**BEFORE THE PUBLIC SERVICE COMMISSION OF THE STATEOF MISSOURI**

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| In the Matter of Evergy Metro, Inc. d/b/a Evergy Missouri Metro's Request for Authority to Implement a General Rate Increase for Electric Service | ) ) ) ) | **Case No. ER-2022-0129** |
| In the Matter of Evergy Missouri West Inc. d/b/a Evergy Missouri West's Request for Authorization To Implement a General Rate Increase for Electric Service | ) ) ) ) | **Case No. ER-2022-0130** |

**EVERGY MISSOURI METRO'S AND EVERGY MISSOURI WEST'S NOTICE OF COMPLIANCE FILING**

**COME NOW**, Evergy Metro, Inc. d/b/a Evergy Missouri Metro ("EMM") and Evergy Missouri West, Inc. d/b/a Evergy Missouri West ("EMW") (collectively, "Evergy" or "the Company") and, for their *Notice of Compliance Filing* ("Notice"), states to the Missouri Public Service Commission ("Commission") as follows:

1. On September 6, 2022, the Company filed a *Stipulation and Agreement Regarding Programs and Electric Vehicle Charging Tariffs* ("Agreement") which was approved by the Commission's November 21, 2022 *Report and Order* and subsequent December 8, 2022 *Amended Report and Order.*

2. Pursuant to the provisions of the Agreement[1], the Company submits the attached:

**Exhibit A:** *Evergy Missouri Residential Battery Energy Storage Pilot Program Learning Objectives*

**Exhibit B:** *Evergy Missouri Residential Battery Energy Storage Pilot Program Literature Review*

[1] "C. The Company will do the following:
1. The Company will file in this case a statement outlining all learning objectives for the pilot, including all hypotheses the Company seeks to test, identified on a Company specific basis along with a current literature review.[…]"
(See, *Agreement*, § 5.C.1., p. 4)

**WHEREFORE,** the Company submits the attached to the Commission pursuant to the Agreement.

Respectfully submitted,

*/s/ Roger W. Steiner*

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**Attorneys for Evergy Missouri Metro and Evergy Missouri West**

**CERTIFICATE OF SERVICE**

I hereby certify that a true and correct copy of the above and foregoing document was served upon counsel for all parties on this 14th day of July 2023, by either e-mail or U.S. Mail, postage prepaid.

*/s/ Roger W. Steiner*

Roger W. Steiner

# Evergy Missouri
# Residential Battery Energy Storage
# Pilot Program
# Learning Objectives

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## Overview & Intent

Evergy submits its learning objectives of the Residential Battery Energy Storage Pilot. The submittal of these objectives is responsive to the *Stipulation and Agreement Regarding Programs and Electric Vehicle Charging Tariffs* from Case No. ER-2022-0129/0130.

The Residential Battery Energy Storage Pilot ("RBES" or "Pilot") will evaluate the role of battery energy storage systems in producing customer savings and providing benefits to Evergy's electrical system. The Pilot will consist of the installation of 50 battery energy storage systems at residential sites across Evergy's Missouri ("Evergy" or "Company") jurisdictions with the goal of an equitable customer participation in the MO Metro and MO West service territories. The battery sizes targeted have a capacity of approximately 4.5 kW or 6 kW and 19.4 kWh each. Evergy will evaluate battery sizes and select options that will closely align with the participant's load and demand response potential.

The Pilot will capture operational data from the battery systems during a three-year period (from 2023-2025). The Pilot duration will allow two and a half years to collect, measure and analyze data and conduct a post Pilot evaluation, measurement, and verification to gather results and support findings from the Pilot. At the conclusion of the Pilot, Evergy will evaluate the customer savings and utility benefits of the Pilot and present the results to the Missouri Public Service Commission ("Commission").

As a pilot, RBES will advance Evergy's operational knowledge of how battery energy storage systems can achieve utility and customer savings, while also providing additional operational benefits. The battery energy storage system in the Pilot will utilize various charge and discharge scenarios to evaluate which patterns produce the greatest savings impact to participating customers and the grid with the least amount of impact to daily consumption patterns and suboptimal times to export back to the grid.

The Pilot is consistent with the objectives of Senate Bill 564, (Section 393.1610 RSMo.) which provides for the utility to implement pilots such as this and allows for Commission approval. Section 393.1610 states:

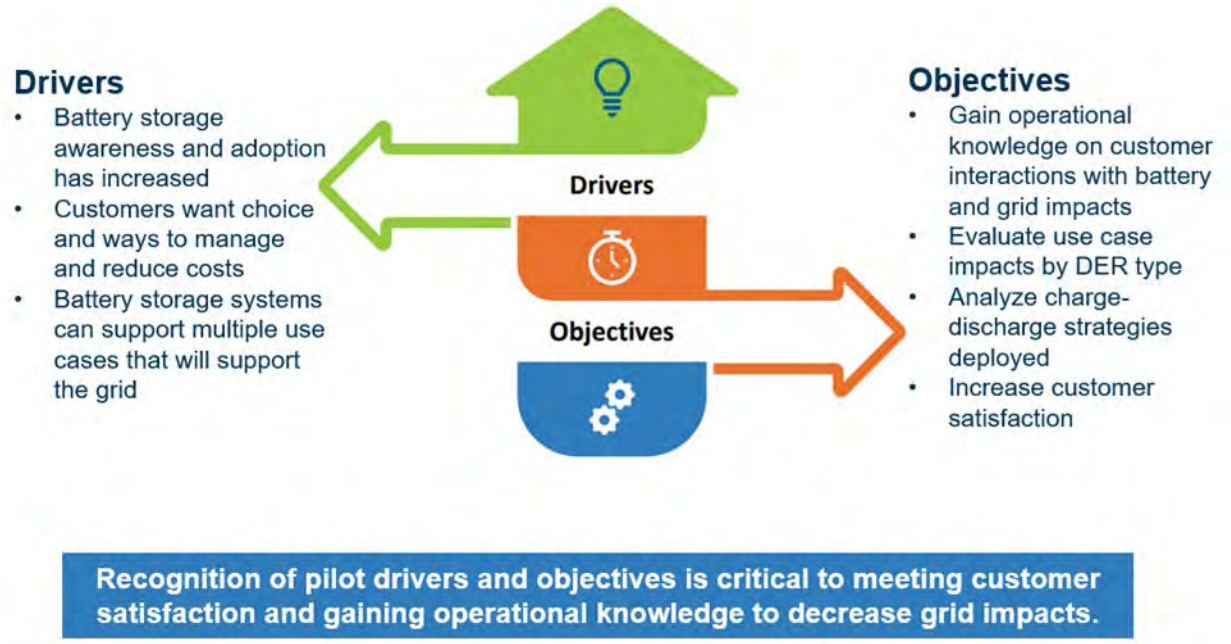
> *"The commission may approve investments by an electrical corporation in small scale or pilot innovative technology projects, including but not limited to renewable generation, micro grids, or energy storage, if the small scale or pilot project is designed to advance the electrical corporation's operational knowledge of deploying such technologies, including to gain operating efficiencies that result in customer savings and benefits as the technology is scaled across the grid or network."*

## Pilot Timeline


The Company will provide stakeholders an update on the pilot and the current data collected on a semi-annual basis through the end of 2025

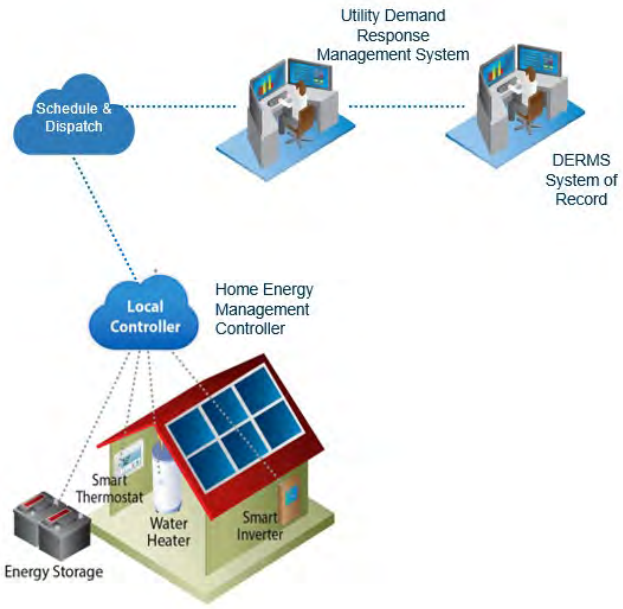
## Learning Objectives

Learning objectives of the Pilot will explore how a network of battery energy storage systems supporting customer and grid use cases can reduce demand and minimize distribution constraints on Evergy's electrical grid. The Pilot will explore the behavioral interaction and acceptance of battery storage technology of participants utilizing home energy management controllers to manage their energy consumption and produce bill savings.




The Pilot will utilize an end-to-end demand response management system ("DRMS") platform to schedule and dispatch batteries, coordinate charge and discharge scenarios and track asset health and performance. The Company will utilize a portion of the stored energy in the battery system to support reductions in peak power purchases and managing localized distribution system constraints. The Pilot will gain knowledge on how batteries connected to a demand response management system have quicker response times and can be used to help maintain distribution system power quality issues and support grid reliability. The Pilot will explore and evaluate customer interest in resilience as batteries are a source of back-up power during short-term power outages.

**Fig 1.0 Demand Response Management System Asset configuration diagram**




The Company will gain key operational insights into system-to-system integrations and asset configuration. The increased visibility into asset availability and performance, overlayed with a network topology allows for those resources to be segmented and optimized to support a variety of use case needs. This optimization allows for increased granularity on grid needs and asset(s) capabilities with which could be coupled with other DER's to mitigate length of events or numbers of events per asset.

The Pilot has identified several key operational and customer objectives that will be evaluated over the duration of the program including:

Operational objectives include:

- Use battery energy storage resources for peak demand reduction
- Use battery energy storage to support self-consumption of renewable energy which can minimize distribution grid impacts and increase hosting capacity of the existing distribution systems
- Improve utility grid operations by battery energy resources to help maintain power quality and reliability of the distribution grid and to address localized distribution constraints

Customer objectives include:

- Create retail savings for customers on time-of-use ("TOU") rates
- Integrate storage technology platform with renewable energy or smart technologies to optimize home energy use
- Provide a source of back-up power for customers during grid outages

Energy storage devices can supplement household consumption where demand response can be achieved with less discomfort to customers. The Pilot will evaluate how battery storage systems may be capable of offering greater demand response potential and flexibility potential with less end use consumer discomfort than some HVAC focused distributed energy resource devices. As the need for dispatchable distributed energy resources grows the Pilot will explore how these resources compare to existing demand response resources utilized by the Company.

The Pilot will analyze participant billing consumption data and telemetry data on battery energy flows, photovoltaic ("PV") system output, and home consumption of grid supplied energy to estimate the combined impact of the batteries and transition to a TOU rate on customer bills.

## Use Cases & Hypotheses.

The value of battery energy storage systems is derived primarily from the ability of the battery to "shift" energy use from periods of lower demand or pricing to periods of higher demand or pricing. Batteries can also be used to provide other benefits to the distribution grid, including voltage control, frequency control, and meeting reactive power needs. Batteries can respond very quickly to changes and are thus well suited to support distribution grid services in rapidly changing conditions.

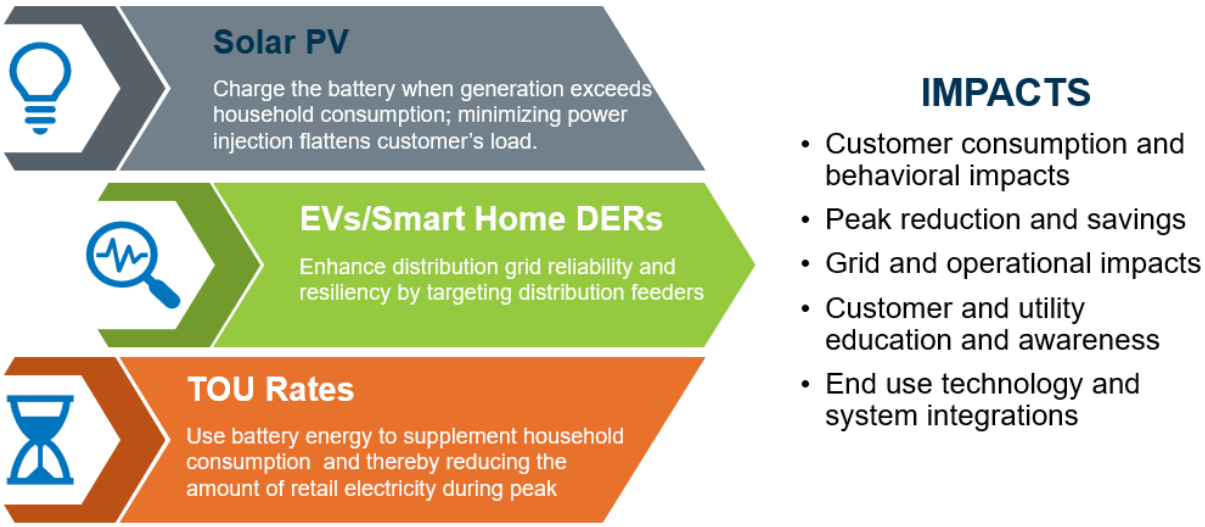
When batteries are in discharge mode, the battery discharges energy, behaving like a generator. Unlike a conventional generator, energy discharged from a battery is limited by the maximum capacity (measured in kW) and storage duration (measured in kWh) of the battery.[1] In residential behind the meter ("BTM") applications, batteries can be used to supplement household electricity consumption or to export power to the grid (if allowed by wholesale market policies and/or utility programs).

The benefits of BTM storage to customers will be influenced by several factors, including the customer's energy use profile, customer rate program, presence of customer-owned smart technology, customer location and behavior preferences. To evaluate these benefits across a range of factors, Evergy is seeking program participants which have a combination of the following characteristics:

- Customers enrolled in TOU rates
- Customers seeking to integrate storage with solar rooftop PV systems
- Customers which own electric vehicles or other smart home devices

[1] A storage duration of approximately 4 hours is typical for lithium-ion technology batteries.

**Figure 1.1 Residential Battery Energy Storage Pilot use cases and impacts**




A brief discussion of the energy consumption patterns and potential savings for each type of user is provided below.

Customers on TOU Rates. One of the primary applications for batteries in the electric industry is to "shift" energy use from higher to lower-priced periods. A battery storage device for a customer enrolled in TOU rates would typically be charged during the off-peak period, when energy prices are lower, and discharged during on-peak periods when energy prices are higher. The energy produced by the battery when discharging would be used to supplement household consumption, reducing the amount of retail electricity purchased during peak pricing periods. Evergy anticipates that customers on Evergy's TOU rate program would receive the greatest potential retail savings by participating in the BTM storage Pilot program.

Customers with Rooftop Solar PV Systems. Residential customers typically utilize rooftop solar PV systems to supplement or replace retail electricity consumption. In Evergy's service territory, customers can choose to participate in a Net Metering (NM) tariff and receive a credit on their monthly bill for any excess energy produced but not consumed during the month (i.e., energy generated during the month more than monthly household consumption). The bill reduction and retail electricity savings for a customer with a solar PV system is dependent on the size of the solar installation, customer's energy use profile, and the variability in solar production with the solar resource.

Installation of a battery storage system would allow some of the solar energy to be diverted to charge the battery when solar generation exceeds household consumption. By minimizing power injection to the grid or reducing peak energy draw, the customer's load profile would be flattened, which could reduce the impacts of distributed generation on the existing distribution system.

Customers with Smart Home Technology. The Pilot would seek participation from customers which own electric vehicles and other smart home devices. Retail bill savings for customers with this profile are expected to be the greatest for those participating in the TOU program. Customers with multiple DERs that can be co-optimized to extend battery draw, and backup power will lead to broader customer benefits. The Pilot might shed insights on, for example, current customer perceptions of the need/value of resiliency. For example, storage might be desirable for customers who are interested in having access to a back-up power source for critical loads during short-term outages. Detailed information on customer's energy usage patterns may also be available to provide insights on ways to optimize future value streams for both the utility and customers.

## Evaluation Measurement & Verification

Evaluation, Measurement and Verification (EM&V) of Evergy's Pilot program is an essential component to determining program impacts, quantifiable benefits and documenting process and programmatic improvements. Evergy's EM&V plan that will meet the primary objectives outlined below.

## Savings Impacts

The Pilot evaluation launched in Q1 2023 with a project kickoff meeting. An EM&V plan was developed to quantify impacts and evaluate process results from the Pilot. These activities will include.

- Costs/Savings to participants and non-participants
- Costs/Savings estimates to the Company
- Effects on peak demand
- Reliability improvements provided to the grid and customer
- Evaluation of potential localized batteries and associated benefits
- Effects on participant usage/behavior
- Tracking of charging/discharging times
- Tracking maintenance issues and costs
- Participant satisfaction surveys

## Customer Impacts Methodology

Under the Pilot, customers can coordinate their battery systems' discharge and recharge cycles to manage TOU rate billing charges. The evaluation team will analyze participant billing consumption data and telemetry data on battery energy flows, PV system output, and home consumption of grid supplied energy to estimate the combined impact of the batteries and transition to a TOU rate on customer bills. The relevant baseline would be the participant's demand if they had not participated in the Pilot, that is, the participant did not adopt a battery and did not switch to a TOU rate.

We will implement the bill impact analysis following these steps:

(1) Analyze the battery system telemetry data to estimate the hourly net energy flows from the batteries during off-peak and on-peak TOU rate periods.

(2) Calculate the change in customer bills attributable to changes in fixed charges, off-peak and peak period prices, and off-peak and peak period consumption.

Analyze customer bills before and after adoption to estimate the weather-adjusted total consumption and billing charge impacts of Pilot participation from the battery adoption

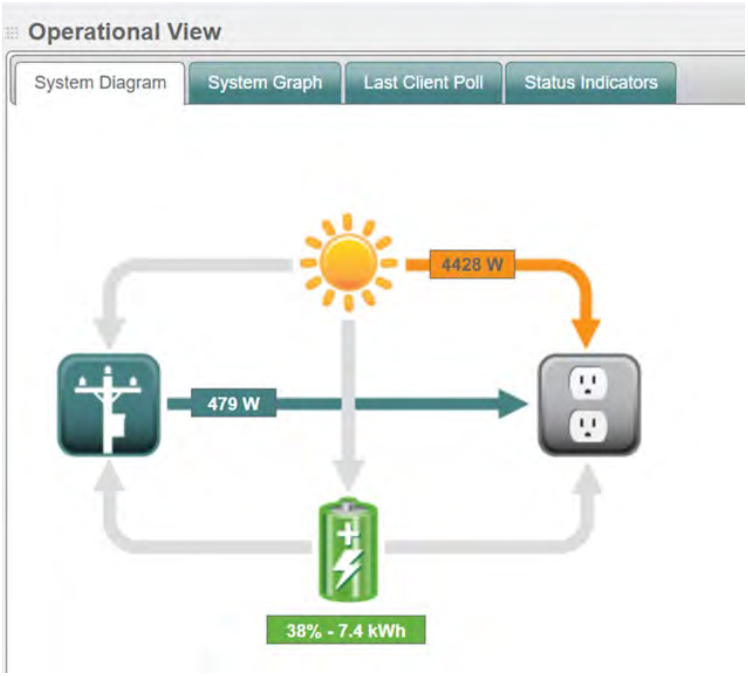
(1) Switching to the TOU rate, provides a top-down estimate of the Pilot billing impact.

(2) Compare the bottom-up and top-down estimates and attempt to reconcile any differences.

## Peak Reduction & Grid Services Impact

The Pilot will seek to enable the Company to provide full visibility and control, linking behind the meter Distributed Energy Resources to core utility enterprise systems. The Pilot will seek to integrate the battery OEM's system to Evergy systems to provide participant unit operational data and status, respond to mode of operation status and test the ability to integrate and act upon real-time data delivered from Company systems or components.

**Figure 1.2 Operational dashboard view of battery to grid interaction from DRMS platform**




The Pilot will identify customers on targeted circuits. During the Pilot period the battery storage system will collect data from each battery discharging to households as backup power during any outages occurring on these circuits during this time. In addition, a validation of the metering data will provide visibility to any voltage reports or issues.

Customers will have local home energy management controllers that will provide.

- Provide real-time optimization of customer benefits
- Additional validation to Pilot testing by minimizing grid impacts and assisting with demand response activities around system capacity and/or distribution constraints
- Ability to optimize and integrate with customer resources (battery, PV, etc.)
- Ability to impact areas of customer bill management, solar self-consumption, and back-up power

Between July 2023 and July 2025, Evergy will call demand response events. The evaluation will aggregate the 5-minute battery energy flow data to 15-minute intervals and estimate the impacts of the events. The demand impacts will be estimated by comparing demand during the demand response event with an estimate of baseline demand. The baseline will be estimated using telemetry data on participant battery energy flow and/or whole home electricity demand. To estimate the demand impacts of each demand response or ancillary grid services event,

Evergy will follow these steps:

(1) Select similar basis days and a baseline estimating method with which to construct the consumption baseline. For example, if the event occurred on a weekday, the basis days could be seven days of the previous ten non-event, non-holiday weekdays with highest electricity demand. Alternatively, the basis days could be the ten closest non-event, non-holiday weekdays on either side of the event, and the baseline could be estimated through a weather-adjusted regression analysis.

(2) Calculate the baseline demand during the demand response event

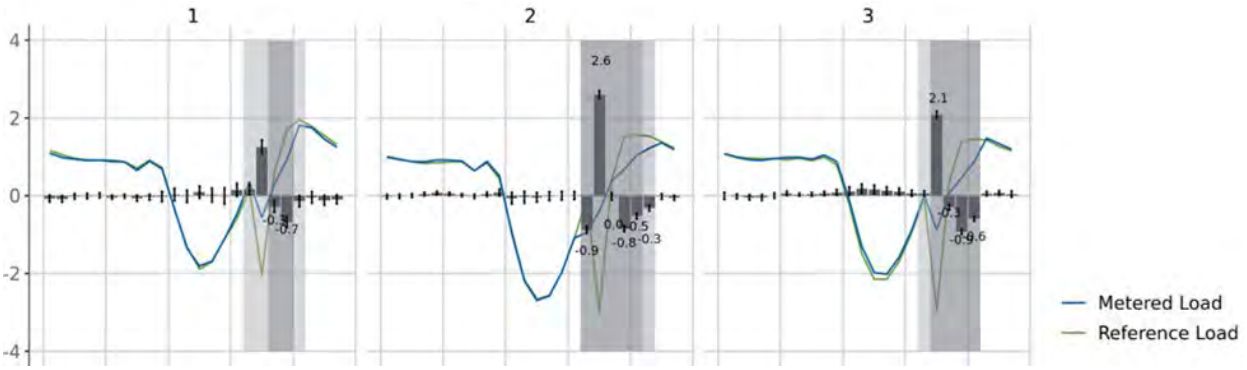
(3) Estimate the demand savings and report the standard error.

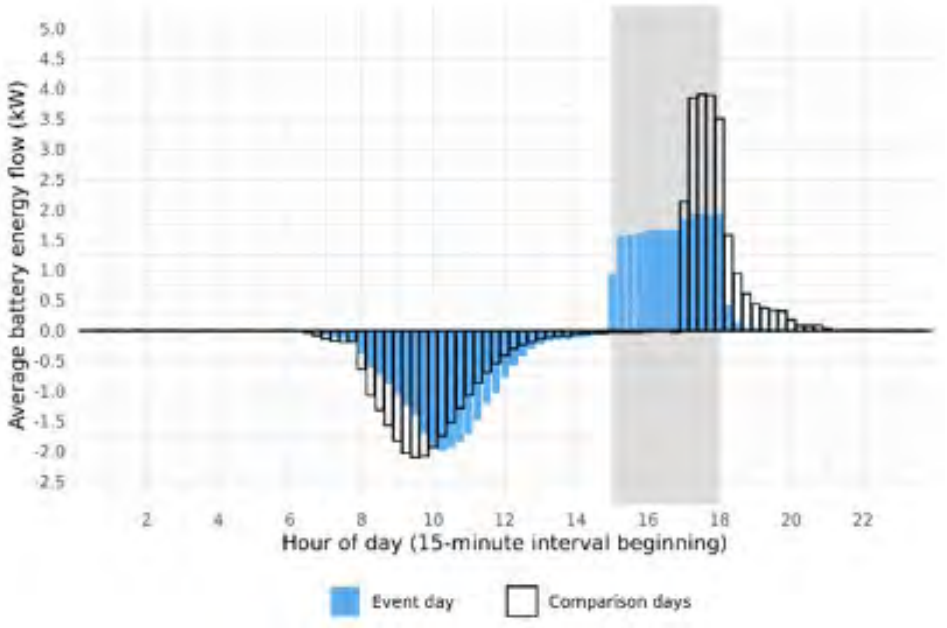
As suggested above, there are many possible approaches for selecting basis days and estimating the baseline. The evaluation team will evaluate the accuracy of different baseline calculation methods for the RBES Pilot. The evaluation team will do this by selecting random non-event days when demand response or grid services events could have occurred and evaluating the accuracy with which different baseline calculation methods can predict demand on the non-event days. Since no demand response event occurred on non-event days, an accurate baseline calculation method should predict a baseline close to the metered demand.

For each event, Evergy will report the following:

- Demand impacts before, during, and after the demand response impacts to document pre- and post-event demand impacts.
- Standard errors and 95% percent confidence intervals to show whether the impacts are statistically different from zero and the uncertainty of the estimates
- Visualizations of the demand response and grid services impacts showing the baseline demand, the metered electricity demand, and the event impacts.

**Figure 1.3 Example of potential Demand Response and Grid Services Impact**






## Process Approach

Evergy will conduct two process evaluation tasks:

- Interviews with RBES program managers
- Materials Review

In 2024, the evaluation team will conduct separate interviews with the Evergy Program Manager and the Battery System Program Manager. The main purpose of the interviews will be to document lessons learned that can be used in scaling the program and improving the program performance and customer experience.

The interviews will cover the following topics:

- Pilot objectives
- Pilot implementation
- Pilot marketing and outreach
- Customer experience
- Control and communications systems integration
- Successes, challenges, and outstanding questions
- Lessons learned
- Plans for future program delivery

The evaluation team will distribute an interview guide with questions to Evergy and the battery OEM managers at least three working days in advance of the interviews.

The evaluation team will summarize the main findings of and conclusions from the interviews as part of a short process evaluation power point presentation. The key findings and takeaways will also be incorporated into the Pilot final report.

In 2024, the evaluation team will conduct a materials review. The materials review will involve the following activities:

- **Review of the Pilot logic model**. A logic model shows the expected relationships between Pilot activities, outputs, and intermediate and long-term outcomes. The Evergy team will review the logic model for accuracy and completeness and recommend changes to improve it. The logic model will also be used to guide the program manager interviews.
- **Review of Pilot regulatory filings**. Along with the program manager interviews, review of Pilot regulatory filings will help to ensure the evaluation team has a deep and comprehensive understanding of public utility commission and other stakeholder priorities for and concerns about the Pilot. Regulatory filing review will also help to ensure that the Evergy team's research is focused on the key policy questions and that the evaluation report addresses regulator and outside stakeholder questions and concerns.
- **Review of print, on-line, and other customer education, marketing, and Pilot communications.** The Evergy team will review these materials to understand and identify opportunities for improving how Evergy educates customers about the potential benefits of BTM batteries, markets the Pilot to residential customers, and communicates to participants about demand response events and opportunities for bill savings. The evaluation team will assess Evergy's communications against industry best practices for educating, marketing, and communicating with residential customers about demand response.

## Research & Substantiation

### Comparison of existing utility behind the meter energy storage programs

In this report, Evergy provides an overview of five existing battery storage programs that are relevant to the Study. With an eye toward understanding the success factors involved in established battery storage programs, Evergy examined program design, ownership model, customer enrollment and eligibility requirements. The programs included in this evaluation are:

- Consumers Energy
- Portland General Electric
- Arizona Public Service
- Liberty Utilities
- Alectra Utilities

These programs were selected because they provide program data and success factors on battery storage pilot deployments. Evergy primarily focused on programs with a utility ownership model; however, the Company did evaluate customer owned models as well and examined critical success factors and lessons learned.

## Summary of Programs

**Consumers Energy's** residential battery pilot program will collect data to help the utility understand how this technology will impact their grid system at a large scale. The utility already has fifty residential batteries in the field; the new proposal will add an additional 2,000 batteries, two at each of 1,000 residential customer homes. The main objectives of the new program are:

To collect battery performance data as both a standalone measure, and when connected to rooftop solar. The utility wants to accurately estimate the benefits they can expect from batteries. This includes generation capacity avoided costs, energy avoided costs, avoided system losses, electricity voltage and frequency support, and the avoided capital costs for installing batteries as an alternative to distribution infrastructure investments. To test different battery ownership models. The program includes two different participation options. Customers can either pay a monthly subscription fee to have access to utility-owned batteries in the event of a power outage or purchase the battery system and then get performance incentives whenever the utility discharges the battery to manage peak demand. 1. The utility-owned program has a resiliency as a service model for customers. The monthly customer fees were calculated to ensure that the customer fee and the sum of capacity, energy, and distribution referral savings for the utility offset the program costs. 2. For the bring-your-own-device (BYOD) programs, the customer incentive ranges from $800-1,050 per kW enrolled in the program. The customer must sign a contract with the utility confirming that, for 10 years, they will only use their battery as a source of backup power during an outage. Customers can charge the battery from a rooftop cellar, if applicable. These customers also have a right to use the battery during outages.

**Figure 1.4: Two participation options for Consumers Energy's proposed battery pilot**

| | Eligibility | Contract Length | Costs and Incentives |
|---|---|---|---|
| Company -Owned | Participating customers must own their own home and have a Smart Meter at their home. | 10 years | Customer pays up to $49 per month to Consumers Energy for resiliency service |
| BYOD | • Participating customers must own their own home and have a Smart Meter at their home.<br>• New BYOD battery is preferred, but existing batteries at the customer's home may be acceptable if the Company determines that performance expectations can be met for full term of contract.<br>• The BYOD battery must be capable of receiving Application Programming Interface ("API") commands to charge and discharge from the utility pilot management software.<br>• The Company will develop an approval process and a list of pre-approved battery systems after conducting the Request for Proposals ("RFP").<br>• Battery must operate for entirety of a 3-hour discharge window.<br>• Customer must agree to limit their use of the battery to only back-up power.<br>• Customer is responsible for maintenance on the battery. | 10 years | Consumers Energy pays up to $1,050 per kW (estimated, may change after RFP) to customer upfront for battery control and discharge to grid during peak system conditions and for other pilot testing purposes. |

**Portland General Electric (PGE)** program will manage the charging and discharging of 525 residential batteries to provide energy to the grid and help reduce demand during peak grid load. The program is a customer owned battery design where participating customers will receive.

- $20 monthly bill credit if the battery can only charge from a PV system
- $40 monthly bill credit if the battery can charge from a PV system or PGE's grid
- Up to twenty-five income qualified customers can receive a $5,000 rebate for their battery system

- Up to two hundred customers who participate in PGE's pilot can receive rebates from $1,000 to $3,000 for their battery system

**Arizona Public Service** offers a Storage Rewards program for customers which provides two options under their utility ownership design.

- One time $500 bill credit for participants
- Free equipment installation

The program intent is designed to study the impact of using battery storage as an energy source during high energy use periods. The pilot commitment is for 10 years or if the program is available, and the battery is functional.

**Liberty Utilities** offers a home battery storage pilot for their New Hampshire service territory. The pilot approved in 2019 was one of the first to combine battery storage with time of use (TOU) rates. The installed utility owned batteries will be charged overnight during off peak times, then the power will be utilized during critical peak times during the day.

For customers with solar the batteries may be charged with solar panels and utilized when the sun is not shining. The off-peak rate is expected to be a savings of over $0.10/kWh during the summer months compared to residential base rates.

Customers pay $25 per month to participate and customer agreements last for ten years. The initial phase will consist of two hundred batteries with a second phase adding an additional three hundred batteries.

The pilot will serve as the basis for a "Bring Your Own Device" program which will allow for future expansion of the program and broader customer choice with more OEM's.

**Alectra Utilities** in Ontario offers their Power House Hybrid pilot program was designed to develop and test cloud-based energy management solution and learn more on how battery storage can support customer choice with decentralized solutions.

The multi-phase pilot began in 2018-2019 with planning and procurement for ten utility owned batteries to serve residents within a concentrated area to build a virtual power plant (VPP) solution that will serve as a mutually beneficial solution for customers and the utility.

The three phases include.

- Phase 1: Planning & Procurement (2018-2019)- Development of key working teams, updated project management and evaluation plan, communication and engagement strategy followed by customer screening and enrollment.
- Phase 2: Installation (2019-2020)- Installation (including site audits and implementation) shipping and installation of all equipment and software; integration between physical and digital assets.
- Phase 3: Operation & Outreach (2020-2022)- Customer and technological support; measurement and verification; continued system operation.

Key drivers intended from the pilot include improved reliability, reduced electric bills, reduced GHG emissions and support of clean energy jobs and market transformation.

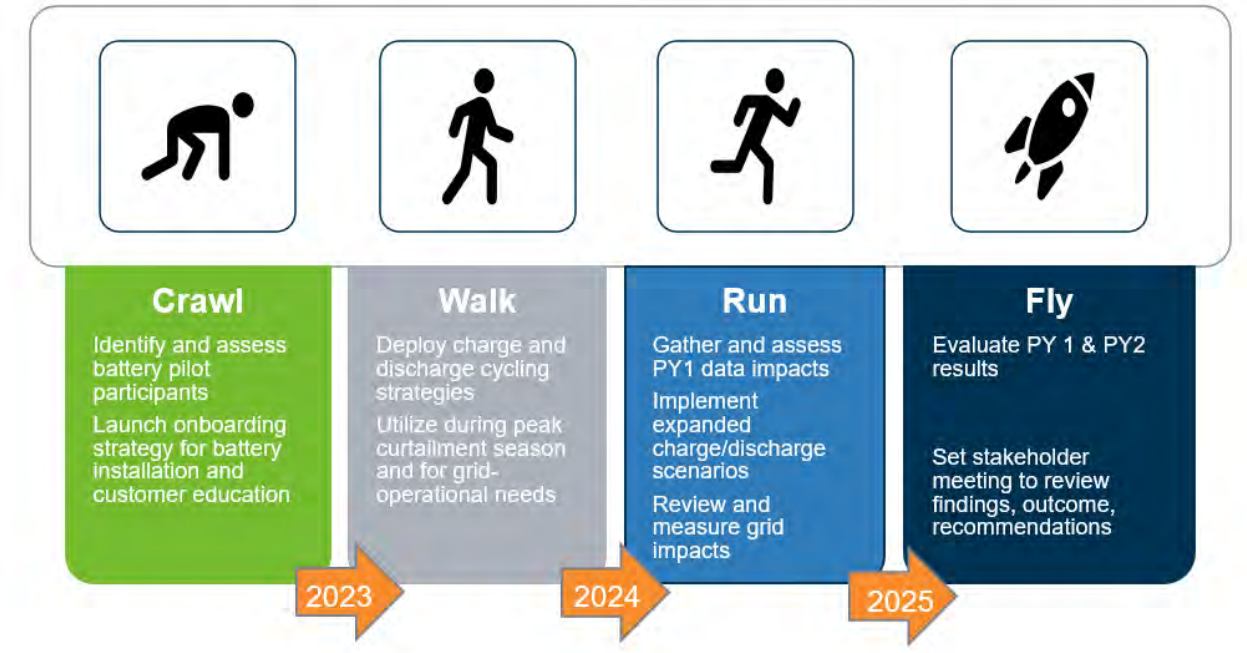
## Go to Market Planning & Customer Education

In Q1 2023 the Evergy Products & Marketing team developed a marketing campaign plan based on the pilot requirements, customer segments identified and desired goals and objectives.

Go to Market planning has multiple phases developed over 2-3 months consisting of the following:

- Customer and Program Research and Audience Development
- Marketing Strategy, Outreach/Advertising Tactics, Timeline and Budget
- Program Naming and Messaging
- Creative Development
- Testing
- Deployment and Measurement

**Figure 1.5 Customer Deployment Journey Phases**




Evergy developed a two-phase marketing strategy to kick-off the Battery Pilot, allowing Evergy to launch the new Pilot into its Missouri territory successfully.

- Phase 1: Soft Launch A soft launch will kick off our communications, allowing Evergy to test messaging and creative, understand questions and create advocates.

- Phase 2: Full Launch Awareness/Education Campaigns: Helps make sure all customers know Evergy offers products and provide energy efficiency and usage education.

**Enrollment Campaign**
The awareness campaign will also give Evergy the ability to capture customers with a true interest, such as through an online sign-up form to be notified when the programs are fully available. This will allow Evergy to target the most interested customers not only immediately upon program availability, but also through the most cost-effective channel for conversion. During and after each step and phase, Evergy will continue to analyze performance data and analytics to understand how messaging and marketing tactics are preforming. Evergy will continue to adjust the strategy throughout the program period.

**Targeted Marketing Communications**
A fundamental part of all marketing is to get the right message to the right customer via data, targeting, modeling and customer-initiated actions. There is no one size fits all approach, as the Company consistently works to identify the target market opportunity on an ongoing basis, as comparative ads are tested, and insight is gained into both who is converting and who is simply engaging. The constant monitoring of this activity, combined with refinement and growth of our data architecture, allows Evergy to change and tweak messaging and imagery to align efforts with what the data is telling.

Evergy proposes to include targeted marketing communications in the mix of strategies that make up the larger integrated marketing communications approach. While mass marketing casts a wide net, targeted marketing is like spearfishing. To capture individual customers and push them through the marketing funnel, three elements are needed:

- A well-defined target group of customers whose needs match an offering
- Messaging that helps customers understand how they benefit from the offering
- Distribution at relevant times for the customer and integration with other marketing

Evergy will use primary and secondary research to dig deeper and more fully analyze how proposed and continuing programs are perceived and used, and further explore customers' decision-making process and the benefits they find most motivating. These insights support the continued creation of tailored messaging with a focus on educating customers to encourage enrollment.

The collateral needed to implement the Pilot program will span multiple marketing channels such as printed materials and digital/online assets. Items to be developed include (but are not limited to) informational and sales brochures, program applications for customers, FAQ and Safety documents, digital newsletters, emails, promotional items, information leave behind flyers, postcards, door hangers and more.

Customer Identification Sophisticated customer targeting will be used with a combination of data currently in the Company's customer database, demographic information and building type data to streamline the process of acquiring customers that are appropriate to each program. This allows the marketing and outreach teams to cost-effectively ramp up more quickly and focus on those most likely to participate, or most likely to benefit the most from the Pilot program.

**Program Startup and Procurement**
The Pilot program will be delivered by both internal Evergy staff and an implementer. The Evergy Products and Services team has an experienced program management staff who will leverage existing procurement strategies to meet the program designs filed and collaborate with a qualified implementation team to provide support for such elements as program infrastructure development, staffing, materials development, outreach and/or required program services.

**Tracking Progress and Deliverables**
The Battery Pilot program was assigned supervision from Evergy's Energy Solutions team to ensure that program requirements, quality assurance, budgets and participation goals are being met and on track for delivery. Customer service metrics and other key performance indicators will be developed between Evergy and the Pilot implementation team to ensure quality of service for program consumers.

**Reporting and Stakeholder Feedback**
The Company will provide stakeholder updates on program process, including program launch schedule, annual forecasted performance, and current program results. Stakeholders will be invited to attend these meetings and provide ideas and or feedback to enable program managers to adjust to conditions as they are identified. The feedback from customer engagement groups and other methods will be used to improve programs as they evolve.

## Customer Selection Matrix

The Pilot utilizes a customer selection matrix to identify optimal Pilot participants that allows the Company to tests all identified use cases, learning objectives and customer behavioral interactions with the Pilot. The matrix utilized a weighted scale based on key selection criterion to evaluate customers selected for the Pilot.

**Figure 1.6 Customer Selection Criterion Matrix**

| Criterion | Description | Max Score Possible (% of Total Score) |
|---|---|---|
| Circuit | The best way to evaluate grid impact of behind the meter storage is to install these batteries in clusters on same circuits. We identified 5 cirucits to target that have a low number of customers but a high number of outages | 300 (30%) |
| No Plans to move for 2 years | To maintain continunity in the data and keep from incuring cost to remove and reinstall a battery in the event of a move we prefer to install at homes where there is no immediate plan of transfer of ownership | 150 (15%) |
| Solar | A priority of this this pilot is to analyze the operation and customer impact of behind the meter storage and PV. We want to optimize self consumption and on-site solar management | 100 (10%) |
| Home EV Charger | A priority of this this pilot is to analyze the operation and customer impact of behind the meter storage and EV Charging to mange peak demand | 100 (10%) |
| Smart Devices | A priority of this this pilot is to analyze the operation and customer impact of behind the meter storage and Smart Devices such as, Appliance control, HVAC load center, smart digital circuit breakers, and pool pump controls | 100 (10%) |
| Attached Garage with space for battery | The lowest cost of install will be in an attached garage that has existing space for the battery | 75 (7.5%) |
| Comfortable with the potential of conduit on home | There is the potential conduit on the outside of the home will be needed to faciliate this install. This is a criteria we want addressed prior to incuring cost of the site visit | 50 (5%) |
| All Electric, Single Family home, Primary residence | With this smaller pilot we will not be looking at multifamily residences as this could complicate single installs. To gather consitent data we do want to install on only primary residences and avoid summer or seasonal homes. | 50 (5%) |
| Space in breaker panel | Having existing space in the breaker panel will allow for a lower cost and less distruptive installation. | 50 (5%) |
| Willingness to be surveyed | It is important for us to gather informaiton from program participants. The data gathered through the 4 planned customers survyes will be valuable to end of pilot reporting and any future program design. | 25 (2.5%) |

# Evergy Missouri
# Residential Battery Energy Storage
# Pilot Program
# Literature Review

## Table of Contents

## Overview & Objectives

Evergy conducted a literature review to benchmark the Residential Battery Energy Storage (RBES) Pilot against similar utility RBES programs and to identify lessons learned. The submittal of this review is responsive to the *Stipulation and Agreement Regarding Programs and Electric Vehicle Charging Tariffs* from Case No. ER-2022-0129/0130.

The review differentiated between two types of utility battery storage programs:

- Incentive Programs: Programs that incentivize customer adoption of battery storage but the utility or customer does not actively use the systems for demand management (i.e., for demand response).
- Demand Response Programs: Programs that utilities use the batteries to manage demand on their grid. These programs may incentivize customers to adopt battery storage systems, which the utility would use for demand management, or may incentivize customers who own battery systems to let the utility use the customer batteries for demand management, which is known as bring-your-own-device (BYOD). These programs may also involve utility ownership and use of the battery systems with the sale of services to the customer, such as time-of-use (TOU) rate management or emergency backup, in an energy-storage-as-a service model.

This report reviews both types of programs but addresses the second program type in greater depth given that the objective of the RBES pilot is to evaluate residential behind-the-meter (BTM) battery storage as a demand response resource.

For this review, Evergy relied on research about RBES programs from primary available data that is publicly available from the pilot's evaluator from similar pilot programs and publicly available white papers, market assessments, evaluation reports, industry publications, regulatory filings, and online sources for RBES programs across the country. In addition, the Company also analyzed data from Energy Information Administration (EIA 2022) Form 861 about net metering and non-net metering distributed energy resources to identify residential RBES programs.

### Incentive Programs

The following are examples of utility or government programs that incentivize residential utility customers to adopt RBES systems. Some programs (indicated with dates in parentheses) are inactive. These programs often require the customer to install a specific battery model or a system that meets specific capacity and other performance requirements and to be connected to a solar or other renewable energy system.

- Salt River Project Battery Storage Incentive Program (2018-2020)[1]
- Jacksonville (FL) Electric Authority Solar Battery Incentive Program (2018-2019)[2]
- California Self Generation Incentive Program (SGIP)[3]

[1] Largue (2018).
[2] DSIRE (2019).
[3] California Public Utilities Commission (2020).

- Green Mountain Power Tesla Power Wall and Enphase IQ Battery programs[4]
- NV Energy Residential Energy Storage Incentives Program[5]

These programs pay participants a flat incentive or an incentive that depends on the battery size ($ per kWh). After installation, the participants may enroll the batteries in a utility or an aggregator demand response program.

## Benefits to Participants

There are two principal benefits to residential utility customers for installing battery energy storage systems (Bowen and Gokhale-Welch 2021):

- **Bill savings or management of demand charges**. Customers on TOU rates can engage in arbitrage by charging the battery during off-peak peak periods and discharging it during on-peak periods (Zinaman, Bowen, and Aznur 2020). Customers incurring demand charges can also use the battery to reduce their maximum demand.
- **Emergency backup**. Customers can use the batteries to provide backup power in the event of a grid outage (Zinaman, Bowen, and Aznur 2020; Brown and Muelenbachs 2023). For example, California incentivizes residents in wildfire areas at risk of Public Safety Power Shutoffs to adopt RBES systems (Verdant 2022).

## Grid Benefits

BTM battery energy storage systems may provide benefits to grid operators even if the batteries are not used for demand response. There are several main benefits of the systems:

- **Grid resiliency**. Batteries can supply backup power during grid emergencies and relieve pressure on utilities to restore power. For example, California's Self-Generations Incentive Program (SGIP) provides incentives for the installation of battery systems to customers in areas that have a high risk of public safety power shutoffs because of fires (CPUC 2023).
- **Reduce costs of supplying energy to the grid**. Customers on TOU rates have incentives to use the batteries to shift demand for grid-supplied electricity from periods with higher costs of supply to periods with lower costs (assuming the TOU rates are aligned with the utility's costs of supply). This can result in avoided energy and capacity benefits for the utility (Verdant 2020).
- **Transmission and distribution system investment deferrals**. The batteries can alleviate constraints on system capacity if the batteries are programmed to discharge during times of peak demand.

4 Green Mountain Power (2023).
5 NV Energy (2023).

### *External Benefits*

Battery storage systems can reduce emissions of greenhouse gases (GHGs), sulfur dioxide, and nitrogen oxide from fossil-fuel electricity generation. The emissions impacts of residential BTM batteries depend on when the batteries charge and discharge, the emissions factor for the marginal generation facility supplying electricity to the grid, and whether the batteries are paired with an on-site solar PV system. In California, SGIP residential battery systems reduce net emissions of GHGs because most systems are paired with a solar PV system (Verdant 2020).

## Demand Response Programs

Utilities across the United States are piloting programs to test the capabilities of residential BTM RBES systems to deliver demand response and other grid services. Evergy benchmarked their RBES Pilot against the following programs and pilots:

- HECO Grid Services Purchase Agreement
- HECO Battery Bonus Program
- Green Mountain Power Home Energy Storage
- Portland General Electric Smart Battery Pilot
- Pacific Gas & Electric Residential VPP Pilot
- SCE VPP Pilot
- SMUD – My Energy Optimizer
- Rocky Mountain Power Wattsmart Battery Program
- Rocky Mountain Power Soleil Pilot
- Xcel Energy Renewable Battery Connect Program
- Tampa Electric Company Microgrid Pilot Program

The comparison programs come from a geographically diverse range of utilities with needs for several types of grid services. The programs also have unique designs, some with utilities owning the batteries and others with customers owning the batteries.

## RBES Demand Response Program Design

Table 1 presents the program designs and objectives of the comparison BTM energy storage programs. All programs except SCE's Virtual Power Plant remain active.

Many utilities designed the programs to deliver grid services such as peak demand response capacity, to support the integration of variable renewable energy resources, to evaluate the concept of a virtual power plant (VPP), or to enhance grid resiliency (by, for example, providing customers with emergency backup power). Many programs had BYOD designs, which compensate the customer for the use of the battery but do not incentivize the battery's purchase. Other programs incentivize the purchase or lease (Green Mountain Power, for example) of the battery and pay the customer for the on-going use of it. One utility (Tampa Electric Company), like Evergy, owned the batteries outright. Most programs required the batteries to be paired with and charged primarily from on-site solar, but, like the RBES pilot, Green Mountain Power, Portland General Electric, and Rocky Mountain Power allow charging from the grid or will allow it soon. As Verdant (2020) demonstrates, the source of the battery energy (from the grid or a home PV system) can affect the net greenhouse gas (GHG) impacts of the RBES systems.

*Table 1. Program Design and Objectives*

| Utility | Program | Participation Agreement Term | Program Size | Objectives | Device Ownership | Charge Source | Manufacturers of Eligible Battery Systems |
|---|---|---|---|---|---|---|---|
| HECO | Battery Bonus Program | 2022-2032, 10 years | 55 MW storage<br>(40 MW on Oahu and 15 MW on Maui) | • Add renewable energy sources to grid<br>• Help achieve goal of 100% clean energy by 2045<br>• Strengthen reliability | Customer-owned (BYOD & purchase incentive) | Solar | All battery systems meeting program size and performance requirements |
| HECO | Home Battery Rewards Program (Grid Services Purchase Agreement #2) | ~10 years, through 2031 | 66 MW on Oahu<br>13 MW on Maui<br>13 MW on Hawaii | • Facilitate integration of intermittent renewable energy resources<br>• Deliver grid services formerly provided by recently retired fossil fuel plants<br>• Help HECO meets 100% RPS by 2045 | Customer-owned (BYOD & purchase incentive) | Solar | Tesla Powerwall |
| Green Mountain Power (GMP) | Home Energy Storage (Lease and BYOD options) | 10 years | Each subprogram capped at 5 MW/Year | • Ease stress on the grid and lower electricity supply costs for utility and its customers.<br>• Increase solar adoption | Customer owned (BYOD & purchase incentive) or lease (owned by utility) | Grid or solar | Emporia, Enphase IQ, Generac PWRcell, SolarEdge StorEdge compatible systems, Sonnen Battery, Tesla Powerwall 2.0 |
| Pacific Gas & Electric (PG&E) | Tesla – PGE-Virtual Power Plant Pilot | 1 year | 11.74 MW | • Test grid services of home energy storage batteries<br>• Assess customer willingness to enroll in BYOD program | Customer-owned (BYOD) | Solar | Tesla Powerwall |
| Portland General Electric (PGE) | Smart Battery Pilot | 2020-2025, five-year pilot | 525 homes | • Add renewable energy sources to grid<br>• Strengthen reliability<br>• Lower energy costs | Customer-owned (BYOD) | Grid or solar | Generac, SolarEdge, Sonnen, Tesla |
| Southern California Edison (SCE) | Virtual Power Plant Pilot | 2020-2022, no commitment | 275 homes (Phase 1, 2021-2022) | • Test demand response use cases at the transmission and distribution system levels<br>• Manage grid stresses associated with integration of renewable power into the grid | Customer-owned (BYOD) | Solar | Sunrun Brightbox System |
| Sacramento Municipal Utility District (SMUD) | My Energy Optimizer | 2023-2030, no commitment | 10 MW | • Support integration of more renewable energy sources to grid<br>• Ease stress on grid during peak summer months<br>• Lower energy costs<br>• Provide backup sources of power | Customer-owned (BYOD/Purchase incentive) | Solar | All batteries<br>(Though Partner+ participation level requires Tesla Powerwall) |

| Utility | Program | Participation Agreement Term | Program Size | Objectives | Device Ownership | Charge Source | Manufacturers of Eligible Battery Systems |
|---|---|---|---|---|---|---|---|
| Rocky Mountain Power | Wattsmart Program | 2021-present, four-year minimum contract. | Goal: 50,000 customers, 100 MW storage | • Add renewable energy sources to grid<br>• Keep energy costs low | Customer-owned (Purchase incentive) | Solar currently. Expected to allow grid charging soon. | Sonnen Core Sonnen Eco<br>Sonnen EcoLinx<br>SolarEdge Energy Bank |
| Rocky Mountain Power | Soleil Pilot | 2019-2021 | 12 MW Storage paired with 5 MW Solar, | • Test grid services of home energy storage batteries in multifamily buildings) | Customer-owned | Solar | Sonnen EcoLinx |
| Xcel Energy | Renewable Battery Connect | 5 years | N/A | • Add renewable energy sources to grid<br>• Reduce reliance on natural gas service<br>• Ease stress on grid and prevent outages | Customer-owned (purchase incentive) | Solar | Tesla or SolarEdge |
| Tampa Electric Company | Microgrid Pilot Program | 4-year pilot starting in 2022 | 37 homes | • Test batteries as part of microgrid to operate independently in event of outages. | Utility-owned | Solar | BlockEnergy Smart Platform |

Tampa Electric Company's Microgrid Pilot Program is unique among the other programs listed here. It supports a microgrid among a small subdivision of homes to provide resiliency in the event of a grid emergency and the utility owns the battery and solar PV systems.[6]

## Governing Rules of RBES Systems Utilization

Table 2 presents the participant incentives and parameters governing the utilities and customer's use of the battery systems for the comparison programs. Most programs established clear parameters concerning the use of the batteries:

- The frequency of use. Most programs limit the number of events that can be called and when during the year the events can occur.
- The length of demand response events. Most programs limit the duration of events.
- The maximum amount of battery energy that can discharged. Most programs will leave a percentage of the battery's stored energy for the customer's use in the event of a grid emergency or to manage TOU rate charges. In some programs (e.g., PG&E), the participant may select the percentage of reserve energy.
- Several programs notify customers in advance of when they will use the batteries for demand response events (e.g., Green Mountain Power).

[6] Using the BlockEnergy Smart Platform from Emera Technologies, the program combines battery storage and local generation to generate electricity for this set of homes. This system can use the wider electric grid as backup, but in cases of natural disaster or wider grid outages, it can sustain its own power supply. Rather than one home's battery and on-site solar providing backup for that specific home, the system is integrated across all participating homes so all batteries and solar panels power and provide backup for the community (Tampa Electric Company, 2023).

*Table 2. Program Incentives and Battery Use*

| Utility | Program | Incentives | Rules Governing Utility and Customer Use of Battery |
|---|---|---|---|
| HECO | Battery Bonus Program | • HECO provides $850/committed kW upfront (one-time) incentive<br>• $5/kW monthly peak capacity payment for 10 years of program as a bill credit | • Battery must discharge the committed capacity during a two-hour period from 6:00 p.m. to 8:30 p.m. |
| HECO | Home Battery Rewards Program (Grid Services Purchase Agreement #2) | • Upfront incentive payment of $3,700–$7000 per battery depending on size<br>• Monthly incentive up to $225 per month, depending on battery capacity | • HECO controls battery during fast frequency response (FFR), load build, and load reduction demand response events<br>• Maximum number of load reduction and load building events of each type is 104 for Oahu and 144 for Maui and Hawai'i.<br>• Max duration of capacity build and reduction events is four hours<br>• Capacity build events from 10 a.m. to 2 p.m.<br>• Capacity reduction events from 5 p.m. to 9 p.m.<br>• Participants can reserve power for emergency backup |
| Green Mountain Power (GMP) | Home Energy Storage | **Lease**<br>• Lease two batteries for $55/$65 per month, or one-time payment of $5500/$6500<br>• $2500 installation fee<br>**BYOD**<br>• Upfront incentive payment of $850 per kW for commitment to three-hour events, or $950 per kW for four-hour events<br>• Extra $100 per kW in "grid constrained areas"<br>**Frequency Response Pilot**<br>• Additional $13.50 per month incentive for Home Energy Storage participants who enrolled in the Frequency Response Pilot | **Lease**<br>• Customers can use battery for backup power during outages.<br>• GMP retains use of the battery at other times to manage power supply and reduce power costs<br>**BYOD**<br>• Customer determines capacity to commit to program, utility controls during peak events.<br>• Peak Events projected five to eight times a month for three to six hours at a time (customers notified at least four hours in advance)<br>• GMP works to ensure batteries have sufficient charge when outages may occur (severe weather).<br>• GMP may use battery at any time and may access the battery remotely for program purposes, and to monitor energy usage and discharge, performance, perform diagnostics, and upgrade firmware (Green Mountain Power, 2020).<br>**Frequency Response Pilot**<br>• Two hundred participants with two or more Tesla Powerwall batteries had the option to enroll in the Frequency Response Pilot, which adds on frequency response to the grid services offered by the Home Energy Storage program. |
| Pacific Gas & Electric (PG&E) | Tesla – PGE-Virtual Power Plant Pilot | • Bill credit of $1 per kWh of incremental energy delivered to grid during VPP events (measured against a baseline) | • Events occur when CAISO, Tesla, or PG&E declares alert, warning, or emergency<br>• Customer can set backup reserve energy in app<br>• Customer can opt out of events<br>• Customers are notified of events<br>• Minimum of 20 event hours in 2021 |
| Portland General Electric (PGE) | Smart Battery Pilot | • Rebate of $1.70/kWh during peak time events | • PGE dispatches batteries during peak demand events and when energy may be more carbon intensive<br>• Customer can commit capacity or select default value (9 kWh); minimum commitment is 3 kWh<br>• Participant can opt-out or override any PGE event.<br>• Battery will not be discharged below 20%.<br>• PGE will not discharge batteries when severe weather is predicted that may cause outages. |

| Utility | Program | Incentives | Rules Governing Utility and Customer Use of Battery |
|---|---|---|---|
| Southern California Edison (SCE) | Virtual Power Plant Pilot | • $250 annual incentive | • SCE can dispatch up to 80 events per year ranging in length from three to six hours<br>• 20% of battery reserved for customer emergency backup |
| Sacramento Municipal Utility District (SMUD) | My Energy Optimizer | • $2,500 one-time incentive payment due upon interconnection process completion<br>• Three participation levels:<br>o Starter: one time incentive of $50/kWh of battery capacity up to $500<br>o Partner: one-time incentive of $150/kWh of battery capacity up to $1,500; $0.50/kWh exported to grid during peak events.<br>o Partner+: one-time incentive of $250/kWh of battery capacity up to $2,500 | • Participants must be on Solar and Storage Rate<br>• Starter level: battery only used to power customer's home during time of use (TOU) rate summer peak hours. No power is sent to the grid.<br>• Partner Level: customer allows SMUD to optimize the battery to respond to summer peak demand response events. During these peak events, power from the battery is sent to the grid automatically.<br>• Partner+ Level: same level of control as the Partner level except the battery is utilized for peak events year-round, not only in the summer months.<br>• Maximum of 15 Peak Events each summer, each no longer than 4 hours<br>• Peak Events occur on non-holiday weekdays 8 a.m. – 9 p.m.<br>• Only one Peak Event a day, no more than three Peak Events in a week. |
| Rocky Mountain Power (RMP) | Wattsmart Program | • Upfront incentive payment of $400 per kW for new installations (based on four-year commitment)<br>• Annual participation incentive: $15 per kW per year. | • RMP will not discharge the battery below 20% to reserve energy for emergency backup<br>• RMP may control batteries daily for demand response, FFR, and congestion relief.<br>• RMP may use the batteries daily for grid management |
| Rocky Mountain Power | Soleil Pilot | • No incentives paid to participants | • Utility can control the batteries at all times to deliver grid services |
| Xcel Energy | Renewable Battery Connect | • Upfront incentive of $500 per kW (up to 50% of equipment cost)<br>• Income qualified customers: $800 per kW up to 75% of equipment cost<br>• $100 participation incentive for participating in demand response events | • Xcel Energy will call up to 60 demand response events during periods of high demand<br>• Events will occur year-round<br>• 40% of battery energy will be reserved for customer use or emergency backup |
| Tampa Electric Company | Microgrid Pilot Program | • No customer incentives | • Utility owned and operated battery/PV systems<br>• Batteries and PV systems to form a microgrid able to operate independent of the grid<br>• BlockEnergy platform automatically controls microgrid |

## Benefits to Participants and Nonparticipants

The benefits to participants are similar across most programs, as Table 2 shows. Participants receive financial incentives for providing grid services in all programs except the Rocky Mountain Power Soleil Pilot and the Tampa Electric Company Microgrid Pilot. Some programs also encourage the purchase of battery energy storage systems by providing cash incentives.

A cost of participating in these programs is yielding control of the battery during demand response events, including the possibility that less backup power will be available during a grid outage. However, most programs commit to reserving a certain percentage of battery energy for the customer at all times. Also, many large-scale grid outages (e.g., rolling brown outs due to heat waves or public safety power shutoffs) are predictable, and many utilities (e.g., PGE) and battery service providers have committed to adjusting their use of the batteries to make sure there is sufficient energy available for backup.

Potential benefits to nonparticipating utility customers are lower electricity rates and the increased grid stability and reliability these programs promote by reducing strain during peak demand periods.

## Operational Benefits of Battery Systems

Table 3 shows the grid services use cases for residential battery storage systems by comparison program. We categorized the benefits according to the taxonomy in NREL (2019) and used checkmarks to indicate whether the utility is using or testing the batteries for each use. The grid services are defined as follows:

- System peak capacity: Ability to generate and meet demand for electric power during hours of system peak demand
- Local distribution system capacity: Ability of the distribution system (e.g., infrastructure on a feeder) to meet local demand for power, particularly during times of peak demand
- Energy: Supply or consumption of electricity to or from the grid from battery systems depending on power resources, marginal costs, and market prices
- Frequency response: Ability to slow and stop changes in frequency via rapid and automated responses from battery systems
- Ramping reserves: Used to manage slower variations in net load due to ramping of renewable energy production
- Other operating reserves/reserve margin: This includes regulating reserves to address normal random fluctuations in load and regulating contingency reserves to address power plant or transmission facility failures

*Table 3. Grid Services Uses of Residential BTM Battery Storage Systems*

| | | Energy and Capacity | | | Operating Reserves | | |
|---|---|---|---|---|---|---|---|
| **Utility** | **Program** | **System Capacity** | **Local Distribution System Capacity** | **Energy (Economic)** | **Frequency Response** | **Ramping Reserves** | **Other Operating Reserves** |
| HECO | Battery Bonus Program | ✓ | | ✓ | | | |
| HECO | Home Battery Rewards Program (Grid Services Purchase Agreement #2) | ✓ | | | ✓ | | |
| Green Mountain Power | Home Energy Storage | ✓ | | ✓ | ✓ | | |
| Pacific Gas & Electric | Tesla–PG&E Virtual Power Plant Pilot | ✓ | | | ✓ | | |
| Portland General Electric | Smart Battery Pilot | ✓ | ✓ | | | | ✓ |
| Southern California Edison | Virtual Power Plant Pilot | ✓ | ✓ | | | | |
| SMUD | My Energy Optimizer | ✓ | | ✓ | | | |
| Rocky Mountain Power | Wattsmart Battery Program | ✓ | ✓ | | ✓ | | ✓ |
| Rocky Mountain Power | Soleil Pilot | ✓ | ✓ | | ✓ | | ✓ |
| Xcel Energy | Renewable Battery Connect | ✓ | | | | | |
| Tampa Electric Company | Microgrid Pilot Program | | ✓ | | ✓ | | |

Most comparison programs test the ability of the battery systems to deliver multiple grid services. This use of the batteries is referred to as “value-stacking” and can enhance the cost-effectiveness of the systems (Zinaman, Bowen, and Aznur 2020). In addition to relieving peak generation or transmission capacity constraints, the most frequent other uses of the battery systems are providing local distribution system capacity or frequency response.

## Grid Services Evaluation

Because of the newness of the residential battery storage pilots, preliminary impact evaluation results are available for only a few of the pilots. In an evaluation of Rocky Mountain Power's (RMP) Soleil Pilot, Evergy (2021) concluded that BTM multifamily residential battery storage systems installed as part of the Soleil Pilot program provided frequency regulation services and peak load management to the grid, mitigated congestion issues on the grid, and provided backup power to participants. More specifically, the analysis found that this program enabled the integration of renewable solar energy without adding solar congestion issues. It allowed RMP to change the load usage profile of participants and reduce supply costs by storing excess low-cost solar power generated during the day to use during expensive peak times in the evening and morning. Evergy also found that the program enabled automatic response to electric grid emergencies in the western electric grid in real time.

An evaluation of PG&E's residential Tesla Battery pilot from October to November of 2021 found that the batteries supplied demand response capacity, providing 4.5 kW per battery during the first event hour, 3.0 kW during the second event hour, and less than one kW during the third hour (DSA 2022). These results were encouraging, though it was not possible to assess the performance of the batteries during summer peak hours when they would have most value for the grid.

Evaluation of Phase I of SCE's Virtual Power Pilot (Evergy 2021) found that the pilot produced smaller demand savings than expected and the demand savings averaged close to zero during the 47 demand response events. The pilot did not produce more savings because participants were on net metering and enrolled in TOU rates, and the VPP demand response events tended to occur during the TOU rate on-peak period when the batteries were programmed to discharge (and would have discharged if the event had not occurred). The evaluation also found that the batteries did not dispatch as expected during many demands' response events.

## Financial Benefits and Cost-Effectiveness

Again, as many utilities' residential battery storage pilots are new, there is scant evidence about the financial benefits and cost-effectiveness of battery programs. Green Mountain Power, which deployed the Home Energy Storage batteries to reduce peak demand and peak capacity payments to ISO New England, the region's electrical grid operator, has claimed operational costs savings of $3 million for the first three quarters of 2020 from the deployment (Green Mountain Power 2020b).[7]

Rocky Mountain Power's Wattsmart program in Utah was found to pass the TRC, UCT, and RIM cost-effectiveness tests for 2021 (Rocky Mountain Power 2022).

[7] According to GMP Vice President and Chief Innovation Officer, the home energy storage program is "improving reliability for the customer, paying for itself, and providing a financial benefit for all of our customers" (Greentech Media, 2020b). The batteries also provide value through ISO New England's Regulation Market, which compensates participants for providing regulation—the capability of specially equipped generators and other energy sources to increase or decrease output or consumption every four seconds. Additionally, GMP has said this program will allow them to retire some fossil fuel facilities.

## Participant Satisfaction with Programs

There was a lack of publicly available information regarding participant satisfaction with programs considered in this review. However, many of the programs incorporated features to increase customer satisfaction and attract and retain participants.

**Multiple participation levels:** Sacramento Municipal Utility District (SMUD) offers three levels of participation, which givens customers flexibility to choose the RBES option for them. The incentive payment for each participation level varies based on the utility's control of the battery, with the highest incentive payment for the highest level of utility control. Some customers may not be comfortable with granting control of their battery to the utility year-round, but because of SMUD's program design, they have the option to enroll in a participation level that is more suitable to their interests. (Sacramento Municipal Utility District, 2023)

**Flexible capacity commitments:** Green Mountain Power gives BYOD customers freedom to commit capacity to the Home Energy Storage program. This ensures that the program does not interfere with participants' own use of the battery systems. Although customers in the lease program do not have this freedom, GMP commits to ensuring that customers have sufficient backup power when outages are possible (Green Mountain Power, 2022).

**Advance notification of capacity events:** GMP notifies Home Energy Storage Program participants in advance when the utility anticipates using the battery for peak load management.

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