The Residential Reliability Improvement Project

Hydro One

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Table of Contents

Executive Summary **3**

Introduction and Goal **4**

RRI Project Background 4

Goals and Baseline 5

Approach/Methodology **6**

Baseline Development 6

Customer Experience and Billing Impacts 7

Performance Metrics and Success Criteria 7

Data Collection and Monitoring During the Pilot 7

Results **8**

Residential Reliability Improvement Customer Feedback Survey **11**

Survey Overview 11

Overall Satisfaction 11

Enrollment and Installation 11

Battery Performance and Monitoring 11

Post-Installation Support 12

Key Feedback Themes and Recommendations 12

Challenges and lessons learned **13**

Scaling plan and future considerations **14**

Capacity analysis: 14

Stacked benefits 18

Future OM&A and Monitoring 20

Conclusion **21**

Executive Summary

Hydro One successfully completed the Residential Reliability Improvement (RRI) Pilot Project, a forward-looking initiative to improve service reliability for 100 rural residential customers who have historically experienced over 50 hours of annual outage duration—more than triple the system average. To address this challenge cost-effectively and sustainably, Hydro One deployed behind-the-meter (BTM) Battery Energy Storage Systems (BESS)—specifically, the Tesla Powerwall 2.0—offering whole-home backup power.

Working in partnership with NRStor/MPOWER Energy Solutions, the program provided and installed 200 Tesla Powerwall units across 100 customer homes between early 2023 and the end of 2024. These systems were installed at no cost to customers and are backed by a five-year participation agreement. A fire-rated enclosure was integrated into installations in compliance with updated Ontario Electrical Safety Code (OESC) requirements. Project outcomes significantly exceeded baseline expectations, demonstrating substantial improvements in customer outage duration, frequency, and resilience.

This report presents a compelling and comprehensive evaluation of the Residential Reliability Improvement (RRI) Pilot Project, whose outcomes have significantly exceeded initial expectations. Key performance indicators highlight a notable reduction in both outage duration and frequency, leading to a meaningful improvement in residential energy resilience. Participating customers reported high satisfaction, frequently citing increased peace of mind and a tangible uplift in their daily quality of life.

The initiative has clearly validated whole-home battery backup systems as a viable and impactful solution for bolstering grid reliability in rural areas where traditional infrastructure upgrades may be prohibitively costly.

In addition to technical achievements, the report explores customer experience insights and outlines a strategic path forward to replicate this model in other high-outage communities. It also considers how aggregated storage assets could contribute to broader grid services and support decarbonization objectives.

Ultimately, the RRI Pilot stands out as a forward-thinking and scalable model for equitable grid modernization. Its success reflects Hydro One’s ongoing dedication to enhancing reliability and resilience across Ontario, with a focused commitment to historically underserved communities.

Introduction and Goal

RRI Project Background

The Residential Reliability Improvement (RRI) pilot project was initiated in response to a well-defined service gap in Hydro One's distribution network: rural residential customers experiencing annual outage durations exceeding 50 hours—more than three times the average experienced by the broader customer base. Given the challenging terrain, dispersed loads, and extreme weather exposure along long rural feeders, traditional poles-and-wires upgrades were neither cost-effective nor guaranteed to provide improved resilience. Hydro One proposed a more efficient and customer-centric alternative—behind-the-meter (BTM) Battery Energy Storage Systems (BESS).

Through a technology scan conducted in Ontario, the Tesla Powerwall 2.0 was selected as the optimal residential BESS. Its proven whole-home backup capability, seamless automation, and long-term warranty aligned well with project objectives. To maximize effectiveness, each participating home received two Powerwall 2.0 units (7 kW, 13.5 kWh each), along with supporting infrastructure such as an Energy Gateway. Installations were offered at no cost to customers and configured behind the meter.

The customer engagement process was led entirely by Hydro One and included marketing, outreach, and legal onboarding for voluntary participation. Customers targeted for this pilot were year-round residents in single-family homes located along feeders with chronically poor reliability. In total, 100 homes were equipped with 200 Powerwall units over the course of 2023 to 2024. The systems were designed to reduce both the duration and frequency of sustained interruptions, though they operate with a "break-before-make" transfer mode, resulting in brief momentary outages upon activation.

Hydro One engaged NRStor/MPOWER Energy Solutions to provide a complete solution—from procurement and installation to system monitoring and maintenance. MPOWER, a Toronto-based leader in residential energy storage, brought technical depth and extensive field experience as Canada's top Tesla Powerwall installer. The agreement ensured service continuity for a minimum of five years, after which Hydro One may either extend the agreement, bring support in-house, or consider other vendors.

While the implementation largely adhered to the original project scope, a regulatory update during rollout required Hydro One to adapt. A change to the Ontario Electrical Safety Code (OESC) introduced new fire safety requirements for indoor BESS installations. To comply, Hydro One partnered with Tetra Tech, an engineering consulting firm, to design and install customized fire-rated enclosures for all systems installed within dwelling units.

The project's deployment phase, and a one-year monitoring period is now complete. These assets are expected to remain operational beyond the initial term, supported by the Powerwall's manufacturer-backed 10-year warranty. To balance customer flexibility with program continuity, the initial participation agreement was set at five years, with the option for a five-year renewal should Hydro One continue the initiative.

Goals and Baseline

The Residential Reliability Improvement (RRI) Pilot Project was initiated to address chronic service interruptions along a lengthy rural distribution feeder characterized by historically poor reliability metrics. This feeder, serving a dispersed customer base, frequently experienced sustained outages due to its geographic reach and limited infrastructure redundancy.

At the heart of the project was the deployment of Residential Battery Energy Storage Systems (BESS), designed to bolster energy resilience for participants by directly targeting and mitigating two key reliability challenges:

- The total duration of service interruptions (measured in hours per customer per year)
- The frequency of sustained interruptions, defined as outage events exceeding one minute in duration

By integrating Tesla Powerwall systems into residential premises, the project aimed to provide seamless backup power during grid outages. Recognizing the "break-before-make" nature of the Powerwall's automatic transfer mechanism—where the connection to the grid is interrupted briefly before the battery supply is engaged—the project acknowledged the occurrence of momentary outages during transitions. However, these were expected to be minimal in duration and substantially outweighed by the benefits of long-duration outage mitigation.

Proposed Pilot Objectives

The RRI Pilot aimed to deliver the following quantifiable outcomes for participating customers:

- A **60% reduction in the cumulative outage duration**, thereby dramatically decreasing the number of hours residents are left without power
- **As much as a 65% reduction in the frequency of sustained interruptions**, reducing not only operational disruptions but also the psychological burden associated with recurring outages

Together, these objectives were envisioned to validate residential BESS as a practical, scalable solution for enhancing service continuity in hard-to-reach and infrastructure-constrained rural communities.

Approach/Methodology

The Evaluation, Measurement, and Verification (EM&V) framework was designed to validate the pilot's core performance goals:

- Achieving a minimum 60% reduction in outage duration
- Achieving up to 65% reduction in the number of sustained outages

The framework includes performance monitoring and customer experience evaluation

Assumptions:

- Customer consumption patterns are assumed to remain unchanged during the pilot. However, voluntary load curtailment during outages is possible.
- The Powerwall provides whole-home backup; customers are not required to reduce demand.
- Net energy usage from the Tesla Powerwall is assumed to be zero over the course of the pilot (i.e., charging and discharging are balanced).
- Powerwalls are programmed to serve as the primary backup source, with any existing backup systems declared by participants.

Baseline Development

Baseline conditions were established using historical reliability data from Hydro One's Outage Response Management System (ORMS), Geographic Information System (GIS), and customer smart meter consumption records from 2018–2019. Baseline metrics include:

Average outage hours: 80 hours per customer per year

Annual outage events: Multiple sustained interruptions

Average peak load: ~5.5 kW/hour during mid- and on-peak periods

Feeder-level outage frequency, customer energy usage profiles, and pre-installation customer satisfaction data were also collected to support baseline modeling.

Reliability improvement estimates were calculated using conservative assumptions:

Average load draw of 1 kW/hour per customer

Total usable energy: 27 kWh (from two Powerwalls), adjusted to 24 hours of average support

Outages during off-peak hours assumed to be fully mitigated

High-demand hours (7AM–7PM) modeled with reduced battery duration (~4.3 hours)

This modeling resulted in a projected 60% mitigation of outage duration and 65% full outage event coverage—against which actual field data were compared.

Customer Experience and Billing Impacts

Customer feedback was captured through structured surveys to assess Installation process satisfaction and ease-of-use, Performance, peace of mind, and willingness to recommend.

Billing impact analysis assessed differences in energy costs due to time-of-use rates when the Powerwalls recharged following outages. Load-shifting capabilities were disabled during the pilot to ensure accurate billing impact attribution.

Performance Metrics and Success Criteria

The following categories and metrics were used to measure pilot success:

Table 1 Pilot Success Metrics

Category	Metric	Target
Customer Reliability	Total outage hours and sustained outage frequency	≥ 60% and 65% reduction respectively
Technical Performance	BESS runtime, discharge events, safety incidents	≥ 24-hour support in most cases; zero safety failures
Customer Satisfaction	Post-pilot satisfaction ratings	≥ 90% satisfied
Billing Impact	Net effect of TOU charging cycles	Nominal increase/decrease per customer
Maintenance & Alerts	Number of alarms and service events	No critical failures; minimal in-person resolution

Success is determined by meeting or exceeding the targets outlined above, validated through objective data, customer feedback, and technical system reliability metrics

Data Collection and Monitoring During the Pilot

Data was collected continuously during installation, commissioning, and operational phases. Performance data includes:

- Time, frequency, and duration of outages on feeders and individual customer meters
- Timestamped BESS activity logs (discharge and recharge events)
- Battery state-of-charge tracking during outages
- Number and nature of system alarms, including safety and performance alerts
- Maintenance activities, including remote and on-site service actions

Supplementary metrics were tracked to identify performance risks such as:

- Capacity degradation over time
- Transition delays exceeding 30 milliseconds
- Failure to discharge or reconnect to grid
- Peak load delivery capacity of the BESS

All telemetry, outage, and performance data were centralized through Mpower's monitoring platform and shared periodically with Hydro One. Final project data was validated by the Asset Analytics and Distribution Investment Planning teams and is presented in the following section (Results).

Results

Pre-deployment assessments revealed that participating customers were acutely exposed to both prolonged and recurrent power interruptions, undermining household comfort, safety, and productivity. In response, the RRI Project executed a comprehensive resilience strategy—deploying advanced Battery Energy Storage Systems (BESS), instituting real-time monitoring and analytics, and enforcing rigorous commissioning and maintenance protocols.

By leveraging continuous data analysis to refine dispatch algorithms and recharge cycles, the initiative not only satisfied its original performance criteria but consistently exceeded them. The sections that follow present a detailed breakdown of results for the IESO GIF-funded pilot cohort (100 installations) and for the full program deployment (335 installations).

For only Pilot customer funded under IESO GIF (100 installations):

Table 2 RRI results for 100 Pilot customers

Year	No. of Discharges	Total Outage Time [min]	Total Outage Time Avoided [min]	Customer outage minutes	Avg Discharge Power [W]	Max Discharge Power [W]	Avg Outage Duration [min]	Max Outage Duration [min]	Min Recharge Duration [min]	Avg Recharge Duration [min]	Max Recharge Duration [min]
2023	264	13460	13448	12	4231	14330	72	1073	43	94	366
2024	2629	125709	125290	419	4921	14500	526	1865	8	66	401

• Realized a 99.9 % reduction in outage duration in 2023 and a 99.6 % reduction in 2024, for an overall decrease exceeding 99 %.

• Prevented a total of 138,738 customer-minutes of interruption—equivalent to approximately 2,312 hours.

For all RRI customer (335 installations):

Table 3 Results for all RRI customers

Year	No. of Discharges	Total Outage Time [min]	Total Outage Time Avoided [min]	Customer outage minutes	Avg Discharge Power [W]	Max Discharge Power [W]	Avg Outage Duration [min]	Max Outage Duration [min]	Min Recharge Duration [min]	Avg Recharge Duration [min]	Max Recharge Duration [min]
2023	2884	169210	143177	26033	4231	16100	432	4630	83	194	494
2024	5694	353052	347730	5322	6832	14840	718	2726	14	192	463

• Realized an 84.6 % reduction in outage duration in 2023 and an impressive 98.4 % reduction in 2024, yielding an overall decrease of over 92 %.

• Averted 522 ,262 customer-interruption minutes—equivalent to roughly 8 ,704 hours—across the full deployment.

Even when outages stretched to nearly 50 hours, the BESS uninterruptedly sustained household power requirements. Importantly, some customers shifted their consumption, focusing on essential loads during prolonged interruption, thereby further enhancing overall system efficiency.

Table 4 RRI success Metrics vs Results

Category	Metric	Target	Results
Customer Reliability	Total outage hours and sustained outage frequency	≥ 60% and 65% reduction respectively	Both the outage duration and frequency were reduced by more than 90%
Technical Performance	BESS runtime, discharge events, safety incidents	≥ 24-hour support in most cases; zero safety failures	To date, no safety failures have been reported or observed. Powerwalls successfully initiated backup operations in over 98% of outage events. In the rare instances where the battery failed to engage, systems were promptly inspected, maintained, and, when necessary, the system was repaired or replaced.

Customer Satisfaction	Post-pilot satisfaction ratings	≥ 90% satisfied	84% percent reported they were "very satisfied" and 14 % "somewhat satisfied
Billing Impact	Net effect of TOU charging cycles	Nominal increase/decrease per customer	To date, there have been no reported concerns from customers regarding significant billing impacts. Billing effects for Time-of-Use (TOU) customers have been minimal to negligible.
Maintenance & Alerts	Number of alarms and service events	No critical failures; minimal in-person resolution	In a few instances, certain BESS units experienced failures due to lightning strikes and were subsequently replaced. Only 7% of unexpected service events required on-site intervention—typically involving cable, fuse, or battery repairs or replacements. The majority of service issues were resolved remotely.

Residential Reliability Improvement Customer Feedback Survey

Survey Overview

Between January and March 2025, 213 participants in the Residential Reliability Improvement (RRI) program completed a detailed feedback survey. An impressive 98% of respondents expressed satisfaction with the program and its Tesla Powerwall backup system, underscoring the initiative's success in enhancing household resilience and comfort.

Overall Satisfaction

Respondents overwhelmingly praised the program's reliability and its impact on quality of life. 84% percent reported they were "very satisfied" overall, and 14 % "somewhat satisfied." The instantaneous, whisper-quiet transfer to backup power consistently received commendations, particularly from rural and older households that previously endured frequent outages.

Customer Testimonials:

"We love LOVE this program and the peace of mind it gives us."

"This has virtually eliminated all inconvenience of being in one of the worst areas."

Enrollment and Installation

The RRI onboarding experience earned high marks: 87 % of participants found enrollment easy or very easy, and 96 % were satisfied with the installation process. Installers were lauded for their professionalism, efficiency, and clear communication. A small number of respondents cited isolated delays in scheduling or component delivery, as well as occasional minor installation oversights, all of which were promptly resolved.

Customer Testimonials:

"The whole process was simple… power has gone off several times and we didn't even know."

"The installation by Two Wired Guys was phenomenal! Friendly, knowledgeable and efficient!"

Battery Performance and Monitoring

Battery performance exceeded expectations for most users. 78% of homeowners reported instantaneous switchover during outages, and 91 % indicated that their Powerwall met or surpassed performance expectations. The Tesla mobile app—utilized by % of survey participants—proved indispensable for real-time monitoring and outage notifications. While the system reliably supports interruptions lasting up to 24 hours, respondents noted reduced efficacy for outages extending beyond two days.

Customer Testimonials:

"We had a 44-hour outage… batteries still had 50% left. Furnace, water pump, electronics all ran."

"Power goes out and I don't even know—no more generators, no more stress."

Post-Installation Support

Hydro One and the Tesla/MPower support teams were generally rated as responsive and helpful. Nevertheless, 37 % of participants were unclear about whom to contact for technical assistance post-installation. This gap in support visibility presents an immediate opportunity to enhance customer communications and streamline post-installation guidance.

Customer Testimonials:

"MPower was a pleasure to deal with. Quick responses and proactive support."

"Tesla let me know it wasn't working and helped fix it remotely—very helpful."

Key Feedback Themes and Recommendations

Although the survey results were overwhelmingly positive, several recurring requests emerged:

- Greater user control over energy management—such as time-of-use discharge settings and solar-charging integration.
- Program expansion to additional communities, particularly in underserved rural regions.
- Enhanced educational materials and clearer support-channel documentation for post-installation queries.

By addressing these recommendations (expanding feature control, improving support visibility, and broadening program reach) Hydro One can build on the RRI program's clear success and further strengthen customer confidence and satisfaction.

Challenges and lessons learned

The Residential Reliability Improvement (RRI) Pilot Project afforded Hydro One a critical opportunity to assess the technical, regulatory, and customer engagement challenges associated with the deployment of residential battery energy storage systems (BESS) in support of grid modernization. This first-of-its-kind initiative yielded a diverse array of valuable lessons that underscore the importance of strategic planning, cross-functional coordination, and adaptability in navigating a complex and evolving energy landscape.

Early observations highlighted the necessity of securing Board-level and internal stakeholder approvals during the planning phase to mitigate delays in project initiation. Indirect engagement with manufacturers through third-party vendors proved to be a suboptimal approach, introducing communication inefficiencies, limiting product customization, and delaying delivery timelines. Insufficient vendor technical capacity and subcontractor management issues further underscored the need for robust prequalification processes and clearly defined service-level expectations embedded in contractual agreements. Delays arising from regulatory changes also emphasized the importance of proactive coordination with code authorities and the establishment of contingency pathways in project design.

On the customer front, premature engagement in advance of finalized vendor agreements adversely impacted brand trust and expectations management. Digital enrollment tools presented accessibility challenges for some participants, reinforcing the importance of targeted support resources. A recurring theme among participants concerned the structure of the Participant Agreement; its rigidity constrained Hydro One's ability to implement programmatic refinements in response to operational learnings. Future programs would benefit from a more flexible legal framework that allows for adaptive program evolution while maintaining transparency and customer protection.

In addition, the observed sizing of BESS units relative to actual outage durations revealed a misalignment between installed capacity and practical use cases. While the oversized systems ensured comprehensive backup during outages, they introduced inefficiencies that suggest a more calibrated sizing methodology would enhance cost-effectiveness and asset utilization in future deployments.

Hydro One is actively leveraging the insights gained through this pilot to refine its strategic approach to distributed energy resources. The ongoing MyEnergy Rewards demand response initiative, which includes a subset of RRI participants, will yield additional operational data to inform decisions around optimizing BESS systems for both reliability services and grid support. Collectively, the findings from the RRI Pilot Project will serve as a foundational reference for designing scalable, customer-centric, and resilient energy solutions in alignment with Ontario's evolving energy transition objectives.

Scaling plan and future considerations

The RRI pilot project proved exceptionally successful, both in terms of technical performance and participant satisfaction. It not only exceeded all original targets but also generated strong word-of-mouth demand: pilot-era applicants reported uniformly high satisfaction with their Powerwall installations, underscoring the project's value proposition.

Buoyed by these results, Hydro One officially transitioned from pilot to full program in 2024. Between January and December, an additional 225 residential sites were outfitted—bringing the cumulative total to 335 installations (670 Powerwall units). With over 20,000 customers still eligible, and given the demonstrable benefits and positive feedback, Hydro One has proposed embedding the RRI program in its 2028–2032 rate plan. Subject to Ontario Energy Board approval and funding authorization, the plan envisions at least 300 new installations annually throughout that five-year term.

To maximize long-term value, the project team has undertaken a series of advanced analyses and field tests. These efforts include a detailed assessment of battery capacity margins and evaluation of stacked-benefit scenarios, whereby stored energy may be mobilized for demand-response events or peak-shaving programs.

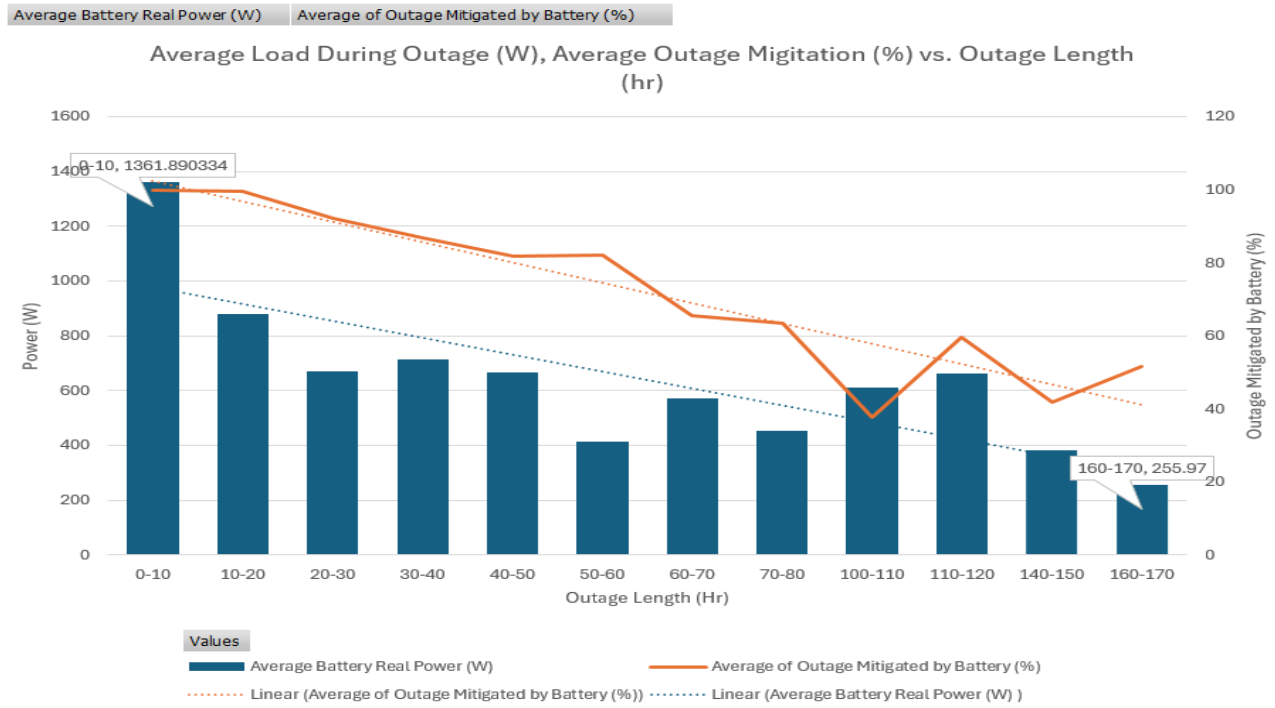
Findings from these studies will guide future operational protocols, ensuring that RRI installations continue to deliver resilience, customer savings, and potential grid-service revenues.

Capacity analysis:

A detailed capacity analysis examined telemetry from ninety RRI sites brought online in 2022 and 2023. Only outage events with complete data on load, state of charge, and duration were included to ensure the findings reflect true system performance under real-world conditions.

Across all events, the average backup load draw stabilized at roughly 1.3 kilowatts. Household consumption patterns shifted as outages lengthened: during interruptions under five hours, average demand measured approximately 1 350 watts, whereas in extended outages the draw fell to about 300 watts. This customer-driven curtailment conserved stored energy and extended the effective runtime of each system. (Figure 1)

Figure 1 | RRI Outage hours, power consumption and % of outage mitigation



Analysis of outage duration versus residual SoC reveals that 75 % of interruptions lasted less than five hours, at which point the mean battery SoC remained above 95 %, affirming that most events impose minimal depth-of-discharge stress. Expanding the window, 90 % of outages concluded within ten hours, with average SoC at restoration measuring 76 %. And fully 99 % of recorded disruptions were resolved before 18 hours had elapsed, underscoring that nearly all grid disturbances fall well within the BESS's full-capacity backup envelope. When combined with customer load management, these systems averted 78 % of potential customer-minutes interrupted, effectively delivering uninterrupted power for more than three-quarters of what would otherwise have been unserved intervals. (figures 2and 3)

Figure 2 |Cumulative Distribution of outage hours

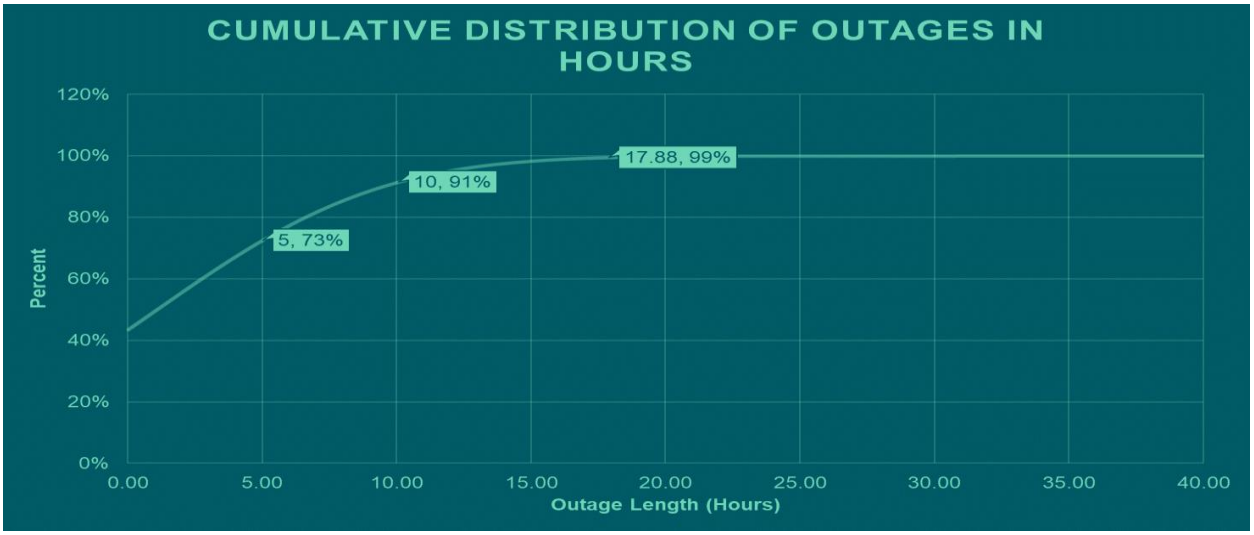
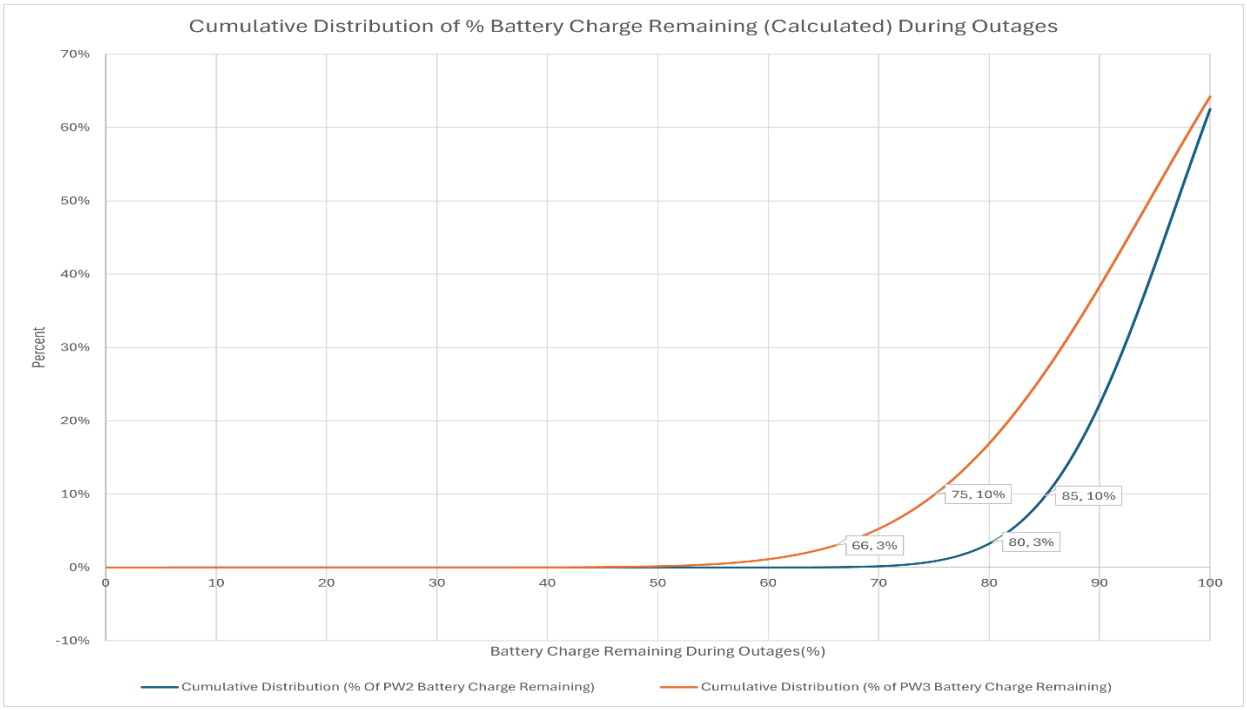


Figure 3 | Cumulative distribution of BESS SoC remaining



Looking ahead, targeted customer education on prioritizing critical loads could yield additional performance gains and incorporating real-time control algorithms that adapt discharge rates based on outage forecasts and user-defined load priorities promises to further enhance system efficiency. Moreover, analysis of post-event state-of-charge data shows that the deployed battery systems retain substantial reserve capacity after most outages, suggesting the current BESS sizing may be oversized if dedicated solely to backup power. To assess cost-effectiveness and operational trade-offs, the project team therefore compared performance against a scaled-down 13.5 kW system (one Powerwall 3 systems), evaluating its ability to deliver equivalent resilience with a smaller footprint.

Powerwall 2 averted 270 825 interruption-minutes (78 %) and fully backed up 73 % of outages. The smaller Powerwall 3 would avert ~250 590 minutes (72 %) and back up 73 %, retaining 93 % of minutes saved and 99 % of full-backup coverage. (Figure 4 and Table 5)

These findings demonstrate that, the smaller PW3 configuration replicates nearly all of the PW2's resilience performance. This close alignment confirms that the current PW2 installations exceed the capacity required for dedicated backup applications, underscoring the potential for cost and footprint reductions without compromising reliability.

Going forward, the RRI program will standardize all installations using either a single Powerwall 3 unit or an equivalent system with comparable capacity.

Figure 4 | Two Powerwall 2 vs One Powerwall 3 Comparison

	0-20	20-40	40-60	60-80	100-120	140-160	160-180
Number of Outages	24021	58	15	10	3	1	1
Sum of all outage Hours backed up by 2 x PW2(hrs)	12163	1501	560	480	183	62	86
Sum of outage hours backed up by 1 x PW3 (Calculated) (hrs)	11670	1212	430	324	152	35	53
Average of Outage Mitigated by 2x PW2 (%)	100.0	95.4	81.9	66.7	52.4	41.8	51.6
Average of Outage Mitigated by 1xPW3 (%)	99.8	77.8	62.2	45.7	43.0	23.8	31.6
Average of Change from 27kWH Battery (%)	1.7	-19.5	-23.2	-33.7	-32.0	-43.0	-38.8

Table 5 2xPowerwall 2 VS 1xPowerwall 3 analysis

Data Source	Total CMI (min)	PW2 CMI Avoided (min)	PW2 CMI Avoided %	PW2% Of Outages Fully Backed up	PW3 CMI Avoided (Estimate) (min)	PW3 CMI Avoided (Estimate) %	PW3 % Of Outages Fully Backed Up (Estimate)	CMI Ratio (PW2/PW3) (Estimate)	Full Outage Mitigation Ratio (PW2/PW3)
2022 & 2023 Outage & Recharge Events	348,248	270,825	78%	73%	250,590	72%	73%	93%	99%

Stacked benefits

A detailed analysis was conducted on a single Powerwall 3 system (13.5 kWh) to evaluate the impact of allocating a specific portion of the battery energy storage system (BESS) capacity to grid services. The study utilized BESS telemetry and outage data spanning from 2022 through mid-2024.

The initial phase of the analysis assessed the extent to which outages could be mitigated using the full capacity of a 13.5 kWh system. In the subsequent scenario, it was assumed that only 20% of the available capacity would be used for reliability improvement. The findings are summarized below:

Table 6 Outage Mitigation Analysis for a 13.5 kWh system for outage data from 2022-July 2024

Outage Mitigated by 13.5 kWH Battery (%)	count of outages	Total count of outages	% of the time BESS covered the outages
>50%	28	24168	0.115855677
<=50%	24140	24168	99.88414432
>65%	106	24168	0.438596491
<=65%	24062	24168	99.56140351
100%	23918	24168	98.96557431

The analysis indicates that utilizing a 13.5 kWh system instead of a 27-kWh system, for the same customers and identical outage scenarios, would have fully covered 98.96% of the outage durations. In 0.116% of outage occurrences, less than 50% of the outage duration would have been covered.

Additionally, in 0.44% of outage occurrences, less than 65% (the RRI program Target) of the outage duration would have been covered.

Table 7 Outage Mitigation Analysis for 20% capacity of a 13.5 kWh system for outage data from 2022-July 2024

Outage Mitigated by 20% of the 13.5kWH Battery (%)	count of outages	Total count of outages	% of the time BESS covered the outages
>50%	629	24168	2.602507344
<50%	23539	24168	97.39335512
>65%	785	24168	3.247962266
<=65%	23383	24168	96.7479002
>100%	979	24168	4.050643386
100%	23189	24168	95.94521908

Based on the dataset and the analysis, the total duration of grid outages recorded was 963,416 minutes. When utilizing just 20% of the Powerwall 3 system's 13.5 kWh capacity for backup, the system was able to provide 521,532.38 minutes of battery-supported power. This corresponds to an outage mitigation rate of approximately **54.13%**, indicating that more than half of all recorded outages could be at least partially covered under this configuration. However, this falls slightly below the **60% mitigation threshold** established by the RRI program benchmark.

The analysis above leverages the same dataset for RRI customers, spanning 2021 to mid-2024. The RRI program primarily focused on enhancing reliability, with the full capacity of the BESS (27 kWh) utilized during outages.

The data reveals that the longest outage lasted 166 hours, representing only 0.4% of total outages. Approximately 75% of outages were under 5 hours, 90% were less than 10 hours, and nearly 99% were shorter than 18 hours.

In this analysis, a 13.5 kWh system is considered as an alternative to the 27 kWh BESS. It assumes that 20% of the system's capacity is allocated for reliability enhancements, another 20% reserved for internal RBESS usage, and the remaining 60% dedicated to grid services such as peak shaving. With 20% of capacity available for outage mitigation, the system would fully mitigate approximately 96% of outages, amounting to 343,487 minutes. Overall, it is estimated that the BESS mitigates around 54% of total customer outage minutes, factoring in outliers and prolonged outages.

While dedicating 60% of capacity exclusively to grid services may initially seem ambitious, the analysis demonstrates that even under these stretched assumptions, performance metrics remain closely aligned with the original RRI program targets. This suggests that a significant portion of the system's capacity could still be effectively leveraged for grid services without compromising reliability goals.

That being said, the program team has not yet finalized the allocation strategy between grid services and backup power. This decision remains open as discussions continue around maximizing stacked benefits while preserving core reliability objectives.

Currently, Hydro One is conducting a targeted pilot initiative involving 20 RRI customers enrolled in a demand response program under the *MyEnergy Rewards* framework. The findings and operational insights derived from this pilot will play a critical role in informing future decisions regarding the optimal utilization of BESS assets installed under the RRI initiative, particularly with respect to enabling stacked benefits that balance both reliability support and grid service contributions.

Future OM&A and Monitoring

Looking ahead, ongoing Operations, Maintenance, and Administration (OM&A) efforts for the RRI program are structured to ensure sustained performance and reliability of the deployed BESS systems. Each participating customer has entered into a five-year Participant Agreement with Hydro One, with the option to extend participation annually for up to an additional five years. To support the program's long-term integrity, Hydro One maintains an active Support and Services Agreement with Mpower, renewed annually, which covers continuous monitoring, maintenance, reporting, and service provision for all current and future RRI customers. Through this agreement, the entire RRI fleet is actively monitored for operational anomalies or unexpected events. Any such issues are promptly reported to Hydro One by Mpower, with corrective actions initiated as necessary. Mpower also provides Hydro One with monthly and annual telemetry and service reports, which are used to evaluate program performance against established targets. In addition, Mpower remains responsible for executing all required maintenance activities, including repair work, component replacements, and on-site service visits, ensuring that system health and service quality are preserved throughout the life of the program.

Conclusion

The RRI pilot has demonstrably achieved its principal performance objectives. The initiative yielded a reduction in outage duration and frequency exceeding 90%, while consistently initiating seamless backup operations and reporting no safety incidents to date. These outcomes reflect the system's exceptional reliability, operational robustness, and technical efficacy. Customer sentiment further underscores the program's success, with 98% of participants expressing satisfaction and no notable billing concerns reported.

Key operational insights have also illuminated avenues for enhanced efficiency, most notably the feasibility of system downsizing without compromising reliability. Comparative evaluation of Powerwall 2 and Powerwall 3 configurations indicates that a more compact system retains the majority of resilience benefits while offering advantages in cost-effectiveness and space requirements.

Looking forward, the adoption of a smaller capacity system configuration and the continued exploration of stacked service capabilities will be critical to the program's evolution. Through sustained customer education, targeted demand response initiatives, and the integration of adaptive control strategies, the RRI initiative is strategically positioned to optimize the deployment of distributed energy resources. The program thereby serves as a replicable model for advancing grid resilience, enhancing customer value, and fostering the transition to a more sustainable and reliable energy landscape.

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