RG&E **Integrated EV & Battery Storage** **Date (3Q2020)** **Active**

Project Start Date: *6/08/2018* **Project End Date:** 12/31/2020

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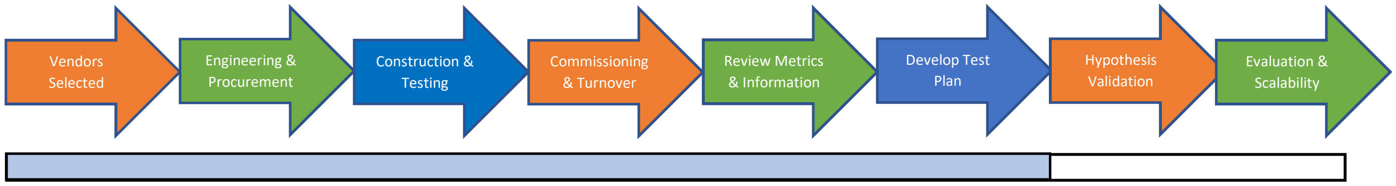

Project Summary: The Integrated EV & Battery Storage Project is demonstrating how battery storage can improve the economics of EV adoption and minimize its impact to the electric grid. The project is demonstrating how battery storage can be integrated with DC fast and level 2 EV chargers to manage cost impacts while optimizing the value of the battery system. The system is located at the RG&E Operations Center at 1300 Scottsville Rd in Rochester, NY and consists of two DC fast chargers, five level 2 chargers, and a 150 kW / 600 kWh stationary battery.

Lessons learned:

- **Utility Operations**
  - Coordination of breaker protection relays can be difficult when an inverter and battery are involved. Since this is newer technology and inverters are historically sensitive to issues encountered on adjacent circuits, especially ground faults, a detailed relay coordination study and modeling should be performed and reviewed prior to commercial operation.
  - Initial results show the impact of the battery in significantly reducing the building peak demand and improve building load factor. Proper sizing of the battery upfront and adjustment to charge/discharge settings of the battery (by analyzing historical building load data) has been the key to achieve this performance. Effective peak demand reduction can reduce the monthly bills of the building.

Issues Identified: Noise generated by the inverter was impacting self-monitoring capabilities of the battery management system.

Solutions Identified: To resolve this issue, the battery stacks have been replaced in Q2.

Recent Milestones/Targets Met:

- Continued data collection on the battery and system performance at the site
- Monitoring of adjacent circuit outages to see the impacts to the battery breaker coordination
- Rebalancing the battery system to ensure full battery power

Upcoming Milestones/Targets:

Phase 2 - Execute

- Continuation of data collection on the battery and system performance at the site
- Continued validation and reporting of use case progress with the collected test data
- Continue to work with internal resources to increase the use of the Level II and DC fast charges when in-person work resumes
- Continue to monitor for adjacent feeder events that could the battery breaker to trip to gain experience with protection coordination of sensitive inverter-based battery equipment
- Grounding of the breaker neutral conduit within the building to eliminate the load imbalance and breaker trips.
- Begin developing the final report outline on project learnings over the past two years

Reforming the Energy Vision

Demonstration Project Q3 2020 Report

Integrated Electric Vehicle Charging & Battery Storage System

RG&E

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1.0 Executive Summary

Rochester Gas and Electric Corporation (RG&E or the Company) submits this quarterly report on the progress of the Integrated Electric Vehicle (EV) Charging and Battery Storage System Demonstration Project (Integrated EV & BSS Project). The Integrated EV & BSS Project is demonstrating how battery storage can improve the economics of EV adoption and minimize its impact to the electric grid. The Integrated EV & BSS Project is demonstrating how battery storage can be integrated with DC fast and level 2 EV chargers to manage cost impacts while optimizing the value of the battery system. The system is located at the RG&E Operations Center at 1300 Scottsville Road in Rochester, New York. The system consists of two DC fast chargers, five level 2 chargers, and a 150KW and 600kWh stationary battery with a Battery Management System (BMS) to optimize all resources, including building demand.

The Integrated EV & BSS Project consists of two phases, including: Integrated System Installation (Phase I), and Hypothesis Validation and Reporting (Phase II). The entire project is anticipated to take approximately thirty-two months, which includes site preparation, construction, and commissioning of the EV chargers and battery system as well as the validation and testing of the hypothesis, use case functionality and final analysis.

With the completion of installation and commissioning in Q2 2019, the project has been focused on the hypothesis validation phase by implementing the use case processes and procedures, along with continued data collection on the battery and system performance at the site.

Anticipated plans for Q4 2020 include:

- Continued data collection on the battery and system performance at the site
- Continued validation of use cases with the collected test data
- Modeling increased usage of the DC fast and Level II EV chargers to demonstrate the variable load impacts to the battery system
- Continued monitoring for adjacent feeder events that could cause the battery breaker to trip
- Installation of a breaker ground connection to reduce power imbalance battery breaker trips

The following report provides a progress update on the tasks, milestones, checkpoints, and lessons learned to date.

2.0 Demonstration Highlights since the Previous Quarter

2.1 Activity Overview

Activity completed and results for Q3 2020 included:

- Continued data collection on the battery and system performance at the site
- Increasing the usage of the DC fast and Level II EV chargers to demonstrate the variable load impacts to the battery system
- Monitoring of adjacent circuit outages to see the impacts to the battery breaker coordination
- Rebalancing the battery system to ensure full battery power

2.1.1 Data collection on the battery and system performance at the site

Collection of battery performance data and system performance monitoring continues to be the main focus of activities in the third quarter of 2020 and will continue through the end of the year. Detailed metrics highlighting use case performance can be found in section 2.2 below.

2.1.2 Increasing the use of the DC fast and Level II EV chargers at the site

The project team has developed a strategy to increase charger usage by employees but has been experiencing challenges in implementing that strategy. The details of that strategy, issues, and new approach can be found in section 2.3.2 below.

2.1.3 Monitoring of adjacent circuit outages to see impacts to breaker coordination

During the 3rd quarter of 2020 there were no adjacent feeder or battery breaker trips at the Scottsville Road facility. The team will continue to monitor for adjacent feeder trips to determine if additional main breaker coordination is needed or if the current settings are sufficient to avoid future mis-coordination events.

2.1.4 Rebalancing the battery system to ensure full battery power

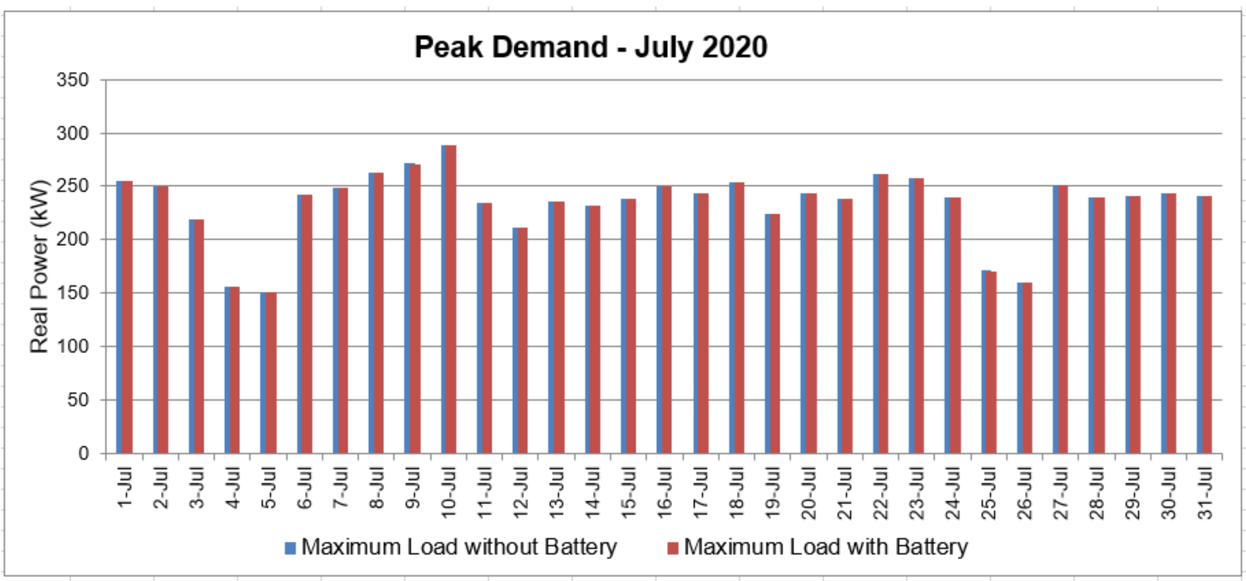
During the 2nd quarter a planned software update was installed designed to resolve an issue with the battery capacity levels being below the battery rating. The software upgrade also required the batteries to be fully discharged and then slowly recharged to balance out the capacity levels of the battery and allow for the full capacity to be achieved. The software was successfully installed at the end of June with the battery rebalancing being scheduled for early July. An issue with the battery breaker experiencing intermittent trips due to a 3-phase load imbalance causing the battery to be off-line has prevented the rebalancing activity from occurring in the 3rd quarter. See section 2.3.3 Intermittent Battery Breaker Tripping below for more details.

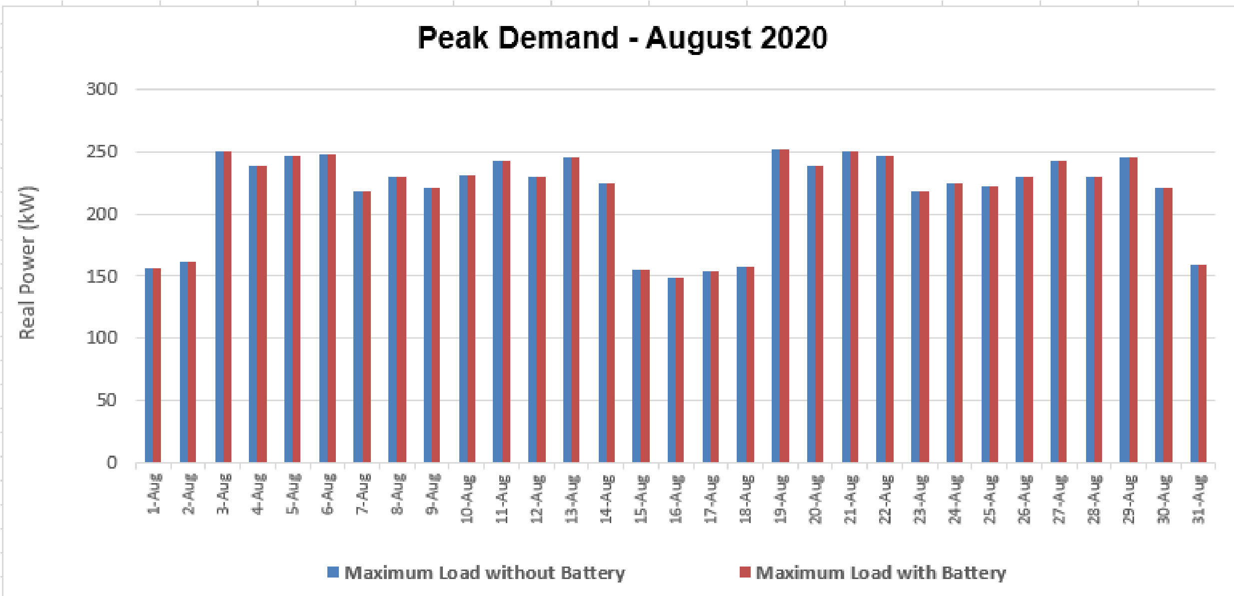
2.2 Metrics and Checkpoints

The demonstration project team has completed all the milestones up to “Phase 1 – Execute” and milestones “Phase 2- Initiate” and “Phase 2 – Plan” portion of the project as defined in the Implementation Plan. Since early August, the project team has spent most of its time on data collection and hypothesis validation.

2.2.1 Reducing Building Peak Demand

The “Reducing building Peak Demand” use case has been identified as one of the metrics that can measure the impact of battery storage on reducing the peak demand of building. Figure 1 shows the maximum daily load of the building with and without the presence of battery storage. As has been historically shown, the battery storage system has significantly reduced the peak demand. Due to the battery being off-line for most of the third quarter, the average daily peak demand reduction on the circuit during the third quarter of 2020 was 0% as shown in Figure 1 below





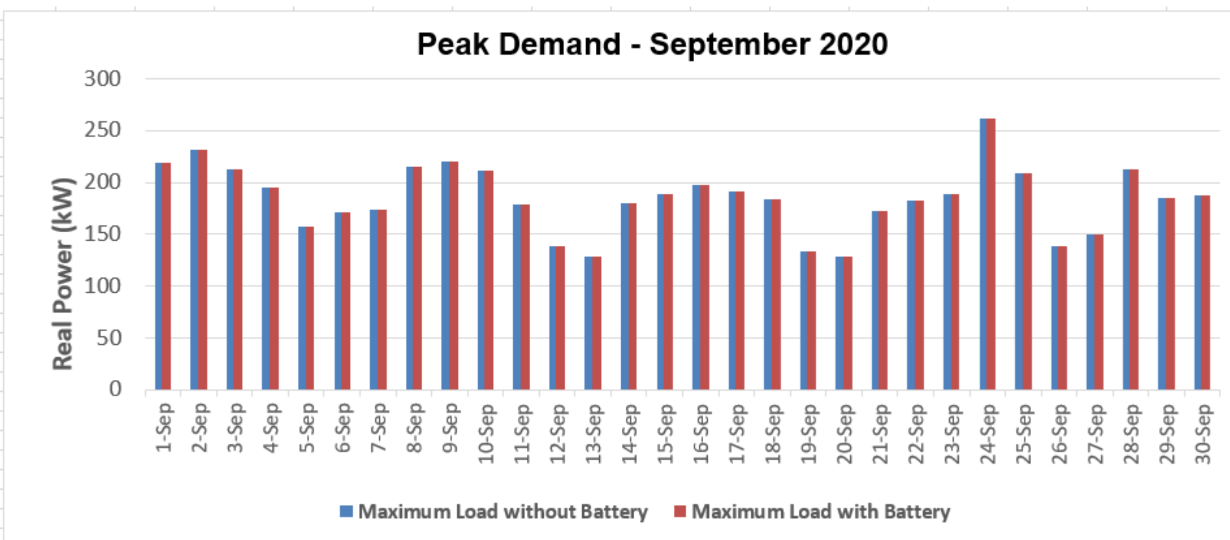


Figure 1. Daily building peak demand w and w/o presence of battery storage

Figure 2 below shows the average hourly load of the building with and without the presence of battery storage during first nine months of 2020. As has been historically shown, the battery system has a positive impact on building performance by shifting peak load to off-peak hours by discharging during peak hours (5AM - 3:30PM) and charging during off-peak hours (3:30PM - 4AM). Due to the battery being off-line for most of the third quarter there has been no impact on building performance during this time period.

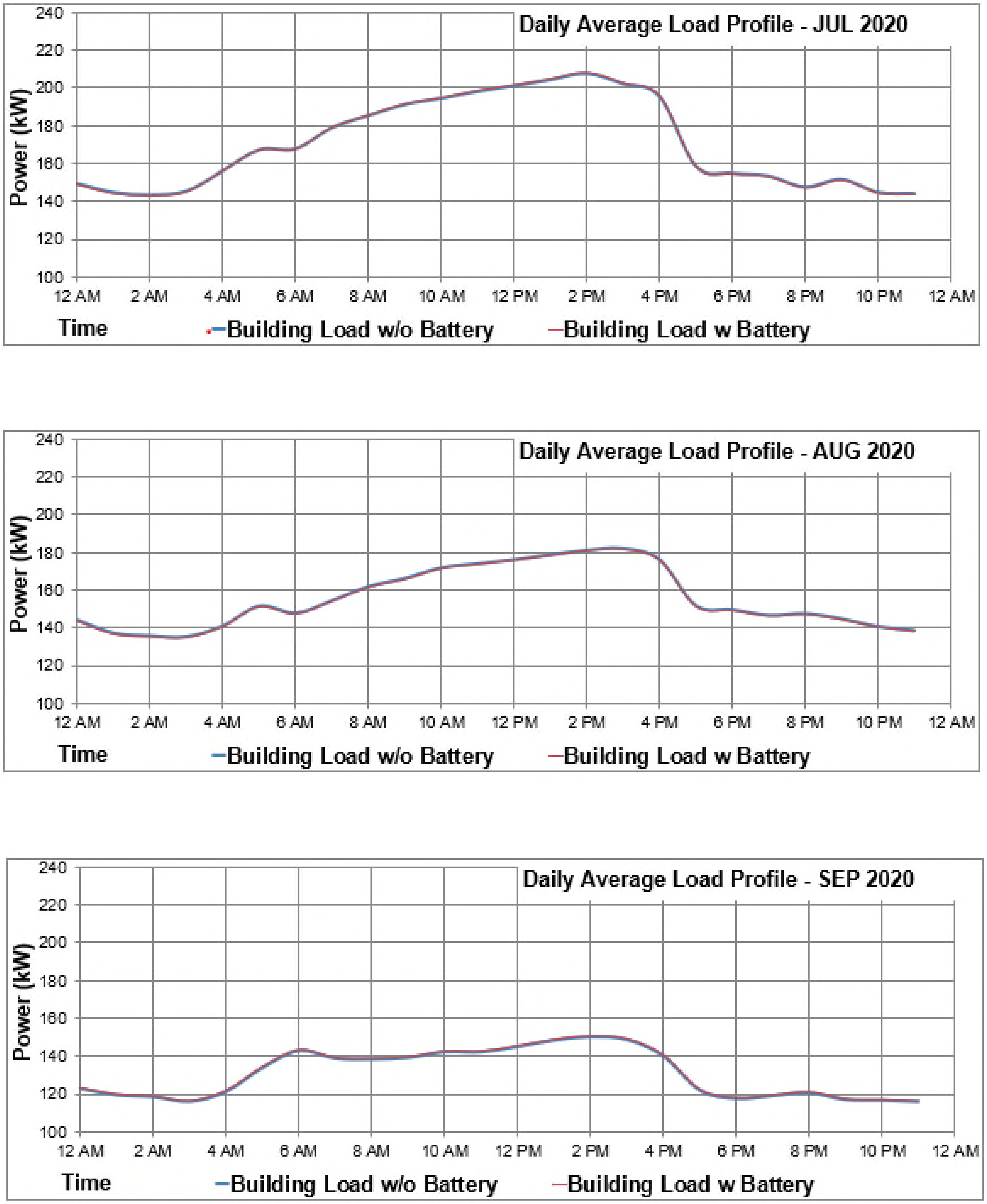
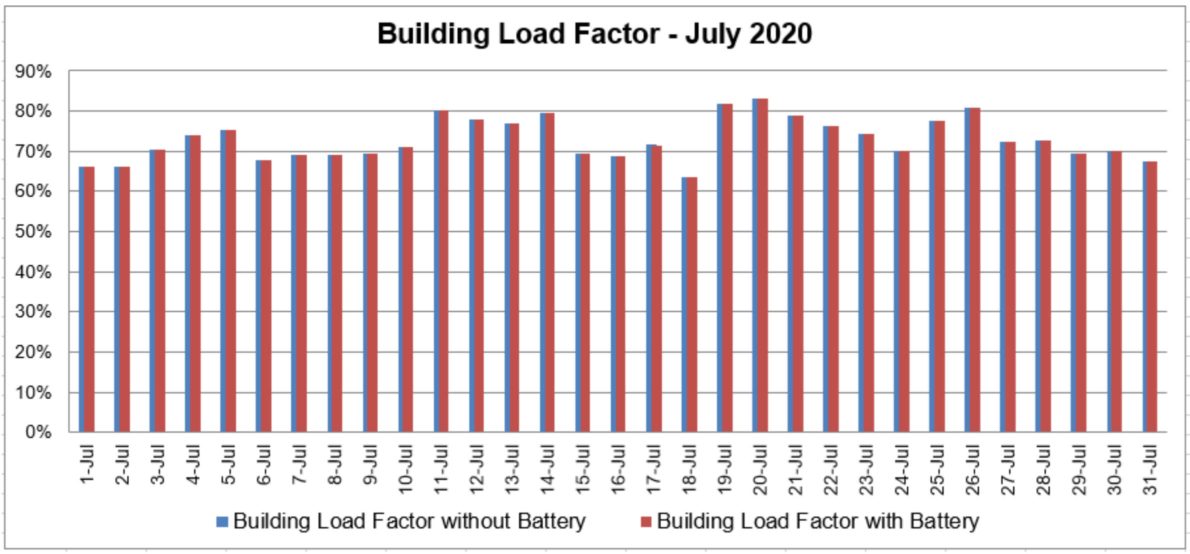
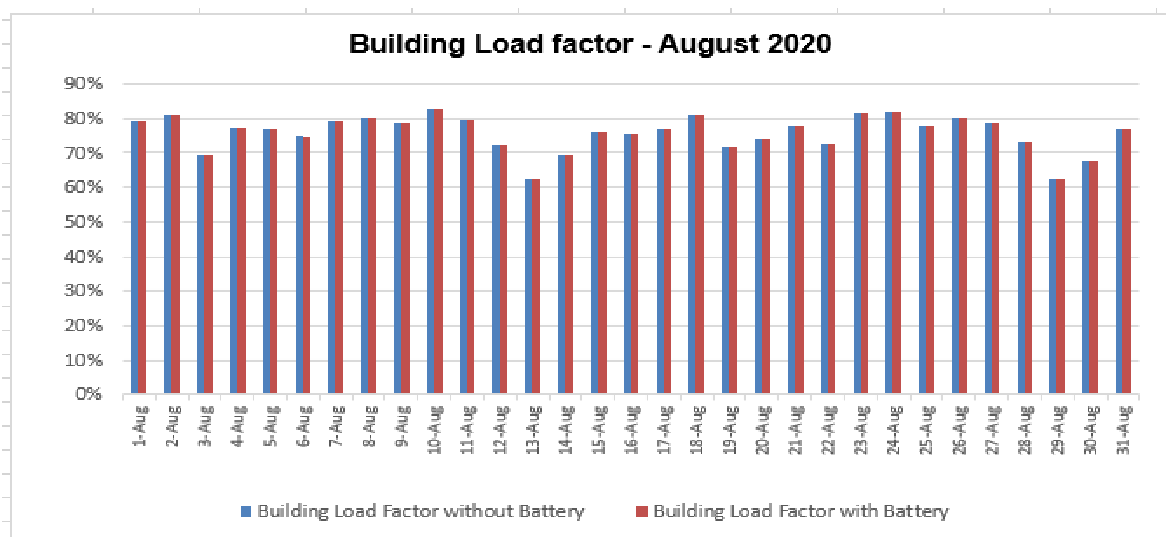


Figure 2. Average hourly building peak demand w and w/o presence of battery storage

2.2.2 Building Load Factor

Another metric defined to track the performance of the battery is "Building Load Factor" use case. The load factor is defined as the average load divided by maximum load. Using the definition and data collected, we tracked building's load factor daily. As has been historically shown, the battery storage system has significantly improved the load factor. Due to the battery being off-line for most of the third quarter, the average daily building load factor improvement during the third quarter of 2020 was 0% as shown in Figure 3 below.





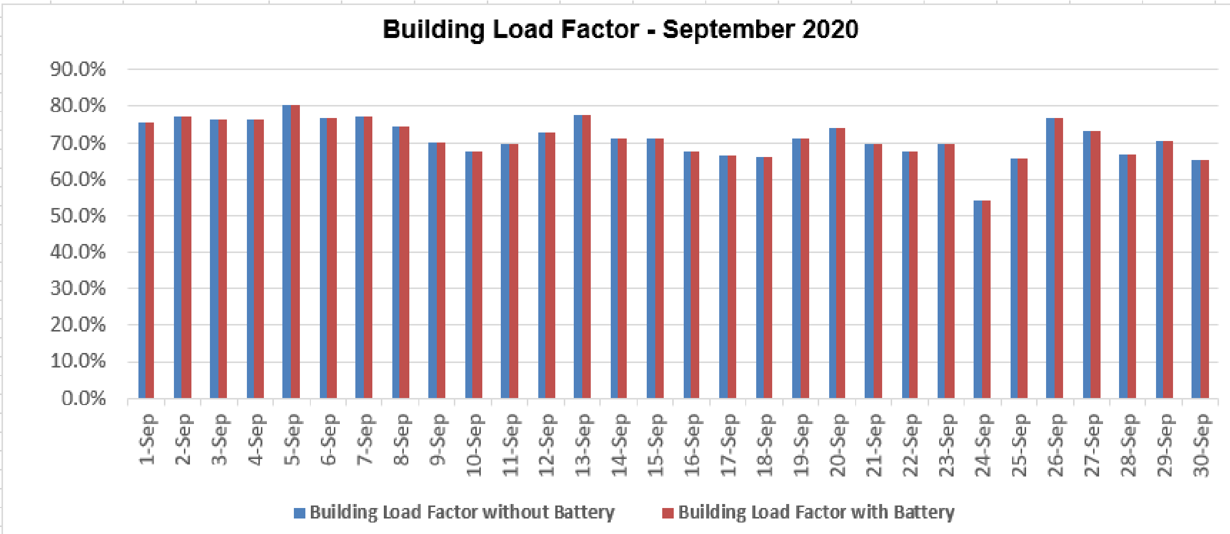


Figure 3. Building load factor with and without the presence of battery storage

2.2.3 Demand Response

Seven demand response events were called in Q3 2020. The battery breaker experienced intermittent trips due to a 3-phase load imbalance causing the battery to be off-line during those events resulting in no update to Table 1 below. Table 1 shows the details of 6 RG&E demand response events during month of July 2019. The project team managed to participate in 4 out of 6 events. The potential saving from the official participation could have been $1,130.

Table 1: Demand Response Events Participated in July 2019

		Event Date	Time Period	Baseline (kW)	Actual Load (kW)	Actual Reduction (kW)
July 10, 2019 14:00-18:00		7/10/2019	3:00 PM	245.14	155.35	89.8
Performance Factor	0.82	7/10/2019	4:00 PM	230.4	154.81	75.59
Total kW	**330.69**	7/10/2019	5:00 PM	228.26	146.3	81.97
Perfomance Payment	**$165.35**	7/10/2019	6:00 PM	159.07	75.74	83.33
July 11, 2019 14:00-18:00		7/11/2019	3:00 PM	227.02	218.18	8.84
Performance Factor	0	7/11/2019	4:00 PM	213.36	217.03	-3.67
Total kW	**0.00**	7/11/2019	5:00 PM	211.38	213.21	-1.83
Perfomance Payment	**$0.00**	7/11/2019	6:00 PM	147.31	172.01	-24.7
July 16, 2019 14:00-18:00		7/16/2019	3:00 PM	241.84	265.13	-23.29
Performance Factor	0	7/16/2019	4:00 PM	221.44	254.42	-32.98
Total kW	**0.00**	7/16/2019	5:00 PM	212.89	240.73	-27.84
Perfomance Payment	**$0.00**	7/16/2019	6:00 PM	151.67	154.61	-2.94
July 18, 2019 14:00-18:00		7/18/2019	3:00 PM	273.22	160.62	112.6
Performance Factor	1	7/18/2019	4:00 PM	252.4	155.72	96.68
Total kW	**404.28**	7/18/2019	5:00 PM	241.81	144.35	97.46
Perfomance Payment	**$202.14**	7/18/2019	6:00 PM	173.49	75.95	97.54
July 19, 2019 14:00-18:00		7/19/2019	3:00 PM	273.22	168.63	104.59
Performance Factor	0.96	7/19/2019	4:00 PM	252.4	143.39	109.02
Total kW	**385.44**	7/19/2019	5:00 PM	241.81	138.08	103.73
Perfomance Payment	**$192.72**	7/19/2019	6:00 PM	173.49	105.39	68.1
July 29, 2019 14:00-18:00		7/29/2019	3:00 PM	272.28	103.71	168.57
Performance Factor	1	7/29/2019	4:00 PM	259.91	101.05	158.86
Total kW	**571.41**	7/29/2019	5:00 PM	253.71	98.66	155.06
Perfomance Payment	**$285.71**	7/29/2019	6:00 PM	207.16	118.25	88.92

Scottsville Road	Enrolled Load Reduction (kW) (July)	July Performance Factor	July Reservation Payment	July Performance Payment	July Total Payment
CSRP-Reservation and Performance	100	0.63	$ 283.50	$ 845.91	$ 1,129.41

2.3 Issues

2.3.1 Total available kWh

Upon installation of the 2nd generation Powin battery in Q2 2019, the team started operating the battery and collecting data. The analysis of data showed that out of the total battery capacity of 700kWh, only 520kWh could be used. The issue was communicated to the manufacture and Powin stated that once the upgraded battery software is available, it will increase the available capacity. The software upgrade took place on October 4th, but the team was still unable to achieve full capacity performance. The RG&E team has been actively working with the manufacture to address this issue and believe we have a resolution that involves installation of a software upgrade and then subsequent rebalancing of the battery system. The software upgrade was completed on June 24th and the rebalancing of the batteries was not able to take place due to an intermittent 3-phase fault being detected by the battery breaker. The rebalancing will be completed once the 3-phase imbalance has been resolved in the fourth quarter.

2.3.2 Limited use of EV chargers

Upon collection of data in Q3 2019, the team has noticed lower than expected use of the EV chargers. The team is working with internal communication channels in the company to encourage employees and fleet management to increase utilization of the chargers. The team began incorporating the following strategies to increase use of the chargers in Q1 2020:

- Transfer of additional EV's to the operational center for employee use
- Increased employee communications on utilizing the pool EVs and chargers
- Potential assignment of EV's to employees as a full-time company vehicle
- Internal communication to employees on the availability of the chargers for personal vehicle charging

Implementation of these strategies continues to be significantly impacted by the various in-person workforce restrictions related to COVID-19. It is expected that this impact will continue throughout Q4 2020 and into 2021 thus the team has decided to model increased usage of the DC fast and Level II EV chargers to demonstrate the variable load impacts to the battery system.

2.3.3 Intermittent Battery Breaker Tripping

The breaker dedicated to the battery system has tripped several times since its initial operation after the recent software upgrade. Adjusting the breakers phase amps to allow for over 100 amps phase difference before the breaker trips has allowed for the breaker to stay in operation. There is a Bender Ground Fault detection unit installed designed to detect ground fault occurrences between the battery and the transformer which has not detected any ground faults indicating that the issue is within the building. Recently, when we attempt to reset the breaker, it immediately opens indicating that the fault triggering the breaker to open is still present even with the battery system isolated from the breaker.

Initially it was believed that a piece of equipment that is more active in the warmer months within the building was causing the imbalance. After further investigation, it was determined that battery breaker is responding to a 3-phase load imbalance caused by a neutral conduit not tied to the battery breaker. To resolve the neutral issue an entire building shutdown must be scheduled to access the conduit. The repairs needed to correct the problem will be coordinated with some existing building shut down work occurring in early November.

3.0 Work Plan

3.1 Budget Review

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3.2 Updated Work Plan

Milestone	Description	Date
Phase 1 - Initiate	Vendors Selected and Kick Off Meeting	Complete
Phase 1 - Plan	Engineering and Procuring Equipment	Complete
Phase 1 - Execute	Construction and Testing	Complete
Phase 1 - Closeout	Commissioning and Turnover	Complete
Phase 2 - Initiate	Review Metrics and Information Gathering	Complete
Phase 2 - Plan	Develop Test Plan and Determine Roles & Responsibility	Complete
Phase 2 - Execute	Hypothesis Validation and Data Collection	January 2019 – December 2020
Phase 2 -Closeout	Results and Report Creation, Scalability Analysis, Demonstration Project Completion	October 2020 - December 2020

The work plan shown above as developed as part of the Implementation Plan has no changes to the current milestones. Milestones "Phase 1 – Initiate, Plan, and Execute" as well as "Phase 2 – Initiate and Plan" are all complete. The project continues to focus on the "Phase 2 – Execute" milestone.

3.3 Next Quarter Planned Activities

In Q4, 2020 the project team aims to continue the following tasks:

Phase 2 - Execute

- Continuation of data collection on the battery and system performance at the site
- Continued validation and reporting of use case progress with the collected test data
- Continue to monitor for adjacent feeder events that could the battery breaker to trip to gain experience with protection coordination of sensitive inverter-based battery equipment
- Complete grounding of the breaker neutral conduit within the building to eliminate the load imbalance and breaker trips.
- Modeling increased usage of the DC fast and Level II EV chargers to demonstrate the variable load impacts to the battery system
- Begin developing the final report outline on project learnings over the past two years

4.0 Conclusion / Lessons Learned

Our experience since commercial operation of identifying and working to resolve technical issues with the battery system continues to expand our technical knowledge of this system and has led to a greater appreciation for the current state of maturity of battery storage technology. We continue to remain diligent in monitoring, testing, and resolving any system anomalies. As a demonstration project, it is important to remain flexible and to use implementation and operational learning to ensure future success of these and other battery storage projects.

Lessons Learned During Operational Phase:

- Data collection on battery performance is critical and needs to be simplified as much as possible. During the initial data mining process, we identified an opportunity to combine data from two different systems. The developed solution was to install an additional system meter which will allow all data to be compiled in one single system simplifying data collection.
- The performance and capabilities of large scale battery systems are still being refined. Operation and monitoring during the early stages of commercial operation revealed an issue with Powin's batteries where load noise generated by the inverter was affecting the battery management system, preventing it from monitoring itself accurately causing frequent battery system disconnection. It was determined that the best solution to this issue is to replace the original batteries with Powin's 2nd generation batteries
- Coordination of breaker protection relays can be difficult when an inverter and battery are involved. Since this is newer technology and inverters are historically sensitive to issues encountered on adjacent circuits, especially ground faults, a detailed relay coordination study and modeling should be performed and reviewed prior to commercial operation.
- Initial results show the impact of the battery in significantly reducing the building peak demand and improve building load factor. Proper sizing of the battery upfront and adjustment to charge/discharge settings of the battery (by analyzing historical building load data) has been the key to achieve this performance. Effective peak demand reduction can reduce the monthly bills of the building.