR programs under utility distributed energy resources DERMS control, there has also been a lot of talk of expanding DR capacity using other measures beyond thermostats. We have evaluated one such DR program in the Southwestern U.S. that incorporated in-home battery storage, hot water heaters, and variable speed drive (VSD) pool pumps into its programs for its territories in the southern and northern part of the state the past two years.

The batteries, water heaters, and pool pumps were controlled by a wi-fi enabled system that allowed the program to discharge the batteries, lower the heat setpoints on water heaters, and put the variable speed pool pumps into their lowest speed during the two-hour DR events. The 2023 program included 11 batteries, 20 water heaters, and 40 pool pumps in the south; in the north there were 9 Batteries and 20 water heaters. In 2024 the program included 25 Batteries, 34 water heaters, and 17 pool pumps in the south; in the north there were 12 Batteries, and 14 water heaters. The baseline load for these measures was calculated through comparing the event day energy consumption with the average energy consumption over the previous 7 non-holiday weekdays—in the case of a weekday event—or the previous 7 weekends and holidays in the case of a weekend or holiday event. Two important metrics are calculated in the evaluation of the program:

- The verified event savings (positive kWh), which is all the savings that occur during the two event hours and the snapback period which is the two hours post event where energy usage may snapback above the baseline in response to the event ending. When the snapback effects are larger than the event savings there can be a net increase (negative savings) in energy usage due to the event.
- The verified peak kW, which represents the highest demand savings in an hour relative to the baseline.
- Please note that:
 - Although the battery may be discharging at 5-8 kWh, if the customer typically discharges during the event hours;
 - Or the water heater temperature may be turned down, if the customer typically doesn't use hot water during the event hours;
 - Or the VSD pool pump may be set to its lowest speed, if the customer typically schedules the lowest speed during the event hours, then the savings relative to the baseline may be small or even slightly negative;

The verified savings information in Table 1 will be useful for other utilities, DERMS planners, and evaluators as these measures are included in more DR programs around the U.S.

Table 7: Verified Energy Savings (average kWh) and Demand Reduction (max kW) for the DR Program

Savings	Southern Program				Northern Program		
	Batteries	Water Heaters	VSD Pool Pumps	Thermostat	Batteries	Water Heaters	Thermostat
Event (kWh)	2.05	0.11	-0.25	0.56	1.88	0.003	6.35
Max (kW)	5.34	2.34	1.00	1.19	7.54	3.12	1.38