

# TECHNICAL INTERCONNECTION REQUIREMENTS FOR DISTRIBUTED GENERATION

Micro Generation &  
Small Generation, 3-phase, less than 30 kW



DT-10-20



#### LIMITATION OF LIABILITY AND DISCLAIMER

Hydro One Networks Inc. ("HONI"), and any person employed on its behalf, makes no warranties or representations of any kind with respect to the DG requirements contained in this document, including, without limitation, its quality, accuracy, completeness or fitness for any particular purpose, and HONI will not be liable for any loss or damage arising from the use of this document, any conclusions a user derives from the information in this document or any reliance by the user on the information it contains. HONI reserves the right to amend any of the requirements at any time. Any person wishing to make a decision based on the content of this document should consult with HONI prior to making any such decision.

**TABLE OF CONTENTS**

1 INTRODUCTION ..... 2

2 SCOPE ..... 2

3 STANDARDS ..... 3

4 DEFINITIONS ..... 3

5 MICRO GENERATION (10 kW or less) ..... 5

    5.1 GENERAL TECHNICAL REQUIREMENTS ..... 5

    5.2 SYSTEM GROUNDING ..... 5

    5.3 TECHNICAL ACCOMODATION REQUIREMENTS ..... 5

    5.4 PROTECTION AND CONTROL REQUIREMENTS ..... 7

    5.5 OPERATING REQUIREMENTS ..... 10

    5.6 REVENUE METERING REQUIREMENTS ..... 12

    5.7 MAINTENANCE ..... 12

    5.8 CONNECTION PROCESS STEPS ..... 12

6 ADDITIONAL REQUIREMENTS FOR SMALL 3-PHASE GENERATION ..... 13

7 LINKS AND REFERENCES ..... 13

    7.1 OEB (Ontario Energy Board): ..... 13

    7.2 Measurement Canada ..... 13

    7.3 CSA (Canadian Standards Association): ..... 13

    7.4 OESC (Ontario Electrical Safety Code): ..... 14

    7.5 ESA (Electric Safety Authority): ..... 14

    7.6 IEEE (Institute of Electrical and Electronics Engineers) ..... 14

    7.7 A GUIDE TO PHOTOVOLTAIC (PV) SYSTEM DESIGN AND INSTALLATION ..... 15

    7.8 HONI (Hydro One networks Inc.): ..... 15

**LIST of TABLES**

Table 1: Recommended Service Voltage Variation Limits ..... 6

Table 2: Response to Abnormal Voltage Levels ..... 9

Table 3: Response to Abnormal Frequencies ..... 9

Table 4: Limits of Harmonic Distortion ..... 11

## TECHNICAL INTERCONNECTION REQUIREMENTS (TIR) FOR DISTRIBUTED GENERATION

### Micro Generation &

### Small Generation, 3-phase, less than 30 kW

## 1 INTRODUCTION

Ontario's electricity system is changing. As a result of the Green Energy and Green Economy Act, 2009 (GEA), the amount of renewable power in our electricity system is expected to increase greatly between now and 2025. Renewable Energy projects range in size from small generators of a few kW to large projects of 100 MW or more.

Hydro One Networks Inc. (HONI) is the largest Local Distribution Company in Ontario, distributing power to more than 1.3 million customers mostly in rural Ontario. HONI expects to offer connections to increasing numbers of Distributed Generation (DG) facilities as a result of the GEA and the associated Feed-in Tariff program.

Distributed generation is not without its challenges. Most of the HONI distribution system was not designed to accommodate and integrate distributed generation. HONI must integrate thousands of new DG connections without jeopardizing the reliability and security of its distribution network for load customers.

This document was prepared to provide DG owners with the technical requirements required in Step 2 of the connection process stipulated in Appendix F of the Distribution System Code. It is also intended to help DG owners understand their role and responsibilities when connecting to the HONI distribution system as a generator. Working together, we can make a greener Ontario while preserving HONI's high level of safety, power quality and reliability.

## 2 SCOPE

These requirements apply to the following individual generating facilities:

- Micro-embedded (or, more simply "micro") generation projects, such as a rooftop solar installation where the total generation at the generating facility is 10 kW or less.
- Three-phase (3 Ø) generation projects, such as those at a shopping mall or small or medium sized commercial establishment, where the total generation at the generating facility is less than 30 kW.

These requirements are not intended to apply to generators connecting momentarily (100 ms or less) through automatic transfer switches (such as back-up generators).

**Note:** The Ontario Energy Board (OEB) has specified a maximum generating capacity of 10 kW for Micro-generators and similarly the Ontario power Authority (OPA) has specified that the maximum generating capacity for a microFIT contract is 10 kW.

Single-phase generators with an aggregate capacity > 10 kW; and three-phase generators with an aggregate capacity ≥ 30 kW are covered under HONI's document "Distributed Generation Technical Interconnection Requirements - Interconnections at Voltages 50 kV and Below"

Hydro One understands that the proponents of generators to which this TIR document applies may not have a technical background and may thus not be familiar with technical terms and documents referred to. As such, Hydro One offers pre-consultations and ongoing assistance to proponents with regard to understanding the requirements outlined in this TIR document

### 3 STANDARDS

To qualify for interconnection, generators shall comply with the following codes and standards as applicable:

- Ontario Electrical Safety Code (OESC)
- C22.2 No. 107.1-01 (General Use Power Supplies)
- CSA C22.3 No-9/08 (Interconnection of Distributed Resources and Electricity Supply Systems)
- Distribution System Code of Ontario Energy Board
- "microFIT" program of the Ontario Power Authority
- HONI's Condition of Services (COS) and Metering Policy (NOP041)
- CAN/CSA-C22.2 No. 257 (Interconnecting Inverter-based Micro-distributed resources to distribution systems) (see Note 1)
- UL 1741, Inverters, Converters and Controllers for use in generating facility (see Note 1)

**Note 1:** *According to ESA Bulletin 84-1-5 (Interconnection of Electric Power Production Sources, Section 84 and Rule 2-010 Issued April 2010, Supersedes Bulletin 84-1-4), inverters certified only to UL1741 standard, will not be accepted as of January 1, 2011:*

*After January 1, 2011 inverters are required to be certified to CSA standard C22.2 #107.1 and bear a certification mark recognized in Ontario.*

*Field Evaluation shall not be accepted for utility-interconnected inverters. Inverters marked as "UTILITY-INTERCONNECTED" or equivalent shall only bear a certification mark, not a field evaluation mark.*

### 4 DEFINITIONS

**Anti-islanding:** A protective functionality aimed at preventing the continued existence of an unintentional electrical island (see "Islanding" below) to avoid safety concerns and potential damage to customer equipment.

**Backup or Emergency Generator:** An independent reserve source of electric energy that, upon failure or outage of the normal source, automatically provides reliable electric power within a specified time to critical devices and equipment whose failure to operate satisfactorily would jeopardize the health and safety of personnel or result in damage to property.

**Coefficient of Grounding (COG):** The ratio  $ELG/ELL$  expressed as a percentage, where:

$ELG$  is highest root-mean-square (rms) line-to-ground power-frequency voltage on a sound phase, at a selected location, during a fault to earth affecting one or both of the other two phases.

**ELL** is to the line-to-line power-frequency voltage that would be obtained, at the selected location, with the fault removed.

**DC Injection:** Power electronic converters (inverters or rectifiers) are potentially capable of injecting DC currents into the utility's ac power system which can impact safety and reliability adversely unless adequately managed at the source.

**Distributed Generation:** Power generators that are connected to a distribution system through a Point of Common Coupling (PCC). **Effectively Grounded:** A system grounded through sufficiently low impedance so that COG does not exceed 80%. This value is obtained approximately when, for all system conditions, the ratio of the zero-sequence reactance to the positive-sequence reactance, ( $X0/X1$ ), is positive and  $\leq 3$ , and the ratio of zero-sequence resistance to positive-sequence reactance, ( $R0/X1$ ), is positive and  $< 1$ .

**Distribution System:** A system for distributing electricity, including any structures, equipment or other things used for that purpose. A distribution system is comprised of the main system capable of distributing electricity to many customers and the connection assets used to connect a customer to the main distribution system.

**External Disconnect Switch:** The utility-accessible alternating current (AC) external disconnect switch (EDS) for distributed generators, is a hardware feature that allows a utility's employees to manually disconnect a customer-owned generator from the electricity grid.

**Flicker:** A perceptible change in electric light source intensity due to a fluctuation of input voltage. (Note: The general meaning of this term could apply to the pulsation of luminous flux from a low-inertia source, such as gas discharge lamps, caused by the zero crossings of the supply voltage at twice the power-system frequency. However, in the context of power supply disturbances, the term applies to perceptible, subjective, objectionable and random or periodic variations of the light output).

**Harmonics:** Sinusoidal voltages and currents at frequencies that are integral multiples of the fundamental power frequency which is 60 Hz in Ontario.

**HONI:** Hydro One Networks Inc.

**Islanding:** A condition in which a portion of a transmission and/or distribution system is energized solely by one or more generators, including DGs, while that portion is electrically separated from the rest of the transmission or distribution system.

**Temporary Over Voltage (TOV):** An oscillatory phase-to-ground or phase-to-phase overvoltage at a given location of relatively long duration (seconds, even minutes) and that is un-damped or only weakly damped. Temporary over-voltages usually originate from switching operations or faults (for example, load rejection, single-phase fault, fault on a high-resistance grounded or ungrounded system) or from nonlinearities (ferro-resonance effects, harmonics), or both. They are characterized by the amplitude, the oscillation frequencies, the total duration, or the decrement.

**Total Harmonic Distortion (THD):** The ratio of the rms value of the sum of the squared individual harmonic amplitudes to the rms value of the fundamental frequency of a complex waveform.

**Point of Supply or Point of Common Coupling (PCC):** The PCC with respect to an embedded generation facility means the connection point where electricity produced by the generation facility is injected into the distribution system.

**Small Generator** (or “small embedded generation facility”) means an embedded generation facility, which is not a micro-embedded generation facility, with a name-plate rated capacity of 500 kW or less in the case of a facility connected on distribution system voltage less than 15 kV and 1MW or less in the case of a facility connected on distribution system voltage greater than 15 kV.

**Synchronization:** The state and operation where the DG facility is connected to the distribution system and supplies loads along with the electric grid.

## 5 MICRO GENERATION (10 kW or less)

### 5.1 GENERAL TECHNICAL REQUIREMENTS

Safety is paramount in generating, transmitting and distributing electricity. DG facilities must meet all applicable federal, provincial, and local construction, operation and maintenance related safety codes, such as the Canadian Electrical Code, Ontario Electrical Safety Code, Occupational Health and Safety Act, etc.

This section provides the technical interconnection requirements. The DG facility interconnection equipment must comply with these requirements in order to be connected to the distribution system. Typical operating conditions, protection functions and correct response to abnormal conditions are also listed.

### 5.2 SYSTEM GROUNDING

- 5.2.1 The DG system must be grounded in accordance with applicable codes. Refer to OESC (Sections 10 – Grounding and bonding, 36 – High Voltage Installations, and 84 – Interconnection of electric power production sources).
- 5.2.2 The interconnection of the DG, through equipment such as an interface transformer and/or external disconnect switch (5.4.2), with the HONI distribution system shall be compatible with the neutral grounding method in use on the HONI distribution system.
- 5.2.3 Three-phase DG connecting to HONI four-wire multi-grounded primary feeders shall not cause the maximum “Temporary Over Voltage” (TOV) to exceed 130% of nominal line-to-ground voltages.

### 5.3 TECHNICAL ACCOMODATION REQUIREMENTS

HONI will be reviewing the generator’s technical characteristics with respect to the following requirements.

#### 5.3.1 Customer Specific Requirements

Any measures required to meet these requirements will be at the generator owner’s cost. HONI will not provide a transformer for the sole purpose of connecting a generator to the distribution system.

- i. The generator shall not exceed the capacity of the customer’s existing electrical service. To meet this requirement, the customer’s existing electrical service may need to be upgraded.
- ii. The generator’s operating voltage range must be compatible with the standard service voltage range. To meet this requirement, matching transformation may need to be installed.
- iii. In order for the voltage at the service entrance to remain within the limits of Table 1 under all system operating conditions, the total connected generator capacity shall not cause the voltage rise on the secondary service conductor to exceed 1% of operating voltage. To meet this requirement, re-conductoring of the service drop may be required.

Table 1: Recommended Service Voltage Variation Limits

Nominal System Voltages	Recommended voltage variation limits for circuits up to 1,000 V, applicable at service entrance			
	Extreme Operating Conditions			
	Normal Operating Conditions			
<u>Single Phase</u>				
120/240	106/212	110/220	125/250	127/254
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635
<u>Three phase 4-conductor</u>				
120/208Y	110/190	112/194	125/216	127/220
240/416Y	220/380	224/388	250/432	254/440
277/480Y	245/424	254/440	288/500	293/508
347/600Y	306/530	318/550	360/625	367/635
<u>Three phase 3-conductor</u>				
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635

Source: CSA CAN3-C235, Table 3

- iv. For transformers rated 50 kVA or higher, the total connected generation capacity, including the proposed generation, must be limited to the nameplate kVA rating of the respective transformer winding. To meet this requirement, the transformer may need to be replaced with one of higher rating (e.g. for a 50 kVA transformer, the maximum permissible generator rating is 50 kW at unity power factor).

- v. Transformers rated less than 50 kVA (typically 10 kVA and 25 kVA) have higher winding resistance. For these, the total connected generation capacity including the proposed generation must be limited to 50% of the nameplate kVA rating of the respective transformer winding. To meet this requirement, the transformer may need to be replaced with one of higher rating.
- vi. For generators connected between line-to-neutral terminals of the transformer secondary, the total connected generation capacity shall not exceed 25% of the transformer nameplate kVA rating. To meet this requirement, the transformer may need to be replaced with one of higher rating.

### 5.3.2 System Requirements

- i. The total generation to be interconnected to a distribution system circuit line section, including the proposed generator, will not exceed 7% of the annual line section peak load. Line section peak load refers to the section of line to which the DG connection is proposed, including all downstream line on the same phase(s) and the line upstream to the nearest automatic reclosing protective device (normally a single-phase line recloser). The total generation excludes generators that cannot export power from a customer's site. To meet this requirement, supply station capacity upgrades may be required and anti-islanding concerns due to cumulative generation will need to be addressed.
- ii. The total interconnected generation, including the proposed generator, will not cause any distribution protective devices and equipment (including but not limited to substation breakers, fuse cutouts and line re-closers) or customer equipment on the system, to exceed 100 percent of the short circuit interrupting capability. To meet this requirement, protective devices may need to be upgraded.
- iii. Voltage unbalance on the distribution feeder must be limited to no more than 2% (calculated by dividing the maximum deviation from average voltage on a single phase by the average voltage, with the result multiplied by 100). To meet this requirement, either the single phase service to which the proposed generation is to be connected must be moved to a different phase, or feeder reconfiguration or upgrades may be required.
- iv. The total generation to be interconnected to the distribution system, including the proposed generator, must respect limitations on the transmission system identified by the OPA or the transmitter. To meet this requirement, transmission system upgrades may be required.

## 5.4 PROTECTION AND CONTROL REQUIREMENTS

This section outlines protection and control requirements and expectations for DG facilities. We all have a role to play in protecting the integrity of our electrical distribution system. Even though they are becoming more common, DG systems are complex and sophisticated. Owners of DG facilities must make themselves aware of the key points in protecting their systems against damage.

#### 5.4.1 Interrupting Device

An interrupting device (e.g. circuit breaker) is required to automatically disconnect from all ungrounded conductors of the distribution system that the generator source feeds, due to the need to ensure safety and mitigate the risk of damage to the equipment of others (as set out in the protection requirements outlined in Section 5.4.3 to 5.4.12 below). It must meet the requirements of OESC Sections 14, 28, 36 and 50 as applicable.

#### 5.4.2 Isolating Device

A customer owned, utility-accessible external disconnect switch (EDS) is required to isolate the DG facility for the purpose of safety during maintenance and during emergency conditions. HONI requires an EDS provided by the customer, which:

- i. is capable of being energized from both sides;
- ii. is clearly labeled as a DG disconnect switch;
- iii. plainly indicates whether it is in the open or closed position;
- iv. has provision for being locked in the open position;
- v. is accessible by HONI personnel;
- vi. is not located in a hazardous location;
- vii. is capable of being opened at rated load;
- viii. is capable of being operated without exposing the operator to any live parts, equipment or devices;
- ix. is capable of being closed with safety to the operator with a fault on the system;
- x. bears a warning to the effect that inside parts can be energized from sources on both sides when disconnecting means is open.; and
- xi. is either at the primary voltage level, which may include load-break cutouts, switches and elbows, or is on the secondary voltage level, which may include a secondary breaker or switch.

#### 5.4.3 Over-current Protection

Over-current protection shall be provided in accordance with OESC Rule 84-010

“Equipment and conductors that are energized from both directions shall be provided with over-current protection from each source of supply.”

#### 5.4.4 Ground Fault Protection

“Ground fault protection shall be provided in accordance with OESC Rule 84-016, and OESC Rule 14-102.”

#### 5.4.5 Abnormal System Voltage Protection

The generator shall disconnect from HONI’s distribution system at abnormal voltage levels and clearing times specified in Table 2.

*By agreement of HONI, different settings may be used for the under-voltage and over-voltage trip levels or time delays.*

Table 2: Response to abnormal voltage levels

Voltage	Clearing Time
$V < 50\%$	6 cycles (0.1 sec)
$50\% \leq V < 88\%$	120 cycles (2 sec)
$110\% < V < 137\%$	120 cycles (2 sec)
$V \geq 137\%$	2 cycles (0.033 sec)

Source: CSA C22.2 No. 107.1, Table 16

5.4.6 For three-phase generation, the voltage thresholds specified in Table 2 apply to each phase individually.

5.4.7 Abnormal System Frequency Protection

The generator shall disconnect from HONI's distribution system at the frequency levels within the clearing times specified in Table 3.

Table 3: Response to abnormal frequencies

Frequency	Clearing Time
$> 60.5 \text{ Hz}$	6 cycles (0.1 sec)
$< 59.3 \text{ Hz}$	6 cycles (0.1 sec)

*Different settings may be used for the under and over frequency trip levels or time delays with the agreement of HONI.*

5.4.8 Paralleling Generation

The act of paralleling generation to the distribution system can cause current and voltage on the distribution system to be disturbed. Connection of generation to the distribution system shall not cause a steady state voltage fluctuation of more than  $\pm 4\%$  at the PCC. This is achieved by different means, depending on the type of proposed generation:

Generating systems that can generate and control alternating current (ac) voltage independent of the distribution system require synchronization capabilities in order to connect to the distribution system. For these types of generating systems, the synchronizing controls must connect only when the differences between the generator and the distribution system voltage waveform are within the following limits:

- i. Frequency difference less than 0.3 Hz
- ii. Voltage magnitude difference less than 10 percent
- iii. Phase angle difference less than 10 degrees

Other types of generation that cannot generate and control ac voltage independent of the distribution system may require different methods of limiting voltage fluctuations to acceptable levels. Examples are soft-start control systems or speed-matching for induction machines.

#### 5.4.9 System Protection

The DG owner shall be responsible for protection of their equipment and shall not cause damage to, and/or adversely affect, other distribution system connected customers for all HONI distribution system operating conditions whether or not their DG is in operation. Conditions may include, but are not limited to:

- i. distribution system faults;
- ii. abnormal voltage or frequency excursions;
- iii. transient voltage due to lightning and switching;
- iv. equipment failures
- v. loss of a single phase of supply (three-phase generators)
- vi. excessive harmonic and negative sequence voltages
- vii. synchronizing generation
- viii. re-synchronizing the generation after HONI restores supply; and
- ix. islanding; Separation from supply.

#### 5.4.10 Anti-islanding

The DG shall cease to energize the HONI system within two seconds of the formation of an island on the distribution system. HONI does not currently allow islanded operation.

#### 5.4.11 Feeder Reclosing Coordination

To maintain reliability, HONI uses automatic reclosing on distribution feeders. The DG needs to take this into consideration when designing DG system protection schemes to ensure that the DG system ceases to energize the distribution system prior to automatic reclose of the feeder breakers or line re-closers. The typical automatic reclosing times range from one to two seconds. The DG protection and controls must be designed to coordinate with the HONI reclosing practices.

#### 5.4.12 Reverse Power Protection

Generators that do not meet the requirements of section 3 above must utilize reverse power relays or other protection devices and/or methods that ensures no export of power from the customer's site. This includes any inadvertent export that could adversely affect protective devices on the distribution feeder.

### 5.5 OPERATING REQUIREMENTS

DG facilities must comply with a number of operating requirements that HONI has in place to safeguard the reliability and integrity of the distribution system. Compliance with the following operating requirements is required to protect the safety and reliability of HONI's distribution network. Failure to maintain industry acceptable facilities and maintenance

standards may result in disconnection of the facility from the distribution system, at HONI's discretion, in accordance with the requirements of the Distribution System Code.

- 5.5.1 If high-voltage, low-voltage or voltage flicker complaints arise from other customers due to the operation of the DG facility, HONI reserves the right, in accordance with the requirements of the Distribution System Code, to require that the DG facility be isolated from the distribution system until the problem has been resolved at the DG facility owner's cost, without compensation by HONI.
- 5.5.2 The total harmonic distortion of the output current over the entire generator operating range shall be less than 5% of the rated fundamental current. Individual harmonics shall not exceed the limits in Table 4, expressed in relation to rated fundamental current.

Table 4: Limits of Harmonic Distortion

Harmonic numbers	Maximum distortion	
	Even harmonics	Odd harmonics
2nd through 9th	1.0%	4.0%
10th through 15th	0.5%	2.0%
16th through 21st	0.4%	1.5%
22nd through 33rd	0.2%	0.6%
Above the 33rd	0.1%	0.3%

*(Source C22.2 No. 107.1-01 Table 15)*

- 5.5.3 The DG facility shall not inject a direct current (dc) greater than 0.5% of its rated output current.
- 5.5.4 The DG shall discontinue parallel operation when requested by HONI after reasonable prior notice, except in an emergency, so that maintenance and/or repairs can be performed on the distribution system.
- 5.5.5 The DG shall not energize the distribution system after loss of utility supply until this supply has been restored for a minimum of five minutes. The DG facility shall be designed to prevent the DG from being energized to a de-energized distribution system.
- 5.5.6 For safety reasons, backup or emergency generators without a power export agreement must utilize either open transition switching in order to ensure no back feed or closed transition, which must not be greater than 100 ms (6 cycles). This is a critical safety requirement.

## 5.6 REVENUE METERING REQUIREMENTS

Metering equipment shall be revenue class and shall comply with Measurement Canada requirements and HONI requirements. Revenue metering shall be in accordance with HONI's Policy document "NOP – 041" Metering for Embedded Generator connecting to HONI distribution system.

For existing load customers, the generator meter must be located beside the existing load meter. In the case of a standalone or direct connection, the meter must be located no more than 30 m from the transformer (or crossing pole), and the meter must be accessible year round.

In accordance with the OEB's directive dated May 19, 2010, and Measurement Canada's concerns (as noted in its information bulletin "In-Series Metering Connection Configurations Ontario Power Authority Feed-in Tariff Program" dated June 3, 2010 "Series Configurations" are not allowed by HONI. Parallel metering connection methods are considered capable of providing quantity representations that comply with Measurement Canada's statutory measurement accuracy requirements (Reference 7.2).

The typical metering arrangements are shown under the following link:

<http://www.hydroone.com/Generators/Documents/Feed-In%20Tariff/Connection%20Types.pdf>

## 5.7 MAINTENANCE

The DG owner has full responsibility for routine maintenance of its DG facility and keeping records of such maintenance to the recommendations of the equipment manufacturer and accepted industry standards, in particular Ontario Electrical Safety Code (OESC), section 2-300.

Operation of interconnection system functions shall be verified according to the manufacturer's recommended schedule, or at least annually if there is no manufacturer recommendation. In particular, operating the disconnecting means and verifying that the DG facility automatically ceases to energize the distribution system and does not resume energizing until the distribution system is stabilized after the disconnecting means is closed is required.

Failure to maintain OESC and industry acceptable facilities and maintenance standards can result in disconnection of the DG facility.

## 5.8 CONNECTION PROCESS STEPS

For Connection Process Requirements and steps please visit

<http://www.hydroone.com/Pages/Default.aspx>

or follow the link:

<http://www.hydroone.com/Generators/Documents/Feed-In%20Tariff/microFIT%20Checklist.pdf>

## 6 ADDITIONAL REQUIREMENTS FOR SMALL 3-PHASE GENERATION

(i.e. exceeding 10 kW, but less than 30 kW)

- All of the above requirements applicable to Micro Generation are also applicable to Small Generation, less than 30 kW. Specific and additional requirements are specified below.
- DG facilities must ensure that upon loss of voltage in one or more phases of the main 3- Ø supply, the generator shall:
  - be automatically disconnected from the system; and
  - not be reconnected until the normal voltage on all 3- Ø of the main 3- Ø supply system are restored
- The connection processes and the time lines defined in the Distribution System Code for the category of “Small Generation” must be followed.
- The “External Disconnect Device” must be gang-operated in addition to the requirements cited under (5.4.2)

## 7 LINKS AND REFERENCES

(Note that referenced links may change over time)

### 7.1 OEB (Ontario Energy Board)

Distribution System Code and its appendix F

<http://www.oeb.gov.on.ca/OEB/Industry/Rules+and+Requirements/Rules+Codes+Guidelines+and+Forms#electricity>

### 7.2 Measurement Canada

<http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04345.html>

### 7.3 CSA (Canadian Standards Association)

C22.2 No. 107.1-01

CSA C22.3 No-9/08,

CAN/CSA-C22.2 No. 257

<http://www.csa.ca/cm/ca/en/home>

### OPA (Ontario Power Authority)

Micro-FIT and FIT programs

[www.powerauthority.on.ca](http://www.powerauthority.on.ca)

Renewable Energy Standard Offer Program

Feed-in Tariff Program

#### 7.4 OESC (Ontario Electrical Safety Code)

[http://www.esasafe.com/Contractors/stt\\_0028.php](http://www.esasafe.com/Contractors/stt_0028.php)

#### OHSA (Occupational Health and Safety Act)

<http://www.labour.gov.on.ca/english/hs/>

#### 7.5 ESA (Electric Safety Authority)

ESA Requirements and guidelines

ESA-SPEC-004 Electrical guidelines for inverter-based micro-generating facility 10 kW and smaller; and

ESA-SPEC-005 Process Guideline for the Installation of Parallel Generating Systems, 10 kW or Greater

[http://esasafe.com/GeneralPublic/sgi\\_002.php?s=24](http://esasafe.com/GeneralPublic/sgi_002.php?s=24)

[http://esasafe.com/pdf/Electrical\\_Guidelines\\_for\\_InverterBased\\_Micro\\_Generation\\_Facilities.pdf](http://esasafe.com/pdf/Electrical_Guidelines_for_InverterBased_Micro_Generation_Facilities.pdf)

#### NRCan (Natural Resources Canada)

*Connecting Micro-power to the Grid: A Status and Review of Micro-power Interconnection Issues and Related Codes, Standards and Guidelines in Canada 2nd Edition*

[http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/renewables/integration\\_der/publications/2006073.html](http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/renewables/integration_der/publications/2006073.html)

The RETScreen Clean Energy Project Analysis

[www.retscreen.net](http://www.retscreen.net)

#### 7.6 IEEE (Institute of Electrical and Electronics Engineers)

STD 1547 – 2003 (Standard for Interconnecting Distributed Resources with Electric Power Systems)

<http://standards.ieee.org/>

[http://grouper.ieee.org/groups/scc21/dr\\_shared/](http://grouper.ieee.org/groups/scc21/dr_shared/)



DT-10-20

**7.7 A GUIDE TO PHOTOVOLTAIC (PV) SYSTEM DESIGN AND INSTALLATION**

CALIFORNIA ENERGY COMMISSION

[http://www.energy.ca.gov/reports/2001-09-04\\_500-01-020.PDF](http://www.energy.ca.gov/reports/2001-09-04_500-01-020.PDF)

**7.8 HONI (Hydro One Networks Inc.)**

<http://www.hydroone.com/Generators/Pages/Feed-inTariff.aspx>