DER TIR SUMMARY

FORWARD

The following DER TIR Summary is in reference to Tillsonburg Hydro Inc's Distributed Energy Resource Technical Interconnection Requirements and presented as a summary of the full standard

1. INTRODUCTION

The power producer shall consult ERTH Power Corporation prior to designing, procurement and installation of electrical equipment.

2. CONNECTION PROCESS

The Ontario Energy Board has prescribed the Distributed Energy Resource Connection Procedures for power producers and electrical system owners to follow for DER interconnections.

3. GENERATION CLASSES

Tillsonburg Hydro Inc will determine the generation class that a proposed project qualifies for based on the electrical single line diagram and information provided in an application.

Micro: a facility with a name-plate rated capacity of ≤ 10 kW or less;
Small: a facility with a name-plate rated capacity of > 10 kW and:

- ≤ 500 kW for connection to a distribution system voltage ≤ 15 kV,
- ≤ 1,000 kW for connection to a distribution system voltage > 15 kV;

Mid-sized: a facility with a name-plate rated capacity of < MW and:

- > 500 kW for connection to a distribution system voltage ≤ 15 kV,
- < 1,000 kW for connection to a distribution system voltage > 15 kV;

Large: a facility with a name-plate rated capacity of > 10 MW.

Emergency backup generation facility, means a standby power system that is installed on a customer site for the sole purpose of providing electrical power if the primary or system power has been interrupted or is unavailable;

Storage facility, means, for the purpose of connections, a facility that uses electrical energy (i.e. charges), and then stores such energy for a period of time, and then provides electrical energy as an output, minus any losses (i.e. discharges);

3.1 PROJECT TYPES

3.1.1 Load displacement

Load displacement projects, in relation to a DER facility that is connected on the customer side of a connection point, that the output of the generation facility is used or intended to be used exclusively for the customer's own consumption. The DER facility is non-exporting to the distribution system.

3.1.2 Net Metering

Net metering is defined by O.Reg. 541/05 Net Metering Regulation and related laws. Net metering is intended to allow customers to generate electricity for their own consumption at their site and to allow eligible generators to convey eligible electricity into the distribution system for a credit.

3.1.3 Feed-in Tariff, Micro Feed-in Tariff

Feed-in Tariff and Micro Feed-in Tariff are programs to allow renewable distributed energy resources a standard connection to the distribution system under contract with the Independent Electricity System Operator.

3.1.4 Emergency Backup Generation

An Emergency Backup Generation (EBG) facility is a standby power system that is installed on a customer site for the sole purpose of providing electrical power if the primary or system power has been interrupted or is unavailable. All EBG shall be Open Transition or Closed Transition. All Closed Transition EBG shall require an application to Tillsonburg Hydro for review. All Open Transition EBG shall be declared to Tillsonburg Hydro.

4. TECHNICAL STANDARDS

DER facilities shall ensure that the safety, reliability and efficiency of the distribution system is not materially adversely affected by the connection of a DER facility to the distribution system. All DER connections shall at minimum meet the following technical requirements:

- Tillsonburg Hydro Inc, Distributed Energy Technical Interconnection Requirements;
- CSA C22.3 No. 9, Interconnection of distributed resources and electricity supply systems;
- IEEE 1547 Series, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems;
- Ontario Electrical Safety Code, Canadian Electrical Safety Code;
- Hydro One Networks Inc:
    - Distributed Generation Technical Interconnection Requirements, Interconnections at Voltages 50 kV and Below;
    - Technical Interconnection Requirements for Distributed Generation, Micro Generation & Small Generation, 3-phase, less than 30 kW;
- Applicable federal provincial or municipal laws, regulations, codes and by-laws.

5. STANDARD SERVICE SUPPLY VOLTAGES

DER facilities shall interconnect to Tillsonburg Hydro's distribution system at the standard supply voltages stated in Tillsonburg Hydro's Conditions of Service. Where the generator output voltage is not that of Tillsonburg Hydro's standard supply voltage, the generator is responsible for interconnecting the generator at the standard supply voltage with an interface transformer owned and maintained by the generator.

Standard secondary supply voltages;

- 120/240V Single Phase 3 Wire;
- 208Y/120V Three Phase 4 Wire, grounded wye;
- 600Y/347V Three Phase 4 Wire, grounded wye.

Standard primary supply voltages;

- 27,600Y/16,000V Three Phase 4 Wire, grounded wye;
- 8,320Y/4,800V Three Phase 4 Wire, grounded wye;
- 4,160Y/2,400V Three Phase 4 Wire, grounded wye.

All primary voltages are location dependent, based on available primary feeders and specified by Tillsonburg Hydro in the Preliminary Consultation Report.

6. GENERATION FACILITY CONNECTIONS

Tillsonburg Hydro shall determine and approve the load or generation facility's Point of Common Coupling or Point of Connection.

- Point of Common Coupling means the point where the load facility or distributed energy resource facility assets connects to Tillsonburg Hydro's distribution system;
- Point of Connection means the point where the distributed energy resource units connect to the DER facility assets;

Distributed energy resource units interconnect at the point of standard supply voltages. The PCC and POC may be the same depending on the design and type of project.

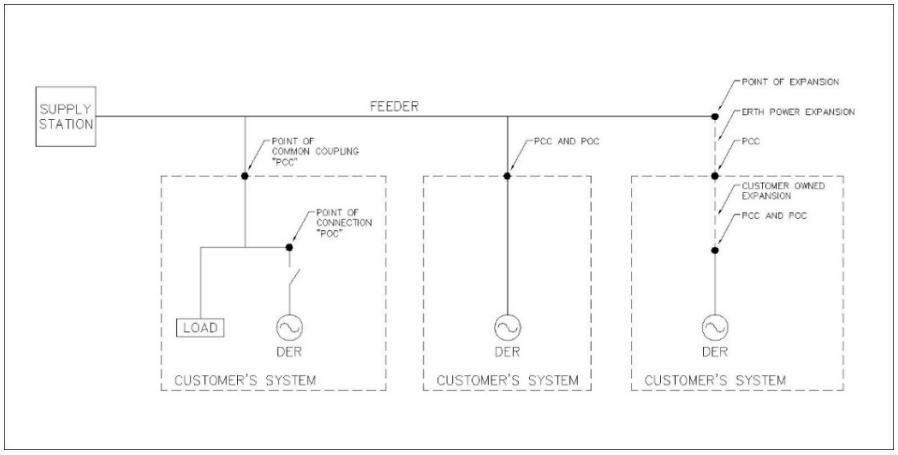

Figure 1. PCC and POC

7. SINGLE PHASE AND THREE PHASE GENERATOR LIMITS

The maximum aggregate name-plated rating of a DER facility for a single-phase generator is less than 150 kVA. The maximum aggregate name-plated rating of a DER facility for a three-phase generator shall be determined by the capacity of the connecting transformer station, municipal station, primary distribution line, interconnecting transformer or any other technical condition that would limit generation.

8. GENERATOR ISOLATION SWITCH

8.1 General Requirements

DER facilities shall have an isolation switch located at the point of common coupling, at the point of connection or both as designated by Tillsonburg Hydro. The isolation switch shall simultaneously disconnect all ungrounded conductors from any distributed energy resource. All isolation switches shall be installed in accordance with the Ontario Electrical Safety Code and Tillsonburg Hydro's requirements and at minimum have the following provisions:

i) be capable being energized from both sides;
ii) plainly indicate whether it is in the open or closed positions;
iii) the operator handle shall be in the "up" position when open;
iv) have contact operation verifiable by direct visible means;
v) have provisions for being locked in the open position;
vi) conform to OESC Sections 14, 28 and 36 if it includes an overcurrent device;
vii) be capable of being opened at rated load;
viii) disconnect all ungrounded conductors of the circuit simultaneously;
ix) bear a warning to the effect that inside parts can be energized when the disconnecting means is open; and
x) be readily accessible;
xi) Located outside as designated by Tillsonburg Hydro.

Note: Breakers or relays shall not be considered acceptable for use as an isolation switch.

8.2 Interconnection Arrangement

DER facility(s) point of connection(s) will depend on the project type and electrical arrangement of the load facility and DER facility.

a) DER facility point of connection shall be designated and approved by Tillsonburg Hydro;
b) DER facility connections shall be at Tillsonburg Hydro supply voltages;
c) DER facility isolation switches shall be installed at the point of connection;
d) Where DER facilities are not directly connected to Tillsonburg Hydro's distribution system, the isolation switch shall only disconnect the DER facility;
e) DER facility isolation switches shall not disconnect load facilities, revenue metering for load facilities or affect other critical or non-critical loads;
f) Electrical arrangements and physical locations may require multiple isolation switches to be present as per the Ontario Electrical Safety Code. The isolation switch at the point of DER facility interconnection shall meet all of Tillsonburg Hydro's requirements;

g) DER facilities with multiple generating units shall provide an isolation switch to disconnect simultaneously all the electric power production sources from the supply authority or at the point of connection;
h) Where multiple DER facility generators are present for different applications, Tillsonburg Hydro shall approve the individual point of connection and isolation switch location and requirements;

8.3 Isolation Switch Location

The generator isolation switch shall be located as specified by Tillsonburg Hydro and be readily accessible to Tillsonburg Hydro personnel at all times for operation and control of the DER facility connection.

Micro-embedded generation (≤ 10 kW) shall have an isolation switch located within 1 meter of the revenue meter.

8.4 Visible Break Isolation Switch

DER facilities greater than 10 kW shall install a visible break isolation switch in accordance with OESC at the generator point of connection to either Tillsonburg Hydro's distribution system or the customer's electrical system. The isolation switch shall have contact operation verifiable by direct visible means under normal operation. All DER connections less than or equal to 10 kW are not required to have an isolation switch with contact operation verifiable by direct visible means under normal operation.

8.5 Transfer Switches (Automatic and Manual)

Transfer switch point of connection will depend on the project type and electrical arrangement of load and DER facility.

a) Transfer switch point of connection shall be designated and approved by Tillsonburg Hydro;
b) Transfer switches shall have the same interconnection requirements as isolation switches;
c) Transfer switches approved for use with emergency backup generation shall not allow the generator to parallel with Tillsonburg Hydro's distribution system (open transfer scheme);
d) Refer to Emergency Backup Generation for closed transition scheme requirements;
e) Transfer switches integral to backup generating units shall not be accepted as a dedicated transfer switch;

8.6 Metering Equipment Isolation

DER Facilities **greater than 10 kW** shall have isolation switches on the line and generator side of metering equipment. The generator side isolation switch shall be located within 3.0 meters of the metering equipment cabinet.

9. DISTRIBUTION SYSTEM NEUTRAL

DER facilities shall require the distribution system neutral to be connected to the DER facility ground grid regardless of the service supply voltage. Where a DER facility is interconnected to a customer owned station transformer, the station ground grid shall be connected to the distribution system neutral.

10. CAPACITY LIMITS ON SUPPLY TRANSFORMER

Allowable limit of micro-embedded DER connections (≤ 10 kW) is equal to 90% of the nameplate KVA rating of the transformer. The maximum transformer size for single phase, overhead is 75kVA. The maximum size for single phase, pad-mounted transformers is 100kVA.

Allowable limit of three phase DER connections is equal to 90% of the transformer nameplate kVA rating to a maximum of 300kVA for overhead transformers. Allowable limit of three phase DER connections is equal to 90% of the transformer nameplate kVA rating to a maximum of 1,000kVA for pad-mounted transformers owned by Tillsonburg Hydro. Allowable limits for customer owned transformer stations shall not exceed the station transformer nameplate rating. All maximum connected generation limits must not exceed the host distributor's TIR limits.

Large DER connection limits shall be calculated on an individual project basis and limited to the available transmission or distribution system capacity at the PCC of the DER site connection.

11. POWER QUALITY MONITORING DEVICE

DER facilities greater than 250 kW shall be equipped with a Power Quality monitoring device capable of providing required reports. The device shall be capable of monitoring harmonics up to the 50th harmonic, impulse transients in the millisecond range and low frequency oscillatory transients less than 5kHz. Power quality monitoring applies to phase voltages, neutral to ground voltage and phase currents.

12. PROTECTION REQUIREMENTS

12.1 Minimum Protection Requirements

All DER connections shall have at a minimum, the following protection functions:

i) under-voltage (27);
ii) over-voltage (59);
iii) under-frequency (81U);
iv) over-frequency (81O);
v) overcurrent, phase/neutral (50/50N);
vi) synchronizing check (25);
vii) Anti-islanding protection.

Additional protection function may be required depending on the generator type and system design. The use of protective functions and equipment shall be prepared and approved by a Profession Engineer of Ontario.

12.2 Reverse Flow Protection

DER connections for non-exporting power shall have reverse power protection.

i) directional power (32R);
ii) directional over-current, phase/neutral (67/67N);

12.3 Transfer Trip

Transfer Trip shall be required on all DER facilities were the aggregate name-plate generation exceeds 1,000 kW. Transfer Trip may also be required as determined by Tillsonburg Hydro at the time of interconnection to Tillsonburg Hydro's distribution system.

12.4 Load Displacement

DER facilities connected for non-exporting, load displacement purposes, shall ensure the design, construction and operation of the DER facility utilize a load following scheme to limit the generation output to 90% of the load facility's consumption. The DER facility shall not export power to the distribution system at any time.

13. MONITORING AND CONTROL REQUIRMENTS

13.1 Supervisory Control and Data Acquisition (SCADA)

DER facilities with an aggregate name-plate rating greater than 250 kW shall provide real-time monitoring and control from the DER facility to Tillsonburg Hydro and the host distributor.

DER facilities greater than 10 kW and less than 250 kW shall have provisions for real-time monitoring and control. The DER facility owner shall provide real-time monitoring and control at the owner's expense upon request by Tillsonburg Hydro or the host distributor. The DER facility shall provide real-time monitoring and control with sixty (60) days of written notice of the request.

Realtime monitoring shall comply with Tillsonburg Hydro's DER Monitoring Standard, IEEE1547.3 IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems and host distributor requirements.

13.2 Monitoring Information

DER facilities requiring monitoring shall provide the following telemetry:

i) connection status of each generating unit;
ii) real power of the generation facility;
iii) reactive power of the generation facility;
iv) phase voltages at the point of connection;
v) phase currents at the point of connection;
vi) distributed generation line end open status;
vii) generator protection fail status;
viii) isolation switch(s) status;
ix) protective relay(s) status; and
x) alarm status.

Additional telemetry may be required as identified in the connection impact stage or design details stage of the project.

13.3 TELECOMMUNICATION REQUIRMENTS

Telecommunications Infrastructure is required for DER facilities requiring real-time monitoring, control or Teleportation. All infrastructure shall be fast, secure, reliable and meet Tillsonburg Hydro's DER-Communication Standard or host distributor's technical interconnection requirements. Tillsonburg Hydro shall provide the mode of communication to be used by the DER facility. The DER facility shall be responsible for the cost of all equipment installations, maintenance, operating and upgrades as required to ensure continuity of telemetry to Tillsonburg Hydro or host distributor's SCADA system.

14. METERING REQUIRMENTS

14.1 Metering Standards

DER facilities greater than 250 kW shall have metering equipment installed. Where metering equipment is not installed at the time of connection, provisions for metering equipment shall be installed. DER facilities shall install metering in accordance with Tillsonburg Hydro's metering standards. Refer to THI-DER Metering Standards for technical requirements. All metering installations shall conform to Measurement Canada standards.

14.2 Metering for Settlement

DER facilities requiring settlement shall have metering installations and wiring compliant with all applicable regulations and conform to Measurement Canada and Independent Electricity System Operators' requirements. The electrical arrangement will vary based on the DER project type.

14.3 Net Metering

Net metering projects shall require bi-direction revenue metering installed to current specifications. Net metering projects with existing retail embedded generation shall maintain an additional revenue meter with the net metered service requiring a bi-directional meter.

14.4 Gross Load Billing (GLB)

Gross Load Billing is applicable to all sub-transmission customers with Load Displacement DER facilities and local distribution companies with embedded generation. Gross Load Billing is applied to DER facilities were any single generating unit at the facility exceeds the following threshold regardless of the cumulative size of the generation facility.

- Equal to or greater than 1 MW with non-renewable generation
- Equal to or greater than 2 MW for renewable generation

Customers identified for GLB will require revenue metering to be installed at the customer's expense.

14.5 Metering Generator Output

DER facilities with a generator rating greater than 250 kW, other an embedded retail generator or emergency backup generator, shall require revenue grade metering of the generator. The metering shall be provided by Tillsonburg Hydro at the DER facility owner's expense. The meter shall be installed at the generator output, point of connection or point of common coupling as designated by Tillsonburg Hydro. Metering shall be provided for power quality monitoring and future capacity reserve charge.

DER facilities shall provide Tillsonburg Hydro metering equipment enclosures with a protected 120Vac supply for ancillary equipment as identified by Tillsonburg Hydro. Metering instrumentation shall be dedicated and accessible by Tillsonburg Hydro staff in an approved metering cabinet and location.

14.6 Metering at Standard Supply Voltages

DER facilities requiring metering shall provide metering connections at Tillsonburg Hydro's Standard Supply Voltages as stated in Tillsonburg Hydro's Conditions of Service.

15. STANDARDS AND REFERENCE DOCUMENTS

This document refers to the following publications, and where such reference is made, it shall be to the latest edition, including all amendments. All distributed energy resources connected to Tillsonburg Hydro's distribution system shall comply with, but not be limited to, the following documents.

- Electricity Act, 1998
- Ontario Energy Board Act, 1998
- O. Reg 541/05 Net Metering Regulation
- O. Reg. 24/17 Net Metering
- O. Reg. 386/22 Net Metering

- Distribution System Code
- Distributed Energy Resources Connection Procedures
- Tillsonburg Hydro Conditions of Service
- Tillsonburg Hydro DER Communication Standards
- Tillsonburg Hydro DER Metering Standards
- Tillsonburg Hydro DER Monitoring Standards

- Hydro One Networks Inc, Distributed Generation Technical Interconnection Requirements – Interconnections at Voltages 50kV and Below (DT-10-15)
- Hydro One Networks Inc., Technical Interconnection Requirements for Distributed Generation, Micro Generation & Small Generation, 3-phase, less than 30kW

- C22.1-06 Canadian Electrical Code, Part 1
- C22.2 No. 107.1 General Use Power Supplies
- C22.2 No. 178.1 Transfer Switch Equipment
- CAN/CSA C22.2 No. 257-06 Interconnecting inverter-based micro-distributed resources to distribution systems
- CAN/CSA C22.3 No. 9 Interconnection of distributed resources and electricity supply systems
- CAN3-C235-83 Preferred voltage levels for AC systems, 0- to 50,000V
- CAN/CSA-C60044-06:07 Instrument transformers – Part 6: Requirements for protective current transformers for transient performance
- CAN/CSA-C61000-2-2:04 Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems
- CAN/CSA-C61000-2-12:04 Electromagnetic compatibility (EMC) – Part 2-12: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems
- CAN/CSA-CEI/IEC 61000-4-2-01 Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
- CAN/CSA-CEI/IEC 61000-4-3:07 Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test
- CAN/CSA-CEI/IEC 61000-4-4:06 Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

- CAN/CSA-CEI/IEC 61000-4-5:08 Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
- CAN/CSA-CEI/IEC 61000-4-12-01 Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test
- IEC 61000-4-15 Part 4-15: Testing and measurement techniques – Flickermeter - Functional and design specifications
- Ontario Electrical Safety Code
- American National Standards Institute (ANSI)
- C84.1-1995 ANSI Electric Power Systems and Equipment – Voltage Ratings (60 Hz)
- Institute of Electrical and Electronics Engineers (IEEE)
- C62.45-2002 IEEE Recommended Practice On Surge Testing For Equipment Connected To Low-Voltage (1000 V and Less) AC Power Circuits
- 1547 IEEE Standard for Interconnecting Distributed Energy Resources with Electric Power Systems
- 1547.1 IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems and Associated Interfaces
- 1547.2 IEEE Applications Guide for IEEE Std 1547, Interconnecting Distributed Resources with Electric Power Systems
- 1547.3 IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
- 1547.4 IEEE Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems
- 1547.6 IEEE Recommended Practice for Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks
- 1547.7 IEEE Guide for Conducting Distribution Impact Studies for Distributed Resource Interconnection
- 1547.8 IEEE Draft Recommended Practice for Establishing Methods and Procedures that Provide Supplemental Support for Implementation Strategies for Expanded Use of IEEE Standard 1547
- 1547.9 IEEE Guide for Using IEEE Std 1547 for Interconnection of Energy Storage Distributed Energy Resources with Electric Power Systems

- C37.90.1-2002 IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- C37.90.2-2004 Standard for Withstand Capability of Relay Systems to Radiate Electromagnetic Interference from Transceivers
- C37.90.3-2001 IEEE Standard Electrostatic Discharge Tests For Protective Relays
- C57.13-1993 IEEE Standard Requirements for Instrument Transformers
- STD 519 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

- UL 1008 – Transfer Switch Equipment
- UL 1741 – Inverters, Converters, and Controllers for Use in Independent Power Systems
- UL1973 – Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail Applications
- UL9540 – Standard for Energy Storage Systems and Equipment