Unlocking DERs Across Ontario

Enel X Canada Ltd.

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Disclaimer: This project is supported by the financial contribution of the Independent Electricity System Operator (IESO), through its Conservation Fund. However, the views, opinions and learnings expressed in this report are solely those of Enel X Canada Ltd.

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Executive Summary

The *Unlocking DER Across Ontario* pilot, conducted by Enel X under the Grid Innovation Fund (GIF) initiative, aimed to address market barriers preventing distributed energy resources (DERs) from fully participating in Ontario's electricity markets. The existing regulatory framework limits DER participation in the Operating Reserves (OR) program by requiring them to register as dispatchable loads—an approach unsuitable for many sites with behind-the-meter (BTM) battery storage capabilities.

This project demonstrated how an innovative participation model that enables aggregation of DERs of varying sizes and response types could help unlock DERs to provide crucial OR and DR services. Over the course of the project, Enel X, along with their partner Powerconsumer, designed a pilot program that required modified daily energy market participation and administered actual dispatches that simulated OR and Capacity Auction events. Additionally, the project introduced alternative measurement and verification (M&V) methodologies to measure this dispatch performance.

Key Activities

- **Modified Participation Structure:** The pilot tested a new participation model that included modifications to existing market rules such as OR aggregation, dual resource participation, and energy bid compliance. The model included components from both the dispatchable load resource type, such as fast response requirements, and components from hourly dispatchable resources (HDR), such as aggregation and energy bid parameters.
- **Alternative M&V Methodologies**: The pilot tested two novel methods for measuring OR performance designed to better capture the unique characteristics of DERs. The first approach was based on aggregated load reductions across several sites within a resource, and the second approach calculated performance using the aggregated output of battery energy storage systems (BESS) located BTM. Both methods assessed OR performance compliance by the sustained load drop rather than meeting energy set points.
- **Software Integration & Optimization**: Enel X and Powerconsumer developed a robust software system to facilitate optimized bid submissions, dispatch management, and real-time monitoring of DER performance. The project highlighted the importance of API connectivity and real-time data validation in improving market participation efficiency.
- **Simulated OR and Capacity Auction dispatches:** Enel X selected 12 sites to participate in the pilot program, with a combined maximum load reduction capacity of 53 MW. Across 42 OR dispatches and 11 Capacity Auction dispatches, the sites delivered 602 MWh of load reduction.

Key Findings

- **Modified Energy Market Structure:** This project successfully tested new dispatch data submission parameters for resources providing OR services. The modified energy bid submissions allowed for a more accurate forecast of the OR resource's curtailment capabilities. It also allowed more MW to be offered into the OR product, as the resource did not have to meet energy set point compliance requirements. These modifications did not at all impact the benefit of fast-responding load reduction that is needed during OR dispatches, as demonstrated by the dispatch results.
- **Dispatch Capability & Performance**: Aggregated DERs proved capable of responding to 10-minute OR dispatch signals, reinforcing the case for expanded DER participation. Both the OR and DR resource demonstrated strong performance, confirming the ability for sites with diverse curtailment methods (ex: both BTM storage and manual curtailment) to participate across programs. For both OR and DR pilots, the aggregated portfolios were more reliable, illustrating the added benefit that aggregation can provide to the grid.
- **Regulatory Barriers & Recommendations**: The study identified key barriers limiting DER integration and used the pilot design to assess paths for improvement. Recommendations include changing energy bid requirements, enabling OR aggregation, creating a new resource type that combines the simplicity of HDRs with the fast-response capabilities of dispatchable loads, and increasing coordination between IESO, LDCs, and market participants.

The *Unlocking DER Across Ontario* pilot successfully demonstrated that aggregated DERs can provide valuable grid services, offering flexibility, reliability, and cost-effective capacity. With peak electricity demand in Ontario expected to rise by nearly 10 GW over the next 15 years, unlocking the full potential of DERs is essential for ensuring grid resilience. By implementing targeted regulatory reforms and refining market participation models, IESO and LDCs can better integrate these resources, supporting a more sustainable and diversified energy future.

Introduction and Goal

This project was designed to address the current barriers preventing DERs from fully participating in IESO markets. The existing regulatory framework for the Operating Reserves (OR) and Capacity Auction programs limits the value that many DERs can provide to the grid. The requirement to register as a dispatchable load in both OR and dual OR/Capacity Auction participation excludes many sites from participating, despite their ability to provide reliable, fast, and localized demand flexibility.

Unlocking DERs Across Ontario is meant to demonstrate a new aggregation model that allows for sites of all sizes and response types to participate across the IESO administered markets (IAMs). The aggregations of DER assets, including BTM battery storage and DR capabilities, were dispatched in realistic simulations of these programs. The demonstration pilot replicated modified daily energy market participation and tested the ability of participating sites to provide the 10-Minute OR product as well as the longer, emergency Capacity Auction DR product.

Another core objective of this project was to establish alternative measurement and verification methodologies that aligned with the proposed participation model. The existing performance assessments, particularly in OR, do not account for aggregation or recognize the unique configuration that many DERs have, where only a portion of a site load is dispatchable.

Overall, Enel X's goal of this project was to challenge existing barriers to DER entry and provide empirical evidence that can be used to support regulatory reforms that will enable broader market participation.

Approach/Methodology

The project was executed in several phases, aligning with the core GIF milestones. The longest and most robust phase was the actual execution of the pilot program and dispatches. This phase is captured primarily in the 'Results' section, where the preparation and design phases are detailed below.

Phase 1: Participant & Partner Selection

Enel X selected 12 sites to participate in the pilot, with a combined maximum load reduction capacity of 53 MW. The sites represent a wide variety of peak load size, industry and location across the province. Nine of the sites utilized BTM battery energy storage systems for load reduction, one participant relied solely on manual curtailment, and two sites utilized both. The sites were selected because they all expressed interested in providing Operating Reserve services but were unable to participate given the high barrier to entry, or were ineligible to do so based on existing program rules. The significant majority of participants were able to respond to dispatch instructions within 5 minutes, with the slowest response time being just under one hour for the manual curtailment site.

Enel X selected Powerconsumer as a project partner due to their advanced software platform, strong relationships with LDCs, and their flexibility in designing new models. These attributes made them an excellent candidate to fulfill the role of market operator, design local dispatch simulations, as well as be a trusted source of dispatch data validation.

Together, Enel X, Powerconsumer, and the 12 participating sites formed the team that executed the remainder of the pilot phases and project deliverables.

Phase 2: Program Design

There were two primary components of the program design phase: the development of program rules and guidelines for how Enel X and its partners executed the simulated market dispatches, and the selection of measurement and verification methodologies with which the dispatches were measured.

Program Rule Development

A comprehensive set of program rules were developed to align with IESO's market structure to ensure the pilot results would be transferrable to the actual market. The rules were designed to balance existing regulatory structures with the innovative approaches that the pilot was testing. The main aspects of the pilot rules that differed from IESO rules were allowance or OR aggregation, modified energy dispatch data submissions, and the ability for sites to participate as different resource types depending on the product they were providing. For example, a site could participate in the resource simulating HDR characteristics for Capacity Auction (referred to as the DR resource), and also in the resource that provided Operating Reserves (referred to as the OR resource).

The program rules defined the qualification criteria for demand response and operating reserve resources. Sites participating as part of the demand response resources were required to be capable of responding to dispatch instructions within two hours, while those participating within the operating reserve resources had to respond within 10 minutes to align with IESO's most stringent requirements. Sites had the ability to offer capacity into both the DR and the OR resources.

Dispatch data requirements were also encompassed in the program rules. Dispatch data submission was structured to ensure smooth integration with IESO market processes. The process for both resources adhered to IESO's Day-Ahead Commitment Process (DACP) and Energy Market Interface timelines.

- Demand Response Resource: availability submitted day-ahead for non-holiday business days during the defined seasonal periods (May–October: 12-9 PM EST, November–April: 4-9 PM EST).
- Operating Reserves Resource: availability submitted day-ahead, with continuous bid updates until the mandatory window.
    - One core difference in the pilot rules was that energy bids were not required to reflect the total site load (including the non-dispatchable and dispatchable portions). Instead, the energy bid was equivalent to the resource's curtailment capability. Essentially, energy bids and OR offers were the same. For example, if the aggregated OR resource had a total load of 45 MW and could provide 20MW of load reduction, both the energy bid and OR offer would be 20 MW. This is in-line with how HDRs submit energy bids. This design reflects the reality that only a portion of site load is dispatchable for DERs, and the difficulty that energy bid compliance poses to aggregated portfolios with large portions of non-dispatchable load. The pilot design allows clear insight to the market on the MW available to be curtailed, and alleviates the current risk of energy bid non-compliance that prohibits many sites from entering OR.

The dispatch criteria was designed to align with the HDR resource for the Capacity Auction and with the 10-minute spinning product for OR. Dispatches were triggered by Powerconsumer at random, without Enel X's prior knowledge, to closely replicate participation in the IAMs.

Measurement & Verification Design

This project also explored alternative measurement and verification (M&V) methodologies to assess the performance of aggregated resources in the Capacity Auction and Operating Reserves programs.

The current M&V policies in the market are not designed to accommodate dynamic assets like behind-the-meter (BTM) storage. Market rules require DER with BTM resources participating in the OR program to enroll as Dispatchable Load resources. This classification requires that the entire site load be submitted in the energy dispatch data, with a portion of the load dispatchable on a 5-minute basis. Many DERs do not fit this requirement because only a portion of the load can be managed, primarily with assets such as batteries or backup generators. The M&V plan developed for the pilot sought alternative approaches that better reflect the capabilities of DER assets.

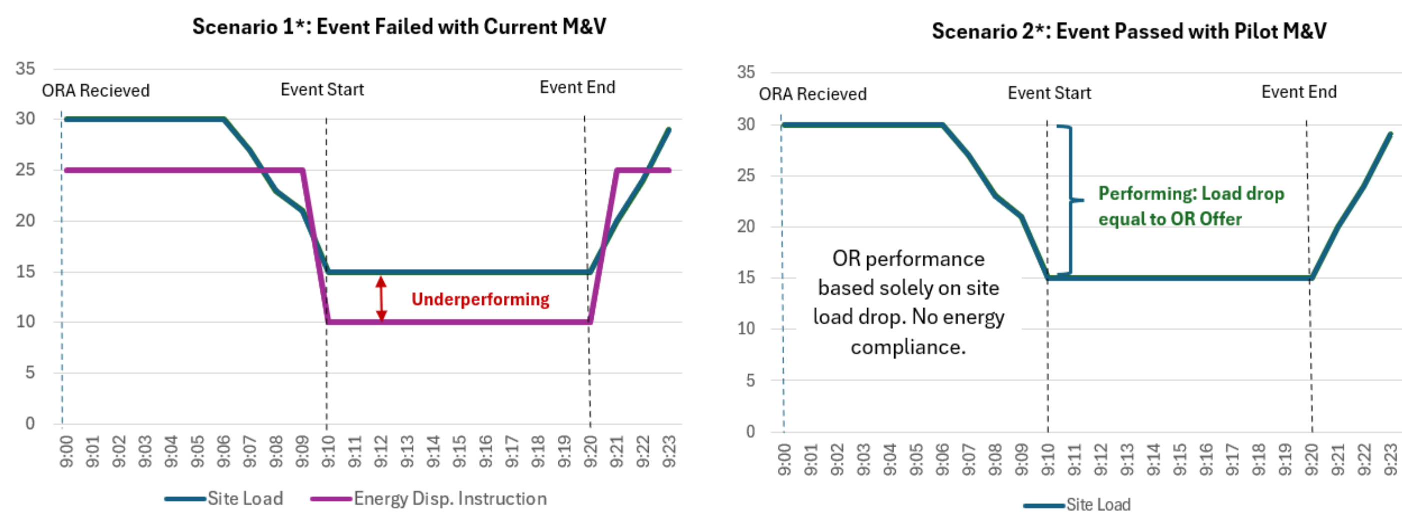
During the demonstration period, two alternative M&V methodologies were tested to evaluate their effectiveness in measuring OR activation performance.

OR Method 1: Aggregated Load-Based Measurement

OR offers submitted to Powerconsumer reflected the forecasted aggregate hourly availability of the BTM storage assets for a one-hour dispatch.

Performance was measured by the quantity of site load dropped at every 5-minute interval after the first measurement interval, which was first 5-minute interval after dispatch start (the third 5-minute interval after dispatch instruction was received). A successful dispatch occurred when the resource load, as measured as the aggregate of the site meters, dropped by at least the cleared OR offer amount beginning at the first measurement interval and sustained that drop for the remainder of the activation. The current OR methodology assesses whether a site meets the energy set point sent during an OR Activation 10-mintues after the dispatch instruction is issued. This energy set point is based off their energy bids, and can require a load drop greater than the OR offer if the site load was running higher than the energy bid at the time of OR activation. An illustrative comparison of the current and pilot M&V can be found in Figure 1.

Figure 1 | M&V comparison of the same dispatch



*Scenario 1&2: OR Offer or 15MW with a site load drop of 15 MW

This methodology removes the requirement for compliance with energy scheduling and allows sites to participate with only a portion of their load. Many sites with BTM storage do not have flexibility in their operations, making any load beyond the battery's capacity non-dispatchable. Under the current market structure, the load forecast uncertainty of the non-dispatchable portion of the resource results in Market Participants offering less OR MW than they have available. A lower OR offer provides a buffer to help mitigate the risk of non-compliance that can occur if an OR activation is called when site load is higher than the energy bid. This can be exacerbated when aggregating several sites. By focusing on only the net reduction in load at the aggregate of a resource's site meters rather than adherence to an energy bid, this pilot method lowers the risk of non-compliance due to forecast inaccuracies. The Measurement Canada certified 5-minute interval assessment also unburdens the sites from costly 2-second telemetry that disincentivizes new sites from entering the OR program.

OR Method 2: Battery Output-Based Measurement

OR offers submitted to Powerconsumer reflect the forecasted aggregate hourly availability of the BTM storage assets for a one-hour dispatch.

Performance was measured by the average battery discharge at the battery energy storage system (BESS) meter at every 5-minute interval after dispatch initiation. A successful dispatch occurs when the BESS output at the battery meter was equal to or greater than the OR offer amount, starting the first 5-minute interval following the start of the event (the third 5-minute interval after dispatch was received) and sustained for the duration of the event.

This approach directly measures the contribution of the DER asset to the dispatch event, offering a higher level of granularity than site load measurement. Since many battery assets are already required to provide telemetry to local distribution companies (LDCs) as granular as 2s, this method minimizes additional metering configuration while providing real-time visibility. It also ensures that only the dispatchable portion of the site load is measured, which is particularly beneficial for aggregated resources within the same LDC jurisdiction.

Measuring performance at the site level (Method 1) is an effective way to validate OR participation without requiring full site dispatchability.

Measuring performance at the battery level (Method 2) provides a more precise assessment of DER contributions and simplifies compliance verification.

Capacity Auction Methodology

The DR resource in the pilot was designed to replicate the HDR resource type in the IESO Capacity Auction. The M&V baselining methodology for dispatches was modeled after the Capacity Auction design detailed in Market Manual 5.5 section 1.6.26.3.1.

While the M&V method used was not new, the ability to measure the same (or very similar) group of sites as different resource types was novel. Many sites that comprised the DR resource also participated as part of the OR resource. Offering them in as two separate resources allowed participants with different dispatch capabilities at the same site (ex: a battery that can dispatch within minutes and additional load that can be curtailed within 1-hour) to offer their full value into the respective OR and DR pilots. This dual participation also ensured that appropriate M&V was applied to each of the services provided.

Phase 3: Software Integration & DER Optimization Process

The completion of the pilot rules and operational structure set the foundation for the software integration between Enel X and Powerconsumer. This software integration was critical to enable the bidding and dispatching activity. Enel X and Powerconsumer developed a Scope of Work, including respective software licenses, to outline key development tasks.

Powerconsumer was responsible for integrating the dispatching service, defining technical specifications, writing functional processes, developing and testing software, and provisioning test and production environments to accept dispatch data from Enel X. Additionally, Powerconsumer enabled bid management capabilities, including accepting, deleting, and updating bids through an API connection between Enel X's Flex Platform and Powerconsumer's system. Dispatch management functions were also developed, allowing Powerconsumer to trigger dispatches for OR and DR products.

Enel X was responsible for four key development requirements. First, optimized bidding tools were developed to assess different revenue opportunities, incorporating site load forecasts, battery state of charge, and program parameters to generate optimal bid schedules. Second, market offer bid creation and integration involved developing logic in the Flex platform to automate dispatch data creation and updates, along with configuring a market adapter to facilitate communication with Powerconsumer's API. Third, Enel X enabled automated DER dispatch to ensure that the Flex platform automatically triggered battery asset deployment within five minutes of when Powerconsumer issued a dispatch notification. Lastly, Enel X worked on integrating its DER and Flex platforms, ensuring that dispatch data could seamlessly flow between the two systems for real-time execution.

Bid Submission

Enel X leveraged an automated API-based data submission system with Powerconsumer, which allowed continuous bid updates to be sent for the DR and OR resources based on their respective availability. Enel X also created an automated system for bid creation using its DER and Flex proprietary platforms.

The DER Platform is comprised of two core components: the bidding tool and the DER Operating System (DER.OS). To create bids and offers that reflected actual availability of the sites, the bidding tool relied on site and battery data, future forecasts, and program parameters to generate optimal bids for each hour for the upcoming 48 hours. These bids were sent, at a site-level, to the Flex Platform.

The Flex Platform then assigned pricing data to the bids/offers and prepared the correct format for external submission. For the purposes of the pilot, Enel X and Powerconsumer treated all bids and offers submitted by Enel X as cleared and subsequently scheduled to provide 10-min OR and/or DR. DR energy bid pricing was set near the cap to replicate their use in the IESO market as a reliability resource during emergencies or to curb extremely high real-time energy prices.

The optimization logic within the bidding tool managed the availability of the sites since they were in two different resources. For example, if the DR resource was put on Standby for dispatch, the bidding tool would decrease the availability of the sites in that resource for other programs (ex: if a 1MW site was in both the DR and OR resource and the DR resource was put on standby, the OR resource bid would decrease by 1MW). The inverse, if the OR resource was scheduled for 10-min OR, did not require changes to the DR resource. Given the minimum 2-hour lead time for DR events, if the OR resource was actually dispatched there was adequate time to adjust market offers for DR. The two-resource program structure, one for OR and another for DR, required Enel X's Market Offer Management application to aggregate individual site bids into a single resource before sending it to Powerconsumer. Powerconsumer then ingested the bids via API into its platform.

Dispatch Process

Powerconsumer's platform, using the appropriate product logic (ex: 12-9pm EST program hours for DR), generated dispatches at random for the OR and DR resources. Dispatches were sent to Enel X's 24/7 Real Time Operations team, who created dispatches within the Event Management application of the Flex platform. A dispatch signal was then automatically sent to the DER operating systems to schedule discharge and, if necessary for the DR events, notifications were sent to contacts at the participating sites that had manual curtailment plans.

During the integration process, Enel X and Powerconsumer conducted a series of controlled dispatch tests, examining site-specific response times, energy output consistency, and bid accuracy. These tests allowed for refinement of dispatch processes and ensured that each DER site met the necessary response thresholds for both OR and DR commitments before entering into the pilot execution phase of the project.

Phase 4: Battery Installation & Pilot Execution

Battery Installation

The project scope included the installation and software integration of battery storage systems at two participating sites. This process began at the outset of the project and was running in parallel with phases 1-4.

The original intention was to have these batteries reach their commercial operation date (COD) during phase 3 so they would be able to participate for the duration of pilot execution phase. However, several challenges arose that delayed their COD. Namely, these challenges included supply chain disruption caused by COVID, unanticipated issues during system integration due to the use of a new OEM, and general construction delays. Further details are outlined in the 'Lessons Learned' section of this report. As a result of the delays, both sites conducted their pilot dispatches on a different timeline than the rest of the participants.

Pilot Execution

The final phase of the project culminated in the actual execution of the DR and OR pilots. The first two months of this phase focused on ensuring that the pilot processes, from bidding optimization to dispatch were operating as anticipated. Powerconsumer then issued OR and DR pilot dispatches at random, in accordance with the predetermined rules developed in phase 2, over the course of the following year. Due to the battery installation delays, Enel's initial plan for dispatches was expanded to ensure a robust data set was collected. A higher volume of dispatches were conducted because Enel wanted to ensure that all sites participated in the number of dispatches initially scoped for the project (ex: if Site A did not participate in the first 4 dispatches, an 4 additional dispatches would be performed with Site A).

Dispatch Type	Initial Dispatch Plan	Actual Dispatches Executed
DR Pilot	**4**	**11**
OR Pilot	**12**	**42**
Local Dispatches	**2-4**	**2**

A detailed breakdown of all dispatches and corresponding performance results are outlined in the following section and Appendix 1.

Results

This section summarizes the results from the pilot execution phase of the project, during which participating sites were dispatched for simulated Operating Reserves and Capacity Auction events. In total, the pilot participants delivered 602 MWh of load reduction across 42 discrete OR dispatches and 11 Capacity Auction dispatches. Participant load reduction capabilities ranged in size from 200kW to 20MW, using both BTM battery storage and manual load reduction as means for curtailing demand.

Dispatch Activity

Operating Reserves Pilot

There were 42 total Operating Reserves dispatches conducted between June 2023 and July 2024. The OR dispatches ranged in duration from 15 minutes to one hour, which is the maximum duration allowed by the IESO for this product. In total, the portfolio delivered 464MW and 146MWh of load reduction. Due to the late completion of battery installation and commercial operation at two of the participating sites, the composition of the OR resource evolved throughout the dispatches.

- 10 site aggregation: 18 OR dispatches were conducted between June and November 2023
- Each site's contribution to the total OR resource's capacity varied in each dispatch due to the dynamic bidding required to reflect real-time availability
- Single, large site dispatches: 24 OR dispatches were conducted between April and July 2024

Capacity Auction Pilot

- There were 11 total Capacity Auction dispatches conducted between June 2023 and July 2024. All the dispatches lasted four hours, which is the maximum duration allowed by the IESO for this product. 12 sites participated in the dispatches, and used one of the three curtailment methods: BTM storage only, combination of BTM storage and manual curtailment, and manual curtailment only. Dispatches were conducted during the corresponding program season hours, and dispatch quantities were based on the DR resource energy bids submitted to Powerconsumer. Due to the late completion of battery installation and commercial operation at two of the participating sites, 5 of the DR tests were completed with all participants and 6 were conducted to test those new batteries.
- 12 site aggregation: 5 DR dispatches were conducted between June and November 2023
  - All 12 sites were included in the dispatches
- Single, large site dispatches: 6 DR dispatches were conducted between April and July 2024

Local Dispatch Testing

In addition to the DR and OR pilots, this project tested local dispatch scenarios with two different LDCs. The LDCs were selected due to the overlap of their service territories with participant site locations, as well as a pre-existing collaborative relationship with Powerconsumer. The local dispatch type was not included in the M&V plan, though both batteries were successfully dispatched during the tests.

Powerconsumer worked with the planning and operations staff at both LDCs to determine whether there was an actual local system benefit that the two project participant sites could provide. Both dispatches were coordinated between Powerconsumer and the relevant LDC. Enel X had to manually send the sites availability data to Powerconsumer due to an error creating a third program type in each of the platforms. More details can be found in the 'Lessons Learned' section of this report.

Dispatch Performance Results

Operating Reserves Pilot

The results of the OR pilot differ based on the M&V methodology used to calculate performance. Measuring event performance using Method 1 (Site Load), which calculates performance at the site meter, resulted in 14 failed dispatches. However, measuring event performance using Method 2 (BESS Output), which calculates performance at the BESS meter, resulted in 50% fewer failed dispatches. This is because Method 2 removes site load fluctuation impacts that the BESS cannot control by directly measuring BESS output. The cause of the remainder of the failed dispatches was due to either optimization issues where BESS availability was miscalculated or communications connectivity issues with Site A or Site B that delayed BESS dispatching.

These results were derived using Enel bid data sent to Powerconsumer. The bids that Powerconsumer received did not always match the bids sent by Enel. This is due to a timestamp issue that can be mitigated by incorporating more real time data validation. See Appendix 1 for additional dispatch detail.

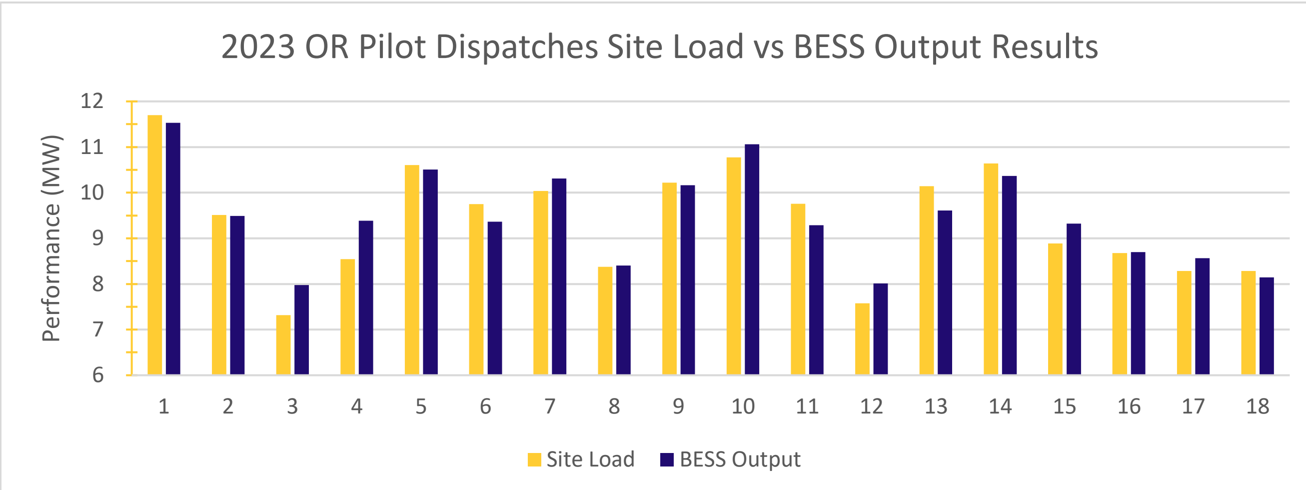
Table 1 | Summary of Operating Reserves Pilot Results Method 1 vs Method 2

OR Pilot M&V Method	Pass	Fail
Method 1 – Site Load	**28**	**14**
Method 2 – BESS Output	**35**	**7**

Chart 1 illustrates how site load fluctuations impacted dispatch performance. There is a significant difference in results when comparing Site Load performance vs BESS Output Performance. Measuring performance at the output of the asset meter provides a more accurate picture of what each resource can offer.

Additionally, the aggregated OR resource performed significantly better than the single site OR resource dispatches. This highlights the increased reliability gained from aggregated OR portfolios.

Chart 1| 2023 Dispatch Performance Results



Capacity Auction Pilot

The results of the capacity auction pilot can be placed into two categories. The first is the 12-site aggregation that completed 5 DR dispatches in 2023 (2023 CA Dispatches), and the second is the Site A and Site B single large site dispatching that completed 6 DR dispatches in 2024 (2024 CA Dispatches). The 2023 CA Dispatches on average performed above 100%. The 2024 CA Dispatches did not perform as well as the 2023 CA Dispatches. This underperformance is because Site A and Site B batteries had to dispatch individually which increased the risk of site load fluctuations having an impact on event performance. The strong performance of the aggregated resource illustrates the benefit that aggregation provides for increased reliability.

These results were derived using Enel bid data sent to Powerconsumer. The bids that Powerconsumer received did not always match the bids sent by Enel. This is due to a timestamp issue that can be mitigated by incorporating more real time data validation. Additionally, in the first few dispatches, fluctuations in bids from hour to hour was due to an error in bid optimization that would reduce or remove bids in when the portfolio was activated for a Capacity Auction event. As a result, this error resulted in high performance for the first two dispatches because the bids did not reflect the actual capacity of the portfolio. This error was fixed for later dispatches.

Table 2 | Capacity Auction Pilot Results

Dispatch Day	Dispatch Start	Hour 1 Result	Hour 2 Result	Hour 3 Result	Hour 4 Result	DR Result (total % across 4 hours)
16-Jun-23	7: 00 PM EDT	16.0	16.7	17.6	11.4	531%
29-Aug-23	6:00 PM EDT	15.2	16.1	17.2	16.6	670%
25-Oct-23	7:00 PM EDT	17.3	23.6	24.4	24.4	175%
31-Oct-23	5:00 PM EDT	14.7	15.5	16.3	13.9	113%
17-Nov-23	9:00 PM EST	6.8	9.1	11.7	8.3	158%
16-Apr-24	7:00 PM EDT	-2.7	-4.5	-4.1	-3.7	-149%
17-Apr-24	9:00 PM EDT	2.2	1.6	1.2	1.1	61%
24-Apr-24	10:00 PM EDT	1.5	2.3	2.9	4.8	114%
12-Jun-24	7:00 PM EDT	10.3	9.7	9.5	5.6	88%
27-Jun-24	8:00 PM EDT	19.3	18.3	14.1	16.6	171%
11-Jul-24	7:00 PM EDT	12.8	12.3	8.8	4.0	95%

Local Dispatch Pilot

In the local dispatch pilot, there were a total of two tests conducted. Powerconsumer worked with both LDCs to identify any local needs on the feeders tied to sites participating in this pilot. In this pilot, it was solely the responsibility of the asset owner to update resource availability across programs. Powerconsumer was responsible for coordinating the dispatch with the distribution utility. Additional scale is needed to better understand the local opportunity.

Local Dispatch Date	Dispatch Time	BESS Dispatched (Y/N)
17 November 2023	**5-7pm EST**	**Y**
25 April 2024	**2-4pm EST**	**Y**

Conclusion

The *Unlocking DER Across Ontario* project successfully demonstrated a novel participation and measurement and verification (M&V) framework, proving that aggregated behind-the-meter (BTM) resources can reliably provide operating reserve and demand response services. With thoughtful regulatory modifications, DERs can be seamlessly integrated into existing programs, enhancing Ontario's resource portfolio with a flexible and dependable energy solution.

Insights gained from this pilot highlight key opportunities to improve coordination between market participants, grid operators, and software platforms, ultimately optimizing the efficiency of future DER integration. Key recommendations include expanding aggregation rules to enable broader participation, introducing M&V methodologies tailored to the unique characteristics of DERs, and establishing a new resource type that bridges the gap between dispatchable load and HDR requirements. Enel X remains optimistic that these recommendations will inform future market design and regulatory updates, fostering a more diversified and resilient energy system in Ontario.

With peak demand in Ontario projected to increase by nearly 10 GW over the next 15 years[1], unlocking the full potential of DERs is more critical than ever. By enabling greater market participation for these fast-response, flexible assets, both the IESO and LDCs can leverage an already-deployed (and growing) network of DERs to provide cost-effective capacity and essential grid support during contingency and emergency events.

[1] 2024 Annual Planning Outlook: Ontario's electricity system needs: 2025-2050.

Lessons Learned

Throughout the course of this project, multiple challenges and opportunities emerged, highlighting key lessons that can inform future DER programs and Grid Innovation Fund projects.

Technical Lessons Learned

- **Software Integration:** The integration of Enel X's Flex Platform with Powerconsumer's dispatch system revealed the complexity of real-time bid management and dispatch execution. Automated data exchange between the platforms improved response times but required iterative testing to ensure accuracy in bid updates and dispatch signals. Future DER integration efforts should focus on enhancing standardized API connectivity, minimizing manual interventions, and refining real-time data validation processes.
- **Software structure:** Enel X and Powerconsumer were able to develop a sophisticated, and almost wholly automated process for both the DR and OR pilots. However, challenges arose when the time came to incorporate the local dispatches. Challenges included the inflexibility of existing software structures, and differing requirements across LDCs. Due to the specific design created for the pilots, there was significant incremental development work required to add the local dispatch component. Because of this, the local dispatches were far more manual than the other programs. The key takeaways are that software or market platform should always be designed in a modular way that allows for frequent updates that require little resources, and requirements should be standardized across LDCs.

Operational Lessons Learned

- **Delays Reaching Battery COD**: The battery storage system installation at two of the participant sites was significantly delayed from the original project plan. Some of these delays were unavoidable, such as the supply chain disruptions caused by the COVID pandemic. However, part of the delay was caused by growing pains associated with using a new OEM. Enel anticipated that its experience integrating DER.OS with other OEMs would easily transfer to the new one. This was not the case, and earlier identification of this incompatibility between the OEM's systems and Enel's operating system would have reduced the time to COD. For any new DER installation, each new provider should be tested end-to-end as early as possible.
- **Coordinating Local Dispatch:** Initially, Enel X and Powerconsumer envisioned having a more robust local dispatch component in this project to supplement the OR and DR pilots. However, the local dispatches were delayed. The first cause was the due diligence required for LDCs to be able to validate exactly what the local needs were at the TS associated with the battery sites. Additionally, there were more levels of approvals needed within the LDC organizations to conduct dispatch testing than originally anticipated. A more streamlined process for testing with LDCs would greatly lower barriers to do more of this testing.

- **Optimized Bidding:** During the course of this project, a few issues were identified in the optimized bidding software that Enel X had deployed. For example, there was an OR dispatch on Sept 28, 2023 where a site had flawed availability logic. On this day, one battery was idled for O&M testing and was not available for dispatch. The bidding software recognized that the battery was charged and online but failed to recognize that it was unavailable/idled for the O&M testing. As a result, when the portfolio received an OR instruction, the bid did not accurately reflect the available MWs, and the portfolio failed the dispatch. Changes were made to coordinate the O&M testing with the market-facing bidding logic. It is important to consider all potential scenarios when creating a bidding tool, in addition to alerting that raises attention when a battery or site load is exhibiting unusual behaviour (ex: low load, zeros, offline status, etc).

Recommended Next Steps

For Ontario to effectively meet its growing energy demands, DERs must play a pivotal role in the solution. To achieve this, regulatory reforms and updates to the existing market framework must be implemented swiftly. The key recommended next steps emerging from this project are outlined below.

Implementing the following recommendations would provide significant value to the IESO, Ontario businesses, and Ontario ratepayers. Unlocking additional participation of DER resources would help reduce the cost of procuring both capacity and ancillary services and improve ratepayer affordability. For example, the price of procuring MW in the 2024 Capacity Auction was 2.6-6.6 times lower than the Long-Term RFP[2]. Many Capacity Auction resources are also ineligible for energy payments, further lowering their cost. Businesses that have invested in DERs would also benefit if they were able to offer more services, such as OR, with their assets. This helps offset the cost of energy to operate their facilities, making them more competitive in the market. Additional value that would accompany these changes include a lower administrative burden on IESO due to a more streamlined number of resources, and reliable performance gained through diversified portfolios (fewer "too big to fail" or single points of failure). Increase reliability from cost-effective resources can help the IESO meet their coming capacity and contingency reserve needs, while mitigating cost increases to ratepayers.

Allow aggregation in Operating Reserves

Enabling an aggregated OR participation option for Market Participants would eliminate several barriers to entry including:

- Sites with flexible capacity that is too small to meet the minimum requirement of 1MW+
- Unlock market access for C&I businesses that do not currently have sufficient resources to navigate the complex energy market landscape on their own
- De-risking OR participation for DERs through the penalty protection and prudential support benefits that aggregators can provide

[2] Calculated by using results in the Long-Term RFP (LT1 RFP) – Final Results and the Capacity Auction Post-Auction Report

Provide DERs with an alternative participation option to Dispatchable Loads

Every aspect of the dispatchable load resource type is designed for extremely large, mostly flexible loads. However, most sites with BTM storage or other DERs have only partially dispatchable loads. Many DERs are also LDC-metered and are unable to complete the sometimes years-long process of transitioning to IESO metering and registration. The 12 participants in this project were selected due to their inability to register to provide IESO OR services despite having the technology to do so.

Enel X recommends that a new resource type be created that marries the simplicity of HDRs with the fast-response capabilities of dispatchable loads.

This new resource type could facilitate some, or all, of the following changes:

- New M&V methodologies
- Dispatch data requirements more aligned with HDR resources, with energy bids and OR offers that represent aggregated curtailment availability instead of total site load consumption. The change in energy bid parameters would eliminate the current energy compliance risk. However, new energy compliance rules could be implemented, such as availability compliance.
- Less costly metering and telemetry requirements and/or piggybacking off existing LDC metering
- Ability to provide OR as an embedded load instead of IESO customer
- Allow for varied response times depending on dispatch type (Ex: 10-minute for OR, 1-hr for Capacity Auction). This would allow site with mixed capabilities to offer their full value across the two programs.

Continue to improve coordination between IESO, LDCs, and Market Participants

The Grid Innovation Fund serves as a strong example of how collaboration is being fostered between the IESO, OEB, and DER stakeholders. To maximize its impact, these efforts must be further strengthened and implemented in actual market rules. While this project had a limited scope for local dispatch planning, it became evident that greater coordination would be highly beneficial. Key areas for enhanced collaboration include:

- Increasing the scale of projects or pilot programs
- Allow market participants to dually participate in the IAMs while doing a local program to get more realistic learnings
- Align on telemetry requirements for BTM batteries, and identify opportunities for data sharing between the IESO and LDCs
- Coordinate market schedules and forecasts (ex: if a Market Participant must update availability ahead of the IESO mandatory window, a local program could be designed to issue scheduling instruction at least 2 hours ahead of a dispatch hour)
- Ensure that incentive structures for the IAMs and local programs do not create conflicting market signals for participants

Appendix 1

Table A1 | Detailed Operating Reserves Pilot Results Method 1 vs Method 2

Dispatch Type	Dispatch Day	Dispatch Start	Bid	Method 1 (Site Load)	Method 2 (BESS Output)	Comments
Aggregated	6/15/2023	6:10 PM EDT	10.93	PASS	PASS	
Aggregated	7/21/2023	2:10PM EDT	8.25	PASS	PASS	
Aggregated	8/30/2023	2:15PM EDT	6.39	PASS	PASS	
Aggregated	9/28/2023	12:10PM EDT	9.11	FAIL	FAIL	Portfolio availability was not accurate due to one idle battery that the optimization SW incorrectly identified as online. As a result, the OR bid was overestimating available MWs
Aggregated	9/29/2023	3:10PM EDT	10.27	PASS	PASS	
Aggregated	10/5/2023	4:10PM EDT	4.86	PASS	PASS	
Aggregated	10/6/2023	2:10PM EDT	6.54	PASS	PASS	
Aggregated	10/16/2023	1:10PM EDT	4.97	PASS	PASS	
Aggregated	10/18/2023	3:10PM EDT	7.46	PASS	PASS	
Aggregated	10/24/2023	1:10PM EDT	10.28	FAIL	PASS	Site load fluctuation impacted Method 1 performance
Aggregated	10/27/2023	1:10 PM EDT	5.32	PASS	PASS	
Aggregated	10/30/2023	12:10 PM EDT	5.69	PASS	PASS	
Aggregated	11/3/2023	3:00 PM EDT	3.50	PASS	PASS	
Aggregated	11/8/2023	2:10 PM EST	6.16	PASS	PASS	
Aggregated	11/9/2023	1:10 PM EST	6.85	PASS	PASS	

Dispatch Type	Dispatch Day	Dispatch Start	Bid	Method 1 (Site Load)	Method 2 (BESS Output)	Comments
Aggregated	11/10/2023	3:10 PM EST	4.98	PASS	PASS	
Aggregated	11/20/2023	4:20 PM EST	7.98	PASS	PASS	
Aggregated	11/21/2023	1:10 PM EST	8.09	FAIL	FAIL	An optimization error limited power output from one BESS for the first five minutes of the event which resulted in underperformance
Site A	4/15/2024	3:25 PM EDT	5.0	FAIL	PASS	Site load fluctuation impacted Method 1 performance
Site A	4/18/2024	2:25 PM EDT	5.0	FAIL	PASS	Site load fluctuation impacted Method 1 performance
Site A	4/19/2024	1:25 PM EDT	5.0	PASS	PASS	
Site A	4/23/2024	10:55 AM EDT	5.0	PASS	PASS	
Site A	4/23/2024	12:25 PM EDT	5.0	PASS	PASS	
Site A	4/23/2024	1: 35 PM EDT	5.0	PASS	PASS	
Site A	4/23/2024	2: 55 PM EDT	5.0	FAIL	PASS	Site load fluctuation impacted Method 1 performance
Site A	4/23/2024	4:25 PM EDT	5.0	PASS	PASS	
Site A	4/25/2024	12:25PM EDT	5.0	PASS	PASS	
Site A	4/25/2024	1:25 PM EDT	5.0	FAIL	PASS	Site load fluctuations impacted Method 1 performance
Site A	4/25/2024	2:25 PM EDT	5.0	FAIL	FAIL	Communications connectivity issue prevented BESS from dispatching on time
Site A	4/25/2024	3:25 PM EDT	5.0	PASS	PASS	
Site B	6/10/2024	3:25 PM EDT	20.0	PASS	PASS	
Site B	6/10/2024	4:25 PM EDT	20.0	PASS	FAIL	BESS did not maintain 20MW of

Dispatch Type	Dispatch Day	Dispatch Start	Bid	Method 1 (Site Load)	Method 2 (BESS Output)	Comments
						power throughout the dispatch. For one 5-minute interval power output was 19.99MW
Site B	6/11/2024	1:25 PM EDT	20.0	FAIL	PASS	Site load fluctuations impacted Method 1 performance
Site B	6/11/2024	2:25 PM EDT	20.0	PASS	PASS	
Site B	7/12/2024	12:25 PM EDT	20.0	PASS	PASS	
Site B	7/12/2024	1:25 PM EDT	20.0	PASS	PASS	
Site B	7/25/2024	12:25 PM EDT	20.0	FAIL	PASS	Site load fluctuations impacted Method 1 performance
Site B	7/25/2024	1:25 PM EDT	20.0	PASS	PASS	
Site B	7/25/2024	3:25 PM EDT	20.0	FAIL	PASS	Site load fluctuation impacted Method 1 performance
Site B	7/26/2024	1:25 PM EDT	20.0	FAIL	FAIL	Communications connectivity issue prevented BESS from dispatching on time
Site B	7/26/2024	2:25 PM EDT	20.0	FAIL	FAIL	Communications connectivity issue prevented BESS from dispatching on time
Site B	7/26/2024	3:25 PM EDT	20.0	FAIL	FAIL	BESS did not maintain 20MW of power throughout the dispatch. For one 5-minute interval power output was 19.99MW

Table A2 | Capacity Auction Pilot Bids

Dispatch Day	Dispatch Start	Capacity Obligation (MW)	Bid Hour 1 (MW)	Bid for Hour 2 (MW)	Bid for Hour 3 (MW)	Bid for Hour 4 (MW)
16-Jun-23	7: 00 PM EDT	21	13.8	13.8	13.8	0.7
29-Aug-23	6:00 PM EDT	21	17.1	1.3	0.0	0.0
25-Oct-23	7:00 PM EDT	21	15.0	15.0	15.0	9.2
31-Oct-23	5:00 PM EDT	21	13.5	13.5	13.5	13.3
17-Nov-23	9:00 PM EST	6.9	5.8	5.7	5.7	5.7
16-Apr-24	7:00 PM EDT	2.5	2.5	2.5	2.5	2.5
17-Apr-24	9:00 PM EDT	2.5	2.5	2.5	2.5	2.5
24-Apr-24	10:00 PM EDT	2.5	2.5	2.5	2.5	2.5
12-Jun-24	7:00 PM EDT	10	10.0	10.0	10.0	10.0
27-Jun-24	8:00 PM EDT	10	10.0	10.0	10.0	10.0
11-Jul-24	7:00 PM EDT	10	10.0	10.0	10.0	10.0

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