System Impact Assessment Report

Final Report - Public

CAA ID: 2023-746
Project: Napanee Energy Storage
Connection Applicant: Portlands Energy Centre L.P. dba Atura Power

July 11, 2024

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Acknowledgement

The IESO wishes to acknowledge the assistance of Hydro One in completing this assessment.

Disclaimers

IESO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of conditional approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Conditional approval of the project is based on information provided to the IESO by the connection applicant and Hydro One at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by Hydro One at the request of the IESO. Furthermore, the conditional approval is subject to further consideration due to changes to this information, or to additional information that may become available after the conditional approval has been granted.

If the connection applicant has engaged a consultant to perform connection assessment studies, the connection applicant acknowledges that the IESO will be relying on such studies in conducting its assessment and that the IESO assumes no responsibility for the accuracy or completeness of such studies including, without limitation, any changes to IESO base case models made by the consultant. The IESO reserves the right to repeat any or all connection studies performed by the consultant if necessary to meet IESO requirements.

Conditional approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed project to the IESO-controlled grid. However, the conditional approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant and the IESO in accordance with Chapter 4, section 6 of the Market Rules. This report does not in any way constitute an endorsement of the proposed connection for the purposes of obtaining a contract with the IESO for the procurement of supply, generation, demand response, demand management or ancillary services.

The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this report to the connection applicant, the connection applicant must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to the connection applicant. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that the most recent version of this report is being used. The IESO provides no comment, representation or opinion, express or implied, with respect to who should bear

the cost of IESO requirements for connection in this report and disclaims any liability in connection therewith.

Hydro One

The results reported in this report are based on the information available to Hydro One, at the time of the study, suitable for a System Impact Assessment of this connection proposal.

The short circuit and thermal loading levels have been computed based on the information available at the time of the study. These levels may be higher or lower if the connection information changes as a result of, but not limited to, subsequent design modifications or when more accurate test measurement data is available.

This study does not assess the short circuit or thermal loading impact of the proposed facilities on load and generation customers.

In this report, short circuit adequacy is assessed only for Hydro One circuit breakers. The short circuit results are only for the purpose of assessing the capabilities of existing Hydro One circuit breakers and identifying upgrades required to incorporate the proposed facilities. These results should not be used in the design and engineering of any new or existing facilities. The necessary data will be provided by Hydro One and discussed with any connection applicant upon request.

The ampacity ratings of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades which are required to incorporate the proposed facilities have been identified to the extent permitted by a System Impact Assessment under the current IESO Connection Assessment and Approval process. Additional facility studies may be necessary to confirm constructability and the time required for construction. Further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

Table of Contents

Project Description

Portlands Energy Centre L.P. dba Atura Power (the "connection applicant") is proposing to connect a 250 MW/1000 MWh Battery Energy Storage System (BESS) at Napanee Generating Station (GS), repurpose the existing circuit breaker D2T3 to connect the BESS and install a new breaker instead of D2T3 (the "project"). Napanee GS is owned by the connection applicant and is connected to Hydro One's (the "transmitter") 500 kV circuits X538N and X534N which are radially connected to Lennox TS.

The proposed in-service date for the project is Q4 2025.

Notification of Conditional Approval

This assessment concludes that the proposed connection of the project is expected to have no material adverse impact on the reliability of the integrated power system, provided that all requirements in this report are implemented. Therefore, the assessment supports the release of the Notification of Conditional Approval for connection of the project.

Assessment Findings

System studies were carried out to identify the impact of the project on the reliability of the IESO-controlled grid, in line with applicable reliability standards. The studied scenarios and main assumptions are available in Appendix D of this report. Please note that these assumptions and the findings around charging and discharging the project as set out below are solely for the purpose of the system impact studies as described in the Disclaimer section above. The detailed study results are available in Appendix E of this report. Based on the assessment results, we have identified the following assessment findings:

1. During outages to one of the 500 kV circuits in the Bowmanville SS to Cherrywood TS corridor (B×C) and following a double-circuit contingency that results in only one B×C circuit remaining, the project, while discharging, exacerbates the thermal short-term emergency rating (STE) overloading of the remaining B×C circuit.
2. The area where the project connects can sometimes be congested and the project, while charging, will marginally exacerbate this congestion. As a result, the project may be required to reduce its charging level, or disconnect to mitigate the congestion.

IESO Requirements for Connection

Specific Requirements

The following specific requirements are applicable for the incorporation of the project and its connection facilities. Specific requirements pertain to the level of reactive power compensation needed, operation restrictions, remedial action scheme (RAS), upgrading of equipment and any project specific items not covered in the general requirements.

Connection Applicant Requirements:

1. To address Finding #1, the connection applicant shall install RAS facilities to participate in the RAS identified in transmitter requirement #1 and work with the transmitter on its implementation. The proposed design of the RAS, including the runback scheme and which breakers will trip the BESS, must be identified in the draft Facility Description Document (FDD) and shall be approved by the IESO during market registration.

   The connection applicant shall ensure that the RAS facilities comply with NPCC Reliability Reference Directory #7 for a Type I RAS.

   Telemetry, including but not limited to, MW, Mvar and breaker status for the feeders/equipment tripped by the RAS, as specified by the IESO at the time of registration, shall be provided.

2. To address Finding #2, during some system conditions, the project may be required to reduce charging active power (MW) or disconnect.

Transmitter Requirements:

1. To address Finding #1, the transmitter shall include the project in the GTA East RAS. During the IESO Market Registration process, a revised FDD for GTA East RAS must be provided and finalized at least nine months prior to in-service. The FDD must contain the finalized RAS matrix as well as expected operating times. The actual operating times must be measured during commissioning and documented as a Performance Validation Record.

   If the FDD or performance testing as per the Performance Validation Record indicates a change in design or slower than expected operating times, as compared to what was assumed in this assessment, then further analysis of the project will need to be done by the IESO. This may delay the grant of IESO final approval to place the project in-service.

   The transmitter shall ensure that the RAS facilities comply with NPCC Reliability Reference Directory #7 for a Type I RAS.

   Telemetry, as specified by the IESO at the time of registration, shall be provided.

General Requirements

The connection applicant and transmitter shall satisfy all applicable requirements specified in the Market Rules, the Transmission System Code (TSC) and reliability standards. Some of the general requirements that are applicable to this project are presented in detail in Appendix A of this report.

Recommendation:

1. Power transformers with a high side, wye grounded winding with terminal voltage greater than 200 kV are subject to North American Electric Reliability Corporation (NERC) standard TPL-007, Transmission System Planned Performance for Geomagnetic Disturbance Events. As per NERC standard TPL-007, the Planning Coordinator in conjunction with its Transmission Planner are required to implement a process(es) to obtain Geomagnetic Disturbance (GMD) measurement data, via geomagnetically-induced currents (GIC) monitors, which will aid in model validation and situational awareness. This data will more accurately support the owner of the applicable power transformer(s) to conduct a thermal impact assessment if required in the future. As such, it is recommended that the connection applicant makes provision(s) to install monitoring equipment for GIC on the new transformer(s).

2. Please note that the IESO is in the process of revising Market Rules Appendices 4.15 and 4.16 to require provision of synchrophasor data for all generator facilities and transmission facilities that fall within applicable criteria. These requirements come into effect on December 31, 2024. The IESO plans to revise Market Rules such that the generator synchrophasor data requirements will also apply to electricity storage facilities (including this project). See the IESO Stakeholder Engagement website: "Updates to IESO Monitoring Requirements: Phasor Data" for more information. As such, it is recommended that the connection applicant designs its facility in such a way as not to prevent it from providing applicable synchrophasor data in the future.

Appendix A: General Requirements

The connection applicant shall satisfy all applicable requirements specified in the Market Rules, the Transmission System Code and reliability standards. This Section highlights some of the general requirements that are applicable to the project.

1. The connection applicant must notify the IESO at connection.assessments@ieso.ca as soon as they become aware of any changes to the project scope or data used in this assessment. The IESO will determine whether these changes require a re-assessment.
2. The connection applicant shall ensure that the BPS elements are in compliance with the applicable NPCC criteria, and the BES elements in compliance with the applicable NERC reliability standards. To determine the standard requirements that are applicable, the IESO provides mapping tools titled "NPCC Criteria Mapping Spreadsheet" for BPS elements and "NERC Reliability Standard Mapping Tool/Spreadsheet" for BES elements at the IESO's website of Applicability Criteria for Compliance with Reliability Requirements.

   Note, the transmitter may request an exception to the application of the BES definition. The procedure for submitting an application for exemption can be found in Market Manual 11.4: "Ontario Bulk Electric System (BES) Exception" at the IESO's website.

   The IESO's criteria for determining applicability of NERC reliability standards and NPCC Criteria can be found in the Market Manual 11.1: "Applicability Criteria for Compliance with NERC Reliability Standards and NPCC Criteria" at the IESO's website.

   Compliance with these reliability standards will be monitored and assessed as part of the IESO's Ontario Reliability Compliance Program. For more details about compliance with applicable reliability standards reliability standards, the transmitter is encouraged to contact orcp@ieso.ca and also visit the Ontario Reliability Compliance Program webpage.
3. As per Appendix 4.2 of the Market Rules, the connection applicant shall ensure that the storage facility has the capability to operate continuously between 59.4 Hz and 60.6 Hz and for a limited period of time in the region bounded by straight lines on a log-linear scale defined by the points (0.0 s, 57.0 Hz), (3.3 s, 57.0 Hz), and (300 s, 59.0 Hz) and the straight lines on a log-linear scale defined by the points (0.0 s, 61.8 Hz), (8 s, 61.8 Hz), and (600 s, 60.6 Hz).
4. The facility shall respond to frequency increase by reducing the active power with an average droop based on maximum active power adjustable between 3% and 7% and set at 4%. Regulation deadband shall not be wider than ± 0.06%.
5. The project is directly connected to the IESO-controlled grid, and thus, according to Appendix 4.2 of the Market Rules, the connection applicant shall ensure that the project has the capability to:
   - Continuously supply all levels of active power output within a +/- 5% range of its rated terminal voltage. Rated active power is the smaller output at either rated ambient conditions (e.g. temperature, head, wind speed, solar radiation) or 90% of rated apparent power. To satisfy steady-state reactive power requirements, active power reductions to rated active power are permitted;

- Continuously (i.e., dynamically) inject or withdraw reactive power at the high-voltage terminal of the main output transformer up to 33% of rated active power at all levels of active power output, and at the typical transmission system voltage, except where a lesser continually available capability is permitted with the IESO's approval. A conventional synchronous unit with a power factor range of 0.90 lagging and 0.95 leading at rated active power connected via a main output transformer impedance not greater than 13% based on generation unit rated apparent power is acceptable. Reactive power losses or charging between the high-voltage terminal of the main output transformer and the connection point shall be addressed in a manner permitted by IESO approval;
- Regulate voltage automatically within ±0.5% of any set point within ±5% of rated voltage at the low-voltage terminal of the main output transformer if the transformer impedance is not more than 13% based on the rated apparent power of the generation facility, or at a point approved by the IESO. Reactive power-voltage droop or AVR reference load current compensation shall not be enabled without IESO approval. The response of the project for voltage changes shall be similar to or better than the response of a generation facility with a synchronous generation unit and an excitation system that meets the requirements of Appendix 4.2;

6. As per the Market Rules requirements, the project shall operate in voltage control mode and provide its reactive power capability requirements by using all voltage control methods available within the project. Specifically, each Main Output Transformer (MOT) at the project is required to have one voltage control system summarized as follow:
   - All inverters shall control the voltage at a point whose impedance (based on rated apparent power and voltage of the project) is not more than 13% from the high voltage terminal of the main output transformer. Appropriate control slope is adopted for reactive power sharing among the inverters as well as with adjacent generators. The reference voltage will be specified by the IESO during operation;
   - Shunt capacitors and reactors (when applicable) shall be automatically switched to regulate the overall reactive power output from the project's inverters (or dynamic reactive power sources) to approximately zero output. The dead band for shunt switching will be set to no less than ±60% of the smallest shunt to avoid control hunting. The switching time of the shunt compensation shall be fast enough to satisfy the requirements relevant to Appendix 4.2 Categories 5, 6, and 12. After having been switched, the shunt compensation shall become available for the next operation within 5 minutes;
   - The MOT under-load tap changer (ULTC) (when available) shall be adjusted manually to regulate the collector bus voltage such that it is within normal range and close to about 100% of nominal voltage;
   - In the event that the voltage control system of the project becomes unavailable, each inverter must automatically switch to reactive power control or terminal voltage control, to maintain its reactive power output or terminal voltage to the value prior to the loss of signal from the voltage control system. Depending on system conditions, further action for reliability purposes would be directed by the IESO.

     The connection applicant shall provide a finalized copy of the functional description of the project's control systems for approval to the IESO before the project is given final approval to connect.

7. In accordance to Appendix 4.2 of the Market Rules, the connection applicant shall ensure that for a constant voltage at the high-voltage terminal of the main output transformer, the project can achieve a sustained reactive power change of 30% of generation facility or electricity storage

facility rated apparent power at the low-voltage terminal of the main output transformer within 3s following a step change no larger than 4% to the AVR voltage reference. AVR response to the voltage error signal must be consistent over the entire operating range.

8. In accordance to Appendix 4.2 of the Market Rules, the connection applicant shall ensure the project shall have the capability to ride-through routine switching events and design criteria contingencies assuming standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times, unless disconnected by configuration.

   The connection applicant will be required to demonstrate the project's voltage ride-through capability during commissioning by either providing manufacturer test results or monitoring several variables under a set of IESO specified field tests, and the test results must be verifiable using the dynamic models provided for the project.

9. The connection applicant shall ensure that the inverters are capable to operate in Grid Forming Control mode. As the power system evolves, the IESO may require the inverters to be operated in that mode. Grid Forming Control mode shall not be enabled without IESO approval.

   NERC functional specifications for Grid Forming Control mode specify that its primary objective is maintaining an internal voltage phasor that is constant or nearly constant in the sub-transient to transient time frame. The voltage phasor must be controlled to maintain synchronism with other devices in the grid and must also regulate active and reactive power appropriately to support the grid.

10. The connection applicant shall ensure that the project's equipment meet the voltage requirements specified in section 4.2 and section 4.3 of the Ontario Resource and Transmission Assessment Criteria (ORTAC).

11. According to Section 6.1.2 of the TSC, the connection applicant must ensure the project's transmission connection equipment is designed to withstand the fault levels in the area. According to Section 6.4.4 of the TSC, if any future system changes result in an increased fault level higher than the project's equipment capability, the connection applicant is required to replace that equipment with higher rated equipment capable of withstanding the increased fault level, up to the maximum fault level specified in Appendix 2 of the TSC.

    It is the connection applicant's responsibility to verify that all equipment and circuit breakers within the project are appropriately sized for the local fault levels.

12. The connection applicant shall ensure that the circuit breakers/switchers installed at the project have rated interrupting time that satisfies Appendix 2 of the TSC. Fault interrupting devices installed at the project must be able to interrupt fault currents at the applicable maximum continuous voltage as specified in Section 4.2 and Section 4.3 of ORTAC.

13. The connection applicant shall ensure that the protection systems are designed to satisfy all the requirements of the TSC. New protection systems must be coordinated with existing protection systems. Protection systems within the project shall only trip the appropriate equipment isolating the fault.

    Associated overvoltage protective relaying must be set to ensure that the project's equipment does not automatically trip for voltages up to 5% above the equipment's corresponding maximum continuous voltage as specified in section 4.2 of the ORTAC.

BPS elements are deemed by the IESO to be essential to system reliability and security and must be protected by redundant protection systems in accordance with Section 8.2 of the TSC. These redundant protection systems must satisfy all requirements of the TSC, and in particular, they must be physically separated and not use common components, common battery banks, or common instrument transformer secondary windings.

The protection systems for transmission voltage BES elements (whose rated voltage is higher than 100 kV) must be redundant. Redundancy must be present in protective relaying for normal fault clearing and control circuitry associated with protective functions including trip coils of the circuit breakers or other interrupting devices. These redundant protection systems must not use common instrument transformer secondary windings. A single communication system, if used, must be monitored and reported and a single DC supply, if used, must be monitored and reported for both low voltage and open circuit.

As the electrical system evolves, transmission voltage non-BPS or non-BES elements (whose rated voltage is higher than 100 kV) within the project, may be re-classified as BPS elements or BES elements. The connection applicant is recommended to design the protection systems for these elements according to the protection requirements for BPS elements or have adequate provisions for future upgrade to meet those requirements.

14. The connection applicant shall ensure that the connection equipment is designed to be fully operational in all reasonably foreseeable ambient conditions. Failures of the connection equipment must be contained within the project and have no adverse impact on the IESO-controlled grid.

15. The connection applicant shall install a permanent device for disturbance recording that meets the technical specifications provided in Section 2.7 of Market Manual 1.6: Performance Validation (formerly Market Manual 2.20). The quantities to be recorded and the trigger settings will be provided by the IESO during the Market Registration process.

16. According to Section 7.3A of Chapter 4 of the Market Rules, the connection applicant shall provide to the IESO the telemetry data listed in Appendix 4.24 of the Market Rules on a continual basis. The whole telemetry list will be finalized during the IESO's Market Registration process.

    The data shall be provided with equipment that meets the requirements set forth in Appendix 2.2, Chapter 2 of the Market Rules, in accordance with the performance standards set forth in Appendix 4.25 subject to Section 7.6A of Chapter 4 of the Market Rules.

    As part of the IESO's Market Registration process, the connection applicant must complete end to end testing of all necessary telemetry points with the IESO to ensure that standards are met and that sign conventions are understood. All found anomalies must be corrected before IESO's final approval to connect any phase of the project is granted.

17. The connection applicant must initiate the IESO's Market Registration process at least eight months prior to the commencement of any project related outages.

    The connection applicant is required to provide "as-built" equipment data for the project during the IESO Market Registration process. If the submitted equipment data differ materially from the ones used in this assessment, then further analysis of the project may need to be done by the IESO before final approval to connect is granted.

Models and data, including any controls that would be operational, must be provided to the IESO. This includes both PSS/E and DSA software standard library models representing the new equipment for further IESO, NPCC and NERC analytical studies. The models and data may be shared with other reliability entities in North America as needed to fulfill the IESO's obligations under the Market Rules, NPCC and NERC rules. The connection applicant may need to contact the software manufacturers directly, in order to have the models included in their packages. This information should be submitted at least eight months before energization to the IESO-controlled grid, to allow the IESO to incorporate this project into IESO work systems and to perform any additional reliability studies.

The connection applicant shall submit a final PSCAD model as well as a study report that benchmarks the PSS/E dynamic model against the EMT model to ensure that the model performance is consistent across different simulation platforms.

As part of the IESO Market Registration process, the connection applicant must also provide evidence to the IESO confirming that the project's equipment installed meets the Market Rules requirements and matches or exceeds the performance predicted in this assessment. This evidence shall be either type tests done in a controlled environment or commissioning tests done on-site. In either case, the testing must be done not only in accordance with widely recognized standards, but also to the satisfaction of the IESO. Until this evidence is provided and found acceptable to the IESO, the Market Registration process will not be considered complete and the connection applicant must accept any restrictions the IESO may impose upon this project's participation in the IESO-administered markets or connection to the IESO-controlled grid. The evidence must be supplied to the IESO within 30 days after completion of commissioning tests. Failure to provide evidence may result in disconnection from the IESO-controlled grid.

If the submitted models and data differ materially from the ones used in this assessment, then further analysis of the project may need to be done by the IESO before final approval to connect is granted.

At the sole discretion of the IESO, performance tests may be required at generation and transmission facilities. The objectives of these tests are to demonstrate that equipment performance meets the IESO requirements, and to confirm models and data are suitable for IESO purposes. The transmitter may also have its own testing requirements. The IESO and the transmitter will coordinate their tests, share measurements and cooperate on analysis to the extent possible.

Once the IESO's Market Registration process has been successfully completed, the IESO will provide the connection applicant with a Registration Approval Notification (RAN) document, confirming that the project is fully authorized to connect to the IESO-controlled grid. For more details about this process, the connection applicant is encouraged to contact IESO's Market Registration at market.registration@ieso.ca.

18. The connection applicant shall ensure that wholesale revenue metering installations comply with Chapter 6 of the Market Rules. This includes any intermediate project stages such as installation of temporary equipment or the use of mobile transformers. For more details, the connection applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group in early stages of project design.

19. As per Market Manual 1.4: Connection Assessment and Approval, the connection applicant will be required to provide a status report of its proposed project with respect to its progress upon request of the IESO using the project status report form on the IESO website. Failure to comply with project status requirements listed in Market Manual 1.4: Connection Assessment and Approval will result in the project being withdrawn.

    The connection applicant will be required to also provide updates and notifications in order for the IESO to determine if the project is "committed" as per Section 3.3 of Market Manual 1.4: Connection Assessment and Approval.

Appendix B: Project Data (Confidential)

Appendix C: Facility Classifications (Confidential)

Appendix D: Study Scope of Work (Confidential)

Appendix E: Detailed Study Results (Confidential)

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