Battery-Powered Future: A Behind-the-Meter Pilot Case Study

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ABSTRACT

Aligning capacity with increasing demand during peak periods is a growing priority for utilities. The industry shift toward renewable energy sources like wind and solar, which do not necessarily coincide with peak demand periods, provides an additional incentive to explore new methods of peak load shifting.

One solution is behind-the-meter (BTM) residential battery storage. Evergy, a midwestern electric utility, is at the forefront of residential battery storage implementation as part of distributed energy resource (DER) management systems (DERMS). Evergy launched its residential battery storage pilot in 2023 with 50 BTM batteries and added 100 more by mid-2025. The batteries use machine learning to predict home demand and optimize charge-discharge schedules around solar capture and time-of-use (TOU) rates, providing savings to customers and offloading peak demand from the grid.

Evergy designed the pilot to assess the viability of a residential BTM battery fleet as a demand response resource and integrated DERMS component. Specifically, the pilot objectives were to explore if batteries: (1) offer customers resiliency through backup power during grid outages, (2) provide bill savings via TOU arbitrage and solar optimization, and (3) enable the utility to access load management, peak shaving, and grid stability benefits.

Cadmus is working with Evergy to evaluate the pilot battery operations for systems with and without solar, demand response event dispatch success and impacts, bill savings, and participant satisfaction. This paper presents an overview of the Evergy pilot, implementation details, battery performance, and lessons learned to inform future DER and demand response offerings.

Introduction: Pilot Overview

The purpose of Evergy's Residential Battery Energy Storage (RBES) pilot is to field test BTM battery storage as a DER to better understand its benefits to the utility and participant customers. Evergy owns 150 BTM pilot battery energy storage systems in its Missouri and Kansas service areas. The utility manages battery daily operations and demand response events in collaboration with the implementer, Budderfly, through its web-based Demand Response Management System (DRMS) and through Evergy's DERMS to validate end-to-end functionality—including asset enrollment, dispatch, and data reporting from the battery systems.

Evergy began implementing the RBES pilot in its Missouri service areas in 2023 and in its Kansas service areas in 2024. The Missouri pilot ran for three years through the end of 2025, and the Kansas pilot is planned to run through 2027. Because of the different stages of maturity of the two states' pilots, the majority of this paper focuses on the Missouri pilot.[1]

[1] Note: We often refer to pilot year (PY1, PY2, or PY3) instead of calendar years to distinguish between pilot maturity levels for the two states in the same calendar year.

Pilot participants received free battery installation and pay $10 per month to participate in the pilot. The batteries help manage TOU rate charges and provide backup power to participants' critical load panel during grid power interruptions. Evergy prioritized prospective participants with existing solar photovoltaic (PV) systems in their homes prior to the pilot, resulting in about one-third of enrolled participants (51 of 150) having existing solar PV. Evergy did not install any additional PV systems as a part of the RBES pilot.

To confirm pilot eligibility and battery placement, Evergy conducted 100 on-site meetings at customer homes in Missouri and 195 phone screenings with Kansas customers.[2] Evergy recruited and installed batteries in the homes of 50 Missouri customers by October 2023 and in the homes of an additional 100 Kansas customers by July 2025. Of the 50 Missouri customers in the pilot, 29 had existing solar PV systems, and of the 100 Kansas customers, 22 had existing solar systems. Regardless of existing PV systems, all pilot participants received the same single-phase AC-coupled battery model, the LG ESS Home 8, with 14.4 kWh nominal usable capacity and 90% round-trip efficiency.[3]

Evergy enrolled each of the pilot participants in a TOU rate plan for the duration of the pilot. Missouri participants were given the option to pick from four different TOU rate plans with varying structures and price differentials, while Kansas participants were all enrolled in the same high-differential, three-period TOU rate plan (Table 1). All TOU plans have an on-peak period from 4 p.m. to 8 p.m. year-round, and the super-off-peak period is midnight to 6 a.m. for all three-period schedules.

Table 1. Pilot participant electric rate plans

<table>
<tr><th>State</th><th>Rate schedule</th><th>Plan name</th><th>TOU period price differential</th><th>Periods</th></tr>
<tr><td rowspan="4">MO</td><td>RPAS</td><td>Default Time-Based Plan[1]</td><td>Very low</td><td>Three</td></tr>
<tr><td>RTOU-2</td><td>Summer Peak Time-Based Plan[2]</td><td>Summer weekdays: high
All else: low</td><td>Two</td></tr>
<tr><td>RTOU</td><td>Nights & Weekends Plan</td><td>Weekdays: high
Weekends and holidays: low</td><td rowspan="3">Weekdays: three
Weekends and holidays: two</td></tr>
<tr><td>RTOU-3</td><td>Nights & Weekends Max Plan</td><td>Weekdays: high
Weekends and holidays: moderate</td></tr>
<tr><td>KS</td><td>RTOU</td><td>Nights & Weekends Plan</td><td>Weekdays: high
Weekends and holidays: low</td></tr>
</table>

[1] In addition to the TOU period pricing, the Default Time-Based Plan also has usage-based block pricing. All other participant rate plans have flat TOU pricing.

[2] Evergy's summer period spans June through September.

Additionally, Evergy created three battery operations programs for participants to select from:

- The **Backup Power** program, which retains a 30% minimum state of charge

[2] An early lesson learned in the Missouri pilot was that site visits were unnecessarily costly compared to robust phone screenings, which usually sufficed for determining pilot eligibility; as such, Evergy did not conduct site visits for the Kansas pilot.

[3] Cadmus verified the round-trip efficiency of pilot batteries each year and found that it settled at around 89% in practice.

- The **Cost Savings** program, which seeks to maximize cost savings by discharging a greater fraction of the battery's capacity every day on peak, down to a 10% minimum state of charge
- The **Both Cost Savings and Backup Power** program, which seeks to find a balance between these objectives, reserving a 20% minimum state of charge

Table 2 presents the number of pilot participants in each battery program by state, electric rate plan, and system type in 2025. As shown in the table, all Missouri pilot participants with solar PV were on the low-differential RPAS rate because, at the time of the Missouri pilot launch (2023), that was the only rate with net metering available for Missouri customers with solar generation.[4] Most participants, regardless of system type, chose the Both Cost Savings and Backup Power program.

Table 2. Number of pilot participants by state, rate, system type, and program

State	Rate	Battery-only participants				Battery participants with PV			
		Backup	Cost savings	Both	Total	Backup	Cost savings	Both	Total
MO	RPAS	1	2	4	7	2	4	23	29
	RTOU	1	-	-	1	-	-	-	-
	RTOU-2	-	1	6	7	-	-	-	-
	RTOU-3	-	3	3	6	-	-	-	-
	Total	2	6	13	21	2	4	23	29
KS	RTOU	33	4	41	78	10	1	11	22

Evergy's RBES pilot is designed to use the battery storage systems as both a DER and demand management resource. Batteries are programmed to charge without straining the grid—either during overnight off-peak periods (battery-only systems) or from solar midday (PV-coupled systems)—and to discharge during the on-peak period (4 p.m. to 8 p.m.) to reduce peak demand on the grid. This type of charging strategy is called TOU arbitrage. Most pilot battery systems run artificial intelligence (AI) programs that predict household consumption at 15-minute intervals and determine how much to charge or discharge the battery to follow the home's anticipated load. This helps to prevent batteries from discharging more power than the home is consuming: only participants with PV have net metering, and battery-only participants cannot discharge to the grid.

In addition to year-round daily TOU arbitrage, pilot batteries participate in demand response events during the summer.[5] During demand response events, energy discharge from the batteries is increased to further support household consumption and reduce Evergy's grid load. Pilot participants' batteries do not back-feed energy to the grid during events due to differences in net metering and compensation for energy exports across customers.

[4] The billing implications of this constraint are detailed in the *Energy Bill Savings* section.

[5] Note: Evergy is also testing the integration of smart thermostats and electric vehicle (EV) charging as part of the battery pilot; however, these use cases are not evaluated in this paper.

Implementation Details

Evergy conducts robust battery system integrations, controls, and operations calibration through a series of hardware and software connections in the pilot. The following sections detail these integrations to give context on why individual battery results may vary and what insights we can draw from them. A key aspect of the RBES pilot is that Evergy does not run a single standard operations program across all batteries, but instead constantly adjusts and fine-tunes the daily and demand response programming of each battery to optimize charging and discharging strategies and address specific customer needs. This individualized approach helps improve battery operational efficiency and better supports household energy needs. It also demonstrates how energy can be intentionally used, timed, and delivered to reduce waste and maximize value.

Budderfly Platform

Evergy, using Budderfly's DRMS platform, controls, monitors, and manages the pilot battery systems. The platform runs both in the cloud and locally on a gateway computer within each battery storage system. The local gateway installed at each customer's house provides intelligence at the grid edge and communicates over the cell modem with the platform every 12 seconds, enabling Evergy to monitor and configure data in real time. The gateway manages and controls the hardware components in the battery storage systems and other controllable devices.

For daily operations, Evergy runs different AI programs on each battery unit to determine whether it should be charged or discharged based on the field configuration (battery-only, PV-coupled, EV-integrated, etc.) and customer preferences. These programs calculate the battery charge and discharge actions according to TOU schedules (on-peak and off-peak periods) and historical customer consumption patterns. The programs are designed to optimize system energy efficiency by (1) minimizing energy losses during charge/discharge cycles, (2) aligning charging and discharging to capture and deploy as much PV as possible, and (3) effectively utilizing stored energy, resulting in reduced participant energy bills and providing reliable backup power during outages.

Broadband Integrations

Evergy aims to use the RBES pilot as an opportunity to gain a deep understanding of technological solutions in the DER space from first-hand experience. To support this, Evergy developed a comprehensive broadband integration plan around the battery storage devices and existing systems, and expanded its focus from daily operations, storm mode preparation, and demand response events to include the areas outlined below.

Field Integration.

- **Integration with participants' solar PV systems.** This enables excess solar generation to charge the battery during the day, with the stored energy discharged after sunset to support the home's electricity needs. This strategy helps evaluate the viability of PV self-consumption.
- **Integration with participants' EV chargers.** This allows Evergy to remotely control, monitor, or pause EV charging during demand response events to reduce peak load.

- **Integration with participants' smart thermostats.** This allows Evergy to test smart thermostat–driven demand response use cases by remotely changing setpoint temperatures to perform load shifting through pre-cooling and drift strategies. This practice helps Evergy understand customer tolerance for curtailment and efficient settings for summer peak time.

Communication Integration.

- **Integration with the public cellular (PLTE) network.** Adding PLTE integration into the pilot allows Evergy to evaluate network performance and use enhanced prioritization (roaming) and security features. Over the long term, PLTE integration will help reduce operations and management costs while improving Evergy's communications infrastructure with DERs.

Systems Integration.

- **SCADA integration.** Evergy is testing the integration of operational telemetry from the Budderfly platform into its distribution SCADA environment via a DNP3 interface. The integration will provide real-time telemetry, status indications, and alarm events to enable Evergy to perform continuous monitoring, providing visibility and situational awareness of battery storage assets within the distribution network. This will help inform whether DER data improves the decision-making from ADMS applications such as FLISR, VVO, and Power Flow.[6]
- **DERMS integration.** Evergy is testing the integration of Budderfly's DRMS platform with its own DERMS using OpenADR 2.0b protocol. The aim is to increase visibility into the status and data from the battery systems and to enable DERMS to initiate demand response events by dynamic grouping on available resources.

Battery Performance

The following sections present the evaluation findings for each of the three core pilot focus areas: peak demand reduction and energy bill savings from TOU arbitrage, demand response events, and backup power during grid outages.

TOU Arbitrage

To ensure power is available for peak-time use, pilot batteries were programmed to charge during the least-cost times for each individual participant. For battery-only participants, this is during the super-off-peak period (midnight to 6 a.m.), when energy from the grid is the cheapest. For participants with solar, it is during the day from PV generation, which has a much lower excess sellback rate than the overnight super-off-peak price of energy. Regardless of the charging strategy, all pilot batteries are programmed to discharge during the on-peak hours of 4 p.m. to 8 p.m. to shift load away from the peak.

Figure 1 demonstrates these patterns with the average hourly system power of Missouri pilot participants by system type in 2025. Note: grid power is the home's energy use at the meter;

[6] SCADA: Supervisory Control and Data Acquisition system. DNP3: Distributed Network Protocol v3. ADMS: Advanced Distribution Management System.

inverter power is the battery activity; and PV power refers to solar generation. Positive values represent power draw or production (grid use, battery charging, or solar generation), and negative values represent power export (grid sellback or battery discharge).

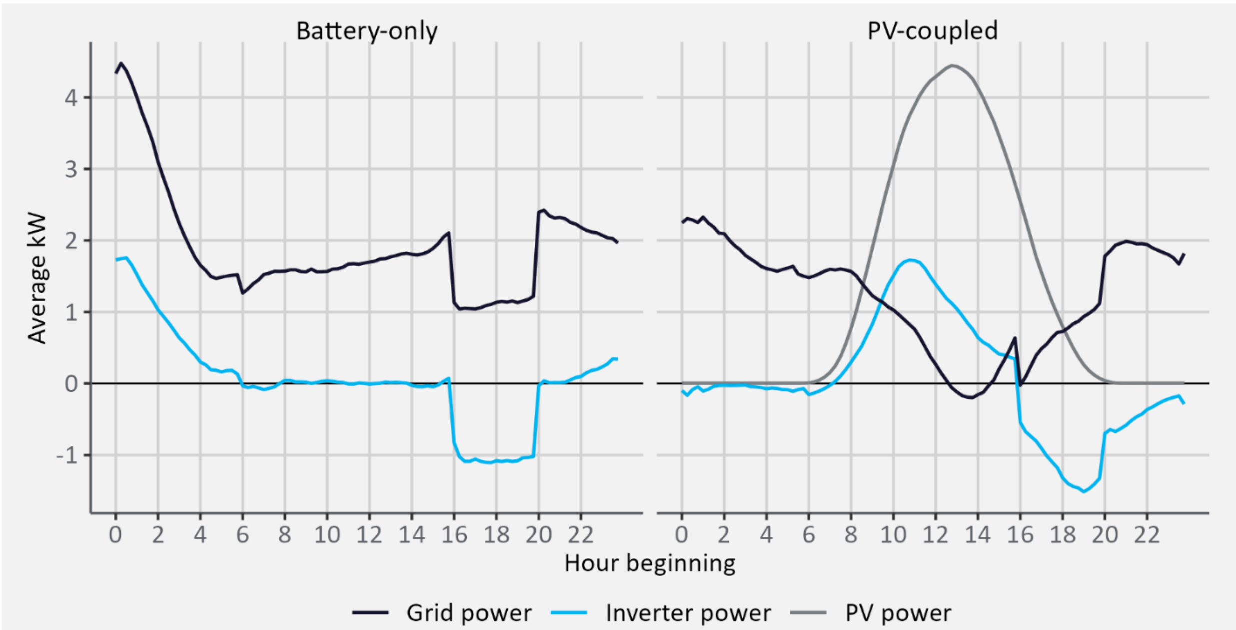

Figure 1. Average hourly system power of Missouri pilot batteries on non-event days in 2025.

As shown in the figure, the pilot batteries charge at the time and in the manner that costs the least for their system type (overnight from the grid for batteries without solar and midday from solar generation for PV-coupled batteries) and discharge for the full on-peak period from 4 p.m. to 8 p.m., when the grid is experiencing the highest demand and energy is the most expensive.[7] While the pilot battery-only systems discharged at a roughly constant rate throughout the peak period, PV-coupled batteries ramped up throughout the period, given solar generation continued to offset home consumption at a diminishing rate as the sun went down.

The batteries' TOU arbitrage provides two main benefits: reduced peak demand on the grid and energy bill savings for participants.

Peak Demand Reduction.

Cadmus analyzed battery telemetry data of Missouri pilot participants to assess how battery TOU arbitrage impacted participants' peak demand on non-event summer days. The analysis focuses on Evergy's summer months because Evergy is a summer-peaking utility and the grid experiences the greatest benefits when load is reduced during peak system demand. Table 3 shows the average battery discharge during summer on-peak hours for each of the three Missouri pilot years by system type. Summer on-peak battery discharge increased from about 1 kW in MO PY1 to about 1.5 kW in MO PY3, or by about 50% by the end of the pilot, a statistically significant increase.

[7] Cadmus also investigated battery activity by electric rate plan and battery program and found that within system types (e.g. solar vs. no solar), charge-discharge timing patterns were not meaningfully different across groups. They are combined here for visual simplicity.

Table 3. Average Missouri pilot battery summer on-peak discharge (kW)

System type	MO PY1 (2023)	MO PY2 (2024)	MO PY3 (2025)
Battery-only	0.96	1.12	1.58
PV-coupled	1.15	1.22	1.50

Cadmus found no significant difference in summer or year-round on-peak discharge among battery programs (Cost Savings, Backup Power, and Both) or electric rate plans. However, system type appears to have an impact: over the three pilot years, PV-coupled systems discharged more on average during on-peak hours than did battery-only systems, though the difference is statistically significant only when considering the whole year, not summer alone, indicating additional seasonal differences between the operations of the two system types.

Cadmus attributes the increase in battery discharge during summer peak hours throughout the life of the Missouri pilot to improvements in Evergy's battery programming (as opposed to increased home demand over time). However, participant homes typically consumed 2 kW to 3 kW on average during peak hours, meaning that the pilot battery systems still have room to improve peak demand reduction, as the pilot batteries are capable of outputting more than 3 kW throughout the duration of the peak period.

Additionally, as noted, the battery operations programs (Backup Power, Cost Savings, and Both) did not appear to produce dramatically different discharge strategies. Table 4 shows the average stored energy remaining in Missouri pilot batteries at the end of the day, right before battery-only systems are programmed to begin charging, by battery program in MO PY3. All pilot batteries had a nominal usable storage capacity of 14.4 kWh and were programmed to retain up to 30% of that capacity (about 4.3 kWh) for backup power after peak time discharging.

Table 4. Average stored energy of Missouri pilot batteries at 12 a.m. in 2025

			Observed			
	Expected		Battery-only		PV-coupled	
Battery program	kWh	Capacity	kWh	Capacity	kWh	Capacity
Backup Power	4.3	30%	8.1	56%	6.1	42%
Both	2.9	20%	6.8	47%	5.1	35%
Cost Savings	1.4	10%	6.8	47%	2.8	20%

As shown in the table, battery-only systems, on average, discharged to only about 50%, regardless of the program target. PV-coupled batteries got considerably closer to their program's target state-of-charge reserve but also showed room for improvement. While allowing participants to choose their battery priorities is likely to help with program satisfaction (as discussed in the *Participant Satisfaction* section), achieving distinguishable results will require more refinement of battery programming.

Energy Bill Savings.

To investigate how battery TOU arbitrage impacted participants' electric bills over a year, Cadmus compared Missouri participants' observed grid consumption in 2025 with counterfactual grid consumption without the battery. We calculated counterfactual consumption by netting the battery's charges and discharges out of grid consumption, so that less energy would have been consumed from the grid when the battery was charging and more when it was discharging. For solar customers, this often resulted in greater excess solar production and sellback to the grid. Additionally, as all Missouri pilot solar participants had block pricing on the RPAS rate schedule, we accounted for net billing before price blocking in each TOU period. We then multiplied participants' actual and counterfactual usage by their respective billing rates for each TOU period to estimate actual and counterfactual monthly electricity costs, calculating electric bill savings as the difference between the two. We based these costs on usage and net metering alone and did not consider fees or other items that may normally appear on customer bills since they are not expected to differ between the actual and counterfactual scenarios.

Table 5 shows the average estimated total electric bill savings by electric rate for Missouri pilot participants in 2025. Batteries on high-differential TOU rates produced much higher arbitrage savings than batteries on the low-differential rate. The charge and discharge cycles of all batteries, regardless of rate, were well aligned with the intended TOU periods. Therefore, differences in savings were mainly due to differences in the rate structures (i.e., the price differentials between TOU periods): if the price differential between TOU periods was not large enough to compensate for the roughly 10% efficiency loss to charge and discharge the battery, using the battery to shift the home's time of energy use did not produce electric bill savings. Meaning, bill savings were constrained by electric rate design, not battery performance.

Table 5. Average total electric bill savings: Missouri participants by electric rate in 2025

Rate schedule	Peak price differential	System type	Average TOU savings (Percentage of total home use cost)
RPAS	Very low, year-round	PV-coupled	$37 (5%)
		Battery-only	-$21 (-1%)
RTOU	High, year-round	Battery-only	$335 (15%)
RTOU-2	High, seasonal	Battery-only	$167 (10%)
RTOU-3	High, year-round	Battery-only	$321 (18%)

Batteries on the high-differential TOU rates produced substantial cost savings for participants through TOU arbitrage—averaging from 10% to almost 20% of the cost of the home's electricity use, depending on the rate. Higher TOU differentials resulted in higher bill savings from TOU arbitrage: batteries on the Nights and Weekends Plan (RTOU) and Nights and Weekends Max Plan (RTOU-3), which had high-differential TOU pricing year-round, produced about 50% higher savings on average than batteries on the Summer Peak Time-Based Plan (RTOU-2), which had high-differential TOU pricing only during the summer.

Similarly, batteries enrolled under the RPAS rate struggled to produce bill savings since the rate has an extremely low TOU differential year-round. PV-coupled batteries, which could charge from solar generation at a much lower cost than that for battery-only systems charging from the grid overnight, produced 5% in savings on average in 2025. However, battery-only systems increased total costs by 1% on average, indicating that the TOU pricing differential under the RPAS rate schedule was not enough to offset the batteries' roughly 10% round-trip energy loss.

Cadmus further analyzed bill savings by battery program (Backup Power, Cost Savings, or Both) and found that battery program priorities mostly aligned with TOU arbitrage results.

Table 6 shows TOU arbitrage cost savings for Missouri pilot participants in 2025 across the three battery programs.

Table 6. Average total electric bill savings: Missouri participants by battery program in 2025

	Average TOU savings (Percentage of total home use cost)		
	Battery-only		PV-coupled
Battery program	High-differential rate	Low-differential rate	Low-differential rate
Backup Power	$335 (15%)	-$25 (-2%)	-$17 (-1%)
Both	$236 (13%)	-$22 (-1%)	$41 (6%)
Cost Savings	$243 (16%)	-$15 (-1%)	$37 (4%)

Within the high-differential TOU rates, pilot batteries programmed to prioritize backup power produced the highest dollar amount of cost savings; however, batteries prioritizing cost savings produced slightly higher savings as a percentage of the total home electricity use cost. It is possible that this nuance is due to differences in average home sizes and related baseline consumption among participants, though exploring this was outside the scope of this evaluation.

For battery-only systems on the low-differential RPAS rate, batteries programmed to prioritize cost savings similarly produced the greatest (or least negative) savings overall. Results varied more among battery programs for PV-coupled systems, all of which were on the low-differential RPAS rate. Batteries with Both Backup Power and Cost Savings programming produced the highest savings overall, with the Cost Savings group close behind. PV-coupled batteries programmed to prioritize backup power produced the lowest (and slightly negative) savings overall, as they focused on maintaining higher states of charge (Table 4).

The Missouri pilot had seven battery-only participants on the RPAS rate and two PV participants in the Backup Power program, totaling nine participants that Cadmus estimated experienced bill increases as a result of using the batteries for TOU arbitrage. Cadmus estimated that the remaining 41 of 50 (82%) Missouri pilot participants saved money on their electricity bills as a result of participating in the pilot.

Demand Response Events

In typical daily operation, Evergy's RBES pilot batteries use historical data to anticipate the home's demand and maintain sufficient reserve power to follow the home's load throughout the day. During demand response events, however, rather than attempting to maintain enough power to follow the home's historical load after the events end, the batteries discharge more power than usual to offload greater peak demand from the grid. All pilot events ran from 4 p.m. to 6 p.m., or the first half of the TOU on-peak period.

Figure 2 presents the average hourly power flow of Missouri pilot batteries during 2025 event and comparison non-event days. As shown in the figure, batteries discharged more power, on average, during the 4 p.m. to 6 p.m. window on event days than on non-event days. The effect is muted for PV-coupled systems because solar generation during those hours in the summer is typically sufficient to offset substantial home consumption, meaning batteries have less home load available to offset than batteries installed in homes without solar.[8]

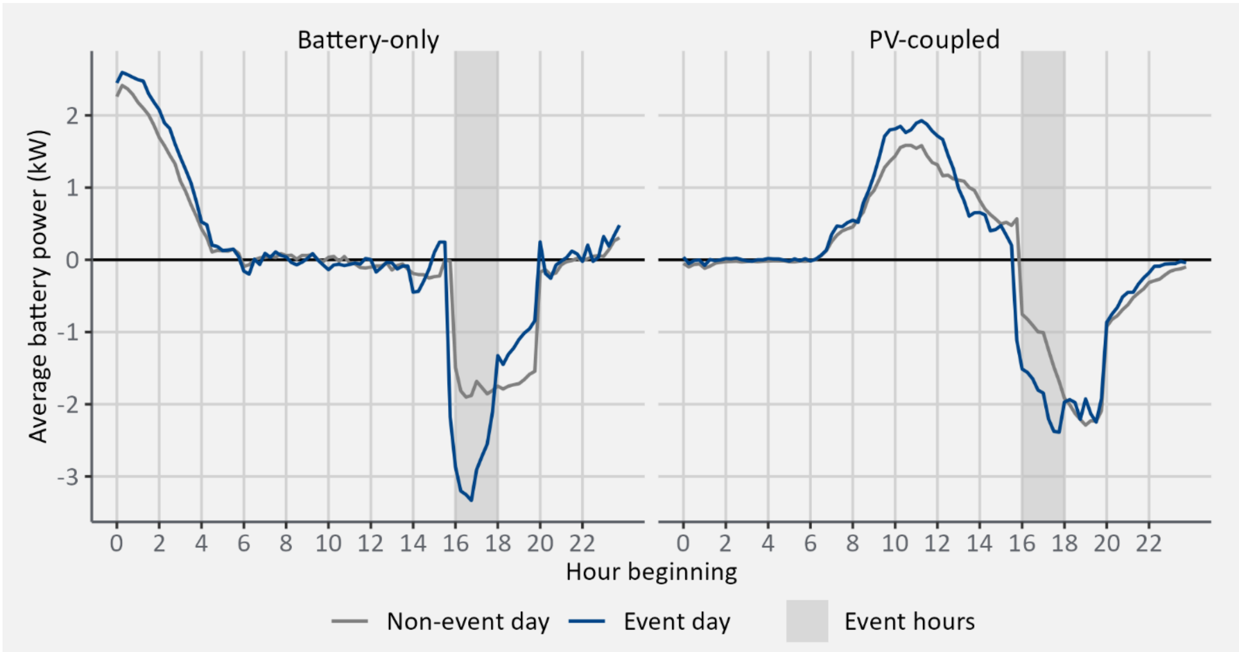

Figure 2. Average hourly power of Missouri pilot batteries on event and comparison non-event days in 2025.

Battery discharge during peak hours, regardless of whether an event was called, improved over time. This higher baseline discharge sometimes diminished the impact of the events themselves, despite increased discharge during the events. Table 7 shows the average battery discharge from 4 p.m. to 6 p.m. on event and non-event days in 2023, 2024, and 2025, along with estimated event impacts and average remaining energy stored in the batteries after the events. Cadmus estimated event impacts using an OLS linear regression of all events in a pilot year and found that all were statistically significant at the 90% confidence level.

Table 7. Demand response event summaries by year

Pilot			Battery average			
Year	Events	State	Baseline discharge (kW)	Event discharge (kW)	Estimated impact (90% CI) (kW)	Post-event stored energy (kWh)
2023	15	MO (PY1)	0.90	1.78	0.88 (0.81, 0.94)	8.99
2024	13	MO (PY2)	0.94	2.06	1.11 (1.07, 1.16)	8.48
2025	7	MO (PY3)	1.31	2.23	0.92 (0.86, 0.98)	7.92
		KS (PY1)	1.34	2.03	0.69 (0.65, 0.72)	8.70

[8] Evergy is testing battery programming for battery-to-grid exports during demand response events for PV customers with net metering.

As the table shows, the Missouri batteries increased both the baseline and event discharge on average as the pilot progressed (although not always proportionally, as the MO PY2 impacts were statistically greater than the MO PY3 impacts). The average baseline discharge was similar between Missouri and Kansas batteries in 2025 (MO PY3 and KS PY1), showing improved default programming. However, while the event days in 2025 were the same for the Kansas and Missouri pilots, the average event discharge for Kansas batteries in 2025 was most similar to Missouri in 2024 (MO PY2), suggesting there is still an opportunity for improved event programming.

As noted in the *Peak Demand Reduction* section, participant homes typically consumed about 2 kW to 3 kW on average during peak hours, meaning battery discharge was not, on average, constrained by home load and could have been further increased to match home consumption. This pattern of batteries not discharging to their full potential is not unique to the Evergy pilot and has been observed in other studies of demand response (Olig et al. 2024) and solar self-consumption (Marin and McAuley 2025; Forrester, Barbose, and Miller 2022). More study is still needed to determine optimal discharge strategies.

Backup Power During Outages

In addition to TOU rate arbitrage benefits, the pilot batteries also provided participants with backup power during grid outages. During the Missouri pilot, eight of 40 participants experienced outages in PY1, 28 of 49 experienced outages in PY2, and 25 of 50 experienced outages in PY3. In PY1 of the Kansas pilot, 40 of 100 participants experienced outages. Based on the outages Evergy reported, Cadmus analyzed battery telemetry data to verify that the batteries provided backup power during outages and found that batteries appeared to reliably provide backup power.[9]

In almost all cases, batteries began discharging power to the home when the grid power outages began and provided backup power to the affected homes for the full duration of the outage. Exceptions typically involved solar output meeting the home's demand for a portion of the outage, after which the battery resumed discharging to power the home. One notable exception, however, was a multiday outage during which the participant's battery provided backup power for 17 hours before depletion.

Figure 3 shows an example of a grid power outage (shaded in purple) experienced by a Kansas pilot participant in 2025. The blue line represents battery inverter power, the black line represents the home's energy draw from the grid at the meter, and the green line represents home energy consumption net of the battery (home + inverter = grid). As shown in the figure, the grid circuit experiences an outage beginning around 12:30 p.m., and the home's grid power drops to zero. However, the home continues to consume energy from the battery's sustained discharge throughout the outage. Importantly, despite the midday outage, the battery continues to discharge for the entirety of the following on-peak period to provide peak demand shaving to the grid and TOU bill savings to the participant.

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[9] Evergy collects outage information at the distribution circuit level, while telemetry data is at the individual customer level. Since portions of a circuit can lose power while other sections remain energized, there can be latency before customer-specific outages are detected and reported. This delay can cause Evergy's reported outage start and end times to deviate from the more immediate and localized outage indications captured in the battery telemetry.

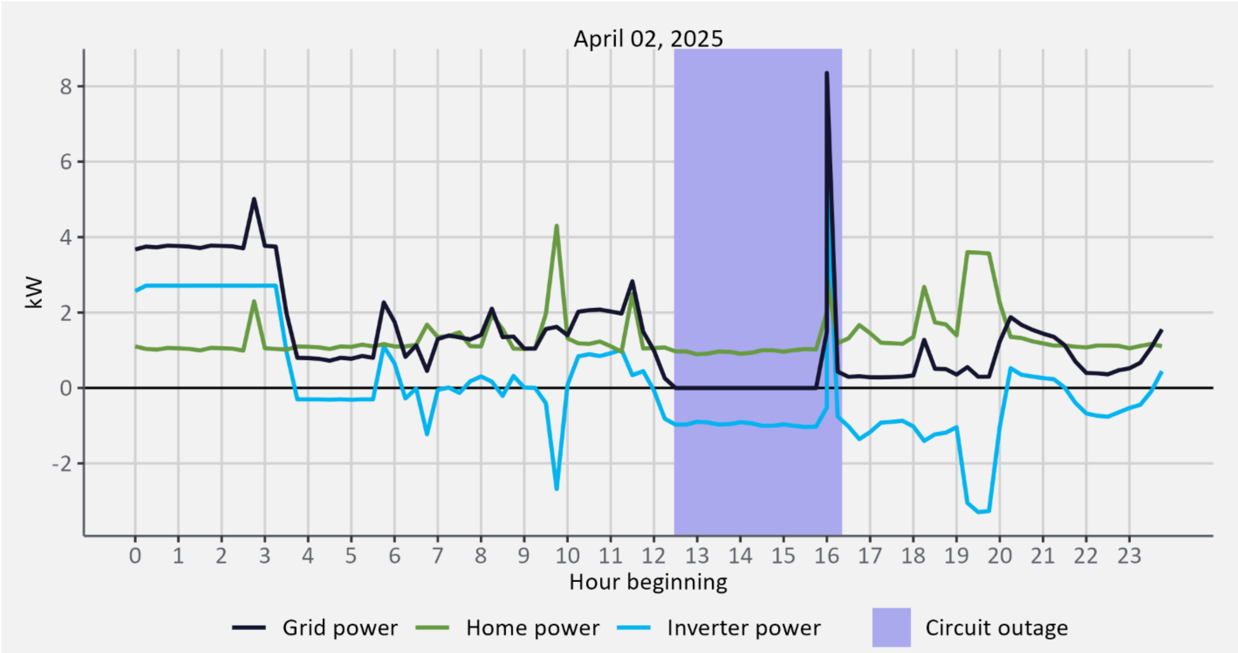

Figure 3. Example grid power outage of a Kansas pilot participant in 2025.

Participant Satisfaction

Evergy conducted two surveys in 2024 (MO PY2) to assess Missouri participant satisfaction with the pilot: one in March through April (Early Evaluation Survey, response *n* = 50 [100%]) and one in September through October (Anniversary Survey, response *n* = 45 [90%]). Overall, survey results showed that respondents were highly satisfied with their pilot experience and battery system benefits. In addition, although many respondents experienced power outages while participating in the pilot, their batteries performed as intended, and thus they were not negatively impacted. However, respondents were mixed on whether they experienced the bill savings that the telemetry analysis detected. Despite that, most respondents indicated they were likely to recommend a battery system to others.

Survey respondents rated their overall satisfaction with the pilot on a 10-point scale, where 1 meant *not at all satisfied,* and 10 meant *very satisfied*. The percentage of those who were satisfied (indicated by a rating of 8, 9, or 10) increased from 58% in the Early Evaluation Survey to 79% in the Anniversary Survey (Figure 4). The average overall satisfaction rating increased from 7.4 in the Early Evaluation Survey to 8.6 in the Anniversary Survey. The increase in participant satisfaction over time is contextually supported by the impact evaluation findings, which show improvements in battery programming and performance throughout the pilot.

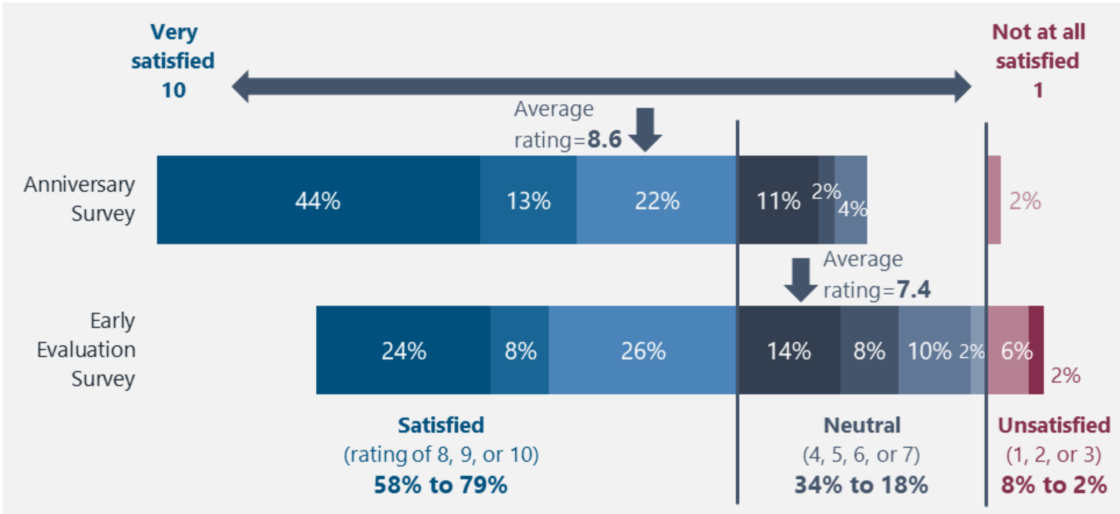

Figure 4. Missouri pilot participant satisfaction with the battery storage pilot. *Source*: Early Evaluation Survey Question 2 and Anniversary Survey Question 1. "Overall, how satisfied are you with the Battery Storage Pilot program so far?" (1=*not at all satisfied*; 10=*very satisfied*)

Survey respondents highly rated battery system benefits, with an average rating of 7.8 across all respondents on a 10-point scale (where 1 meant benefits worked *very poorly* and 10 meant benefits worked *very well*). In response to an open-ended question asking what they especially like about the pilot, the most frequently cited response by a wide margin was having backup power (44% of respondents), followed by savings and technology (each mentioned by 18% of respondents).

Most respondents (73%) reported experiencing a power outage at their home. Of those who experienced an outage, 82% said the battery storage equipment worked as expected and provided power to their critical household systems. This direct participant feedback on backup power performance corroborates the evaluation findings and adds the invaluable context of the quality of participants' lived experience, which telemetry data analysis alone cannot establish.

While only 18% of respondents mentioned savings as a response to the open-ended question about what they liked about the pilot, many more (42%) said that they had saved money on their electricity bills as a result of participating in the pilot (31% said they did not save money, and 27% said they were not sure). However, there is still a disconnect between participants' perceptions and what the data show: our analysis indicated that over 80% of participants saved money on their electric bills as a result of the batteries' TOU arbitrage.

In a study by Gorman et al. (2025), it was found that the reliability value of backup power to customers is outweighed by the opportunity cost of decreased discharge and resulting bill savings in almost all scenarios, which should be considered when noting that RBES pilot survey respondents were less sure of electric bill savings and more heavily favored the backup power provided by batteries. The variation between customer perceptions and evaluation findings highlights the continued need for further research on customer preferences and influencing factors surrounding DER-based demand management solutions.

The ultimate finding of the participant surveys was that most survey respondents (67%) said they were likely to recommend a battery storage system to a friend or relative, providing a rating of 8, 9, or 10 on a 10-point scale (where 1 meant *not at all likely* and 10 meant *very likely*).

The average rating for likelihood to recommend a battery storage system was 7.9 across all respondents (Figure 5).

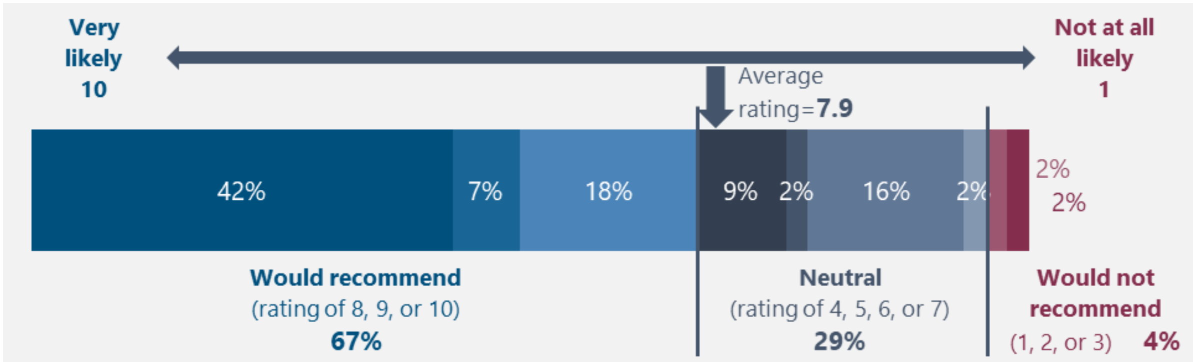

Figure 5. Missouri pilot participants' likelihood to recommend a battery storage system. Source: Anniversary Survey Question 20. "Having used your system for about a year, how likely are you to recommend a Battery Storage system to a friend or relative?" (1=not at all likely; 10=very likely)

Additionally, at the conclusion of the Missouri pilot, Evergy offered each participant the option to purchase their battery at a depreciable value or have it removed free of charge, and 33 of the 50 pilot participants (66%) elected to purchase their batteries for continued use.

Lessons Learned

The implementation of Evergy's RBES pilot resulted in several lessons across program administration, customer interaction, and technology integration. In addition, the pilot evaluation findings support the viability of residential battery storage as a DER and demand response resource, with key lessons surrounding customer buy-in to grid management responsibility and solutions.

Program Administration. *From an administrative standpoint, early planning and resourcing proved critical to program success*. Engaging multiple qualified installers increased scheduling flexibility and reduced deployment risk, while a dedicated internal utility staff ensured consistent oversight across customer engagement, permitting, and vendor coordination. However, site selection required significant effort: 100 site visits were necessary to identify 50 viable installations in Missouri, even after initial prescreening, reinforcing the importance of robust up-front screening criteria. Refining this process enabled staff to use phone screenings alone in Kansas, avoiding costly site visits. Local permitting requirements also varied significantly by jurisdiction, often introducing schedule uncertainty, and homeowner association restrictions were a frequent barrier that needed to be proactively avoided. Similarly, utilities must plan for the storage of batteries and installation equipment, staging logistics, and interconnection timelines well in advance, as installed battery systems require extensive ongoing monitoring and operational coordination. Clear data-sharing policies with vendors were also essential to support operational visibility and long-term asset management.

Customer Interaction. *Customer interaction emerged as a defining factor in program performance.* Pilot participants frequently interacted with their storage systems in unexpected ways, including installing firmware updates or performing manual breaker operations, underscoring the need for clear operational boundaries and education. In addition, many participants did not know their electrical service capacity, which created downstream issues during installation and commissioning. Evergy found that marketing and outreach efforts were most effective when they included targeted education on TOU rates and clearly differentiated messaging for solar versus non-solar customers. Providing participants with agreements early in the enrollment process helped set expectations and reduce friction later in deployment. Structured, frequent communication was necessary to maintain participant understanding and trust throughout installation and operation. Despite these efforts, recruitment of non-solar participants remained challenging, suggesting that future programs may need tailored incentives or engagement strategies for this segment.

Technology Integration. *From a technology and grid-operations perspective, the RBES pilot reinforced that there is no one-size-fits-all approach to DER deployment*. Effective operation required real-time model synchronization across utility systems to support accurate power flow analysis, dynamic grid topology updates, and situational awareness. Controlling multiple DER aggregations in coordination with existing network assets was essential to achieve operational value, particularly during peak events or system constraints. Standardized integration models enabled the utility to interface with multiple vendors while maintaining consistent access to DER data, control capabilities, and health monitoring. Advanced forecasting capabilities—including DER flexibility forecasts and load forecasts informed by weather services—were critical inputs for operational planning. Most importantly, providing grid operators with clear visibility and control of DER assets supported improved emergency management, reliability, and overall system optimization.

Residential Battery Storage Viability. *The RBES pilot demonstrated the viability of residential BTM battery energy storage systems as a reliable DER, both with and without solar attachment.* Battery programming improved over time to solidly align battery charging with the lowest-cost strategies (overnight from the grid for battery-only systems and midday from excess solar for PV-coupled systems) and battery discharging with the TOU on-peak period. Demand response events produced statistically significant increases in battery discharge during on-peak event times relative to baseline discharge in every year of the pilot. However, battery operations management is expected to continue to mature, supporting BTM fleets in reaching their full demand response potential. Utilities prioritizing peak demand shifting should consider discharging batteries as aggressively as possible during peak periods, potentially even enrolling participants in net metering so batteries can discharge in excess of home demand during peak. However, battery TOU arbitrage must be balanced with stored energy reserves, as Evergy pilot participants identified backup power as their favorite attribute of the storage systems.

Customer Perception. *While the impact evaluation showed promise for the battery storage systems, no program can achieve impact without participation*. Missouri pilot participants' satisfaction appeared to improve as battery performance improved over time, with Evergy refining the pilot battery programming. Two out of three participants said they would recommend a battery storage system, and the same proportion later purchased their batteries from Evergy at the conclusion of the pilot. However, despite general satisfaction and even enthusiasm for the batteries, less than half (42%) of Missouri pilot participants believed that participating in the pilot saved them money on their electricity bills, even though telemetry analysis showed that over 80% saved money as a result of the battery TOU arbitrage. Emphasizing non-monetary benefits of battery storage, such as peace of mind from greater backup power, rather than electricity bill savings from more aggressive TOU arbitrage, may help utilities engage customers to be a part of the solution to grid demand management through long-term DER adoption.

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AI Disclosure

During the drafting of this paper, the authors used Microsoft Copilot for minor editing and readability improvements. The authors have reviewed, verified, and assume full responsibility for all content.