GreaterSudburyHydro

Guidelines for Applicants Connecting Distributed Generation

To Greater Sudbury Hydro Distribution Corporation

About Greater Sudbury Hydro Distribution Corporation

"Community-owned, community-operated and community-minded" a heritage that began over 100 hundred years ago when the fledgling community of Sudbury became the first community in Ontario to own and operate its own electricity generating facilities. While the demand for electricity has increased from the original seventy-five thousand watts to two-hundred million watts, the drive to keep customers at the leading-edge of innovation has remained with Greater Sudbury Hydro Inc.

Today, Greater Sudbury Hydro services the needs of 44,000 customers within the City of Greater Sudbury and within the Municipality of West Nipissing. From the original steam-powered plant, we have moved to 30 modern substations controlled by the latest in computerized equipment. This system supplies reliable electricity to residential and commercial customers, insuring that the community has the electrical infrastructure to grow and prosper.

"Community-owned, community-operated and community-minded" are not just buzzwords at Greater Sudbury Hydro. They guide all of our business decisions. This commitment to our heritage and future, combined with local control, will ensure the needs and concerns of our community.

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About Rodan Energy and Metering Solutions Inc.

This document was prepared for Greater Sudbury Hydro by Rodan Energy and Metering Solutions Inc. Rodan Energy & Metering Solutions Inc. is a leading provider of innovative metering and energy management solutions for power producers, consumers and distributors throughout North America.

Rodan is certified as an engineering firm by the Professional Engineers of Ontario and is specialized in market entry services for power producers in Ontario.

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Table of Contents

Appendices

Introduction

The goal of Local Distribution Companies (LDCs) is to provide safe, reliable, efficient delivery of electricity within their LDC's service area while being accountable to their shareholders...usually the Council and citizens of the municipality.

In the past, most electricity generation occurred within large centrally located plants which were connected to high voltage lines that transmitted electricity across the province to the locations where it would be used.

Technological improvements, regulatory policy reform and increased environmental awareness have created new opportunities for electricity to be generated in alternative ways by private and public companies on smaller scales closer to where it is used and increasingly by connecting the generation to lower voltage lines hence the use of the term distributed generation.

The Ontario government's policy to purchase electricity through what is known as the Standard Offer Program (SOP) creates an even greater opportunity for a significant increase in the interest and presence of distributed generation throughout the province.
Your LDC has prepared this information package for those parties interested in learning more about connecting distributed electricity generation facilities to our electricity distribution system.

This package contains an overview of the Ontario electricity transmission system, the LDC's distribution system and safety, power quality, protection and other technical issues related to new generation.

This information package contains the following information:

- A description of the way electricity is typically generated, transmitted, and distributed in Ontario and the resulting technical considerations for prospective distributed generators.
- An overview of the options available for connecting different types of electricity generation facilities to an LDC's electrical distribution system and the different programs in Ontario through which generators can sell their electrical output.
- An overview of the technical, safety, and regulatory considerations that prospective distributed generators must be aware of.
- A description of the administrative process for connecting electricity generation facilities to an LDC's electrical distribution system.
- The Connection Review form that starts the connection process and other helpful resources for distributed generators.
- The Application Form to request a more detailed Connection Impact Assessment for a prospective generation developer
- Links to publicly available web sites where additional documents, information and self help materials on electricity generation, applicable standards, regulations, etc. are available.

Distributed generation is any type of electrical generator or static inverter producing alternating current that has the capability of Parallel Operation with the LDC Power distribution system, or is designed to operate separately from the LDC system and can supply a load that can also be fed by the LDC's system.

Although some distributed generation is intended to provide electricity solely for a customer's own use, such as stand-by or load displacement generation, this guide also covers the emerging role of distributed generation in supplying Ontario's generation needs through the sale of some or all of the electricity generated by exporting it through the LDC's electricity distribution system.

Distributed generation also varies in design and fuels from diesel or natural gas standby generators to natural gas co-generation to wind turbines, photovoltaic cells, biogas and hydroelectric generation. A further variable is size, from very small (micro) wind and photovoltaic units in the under 10 kilowatt (kW) range to generation in the multi megawatt (MW) range.

The variability and breadth of scope make it a challenge to provide information on connecting to an LDC's distribution system and those interested in connecting distributed generation may or may not have an appreciation of the technical requirements and the complexity of electrical delivery systems.

This information package is intended as a starting point for those interested in connecting distributed generation facilities to the distribution system. It provides high level outlines and simplifications of processes and regulations that are described in detail in a number of publicly available documents, the content of which will change from time to time. A list of some of these documents and the agencies that publish them is available in Appendix 2. It is recommended that anyone interested in connecting electricity generation to an LDC's distribution system read all relevant documentation carefully.

Should there be a conflict between this information package and the rules, regulations, and specific information as laid out in relevant documents regarding the connection of electricity generation facilities to a distribution system in Ontario, the rules, regulations, and specific documents shall take precedence.

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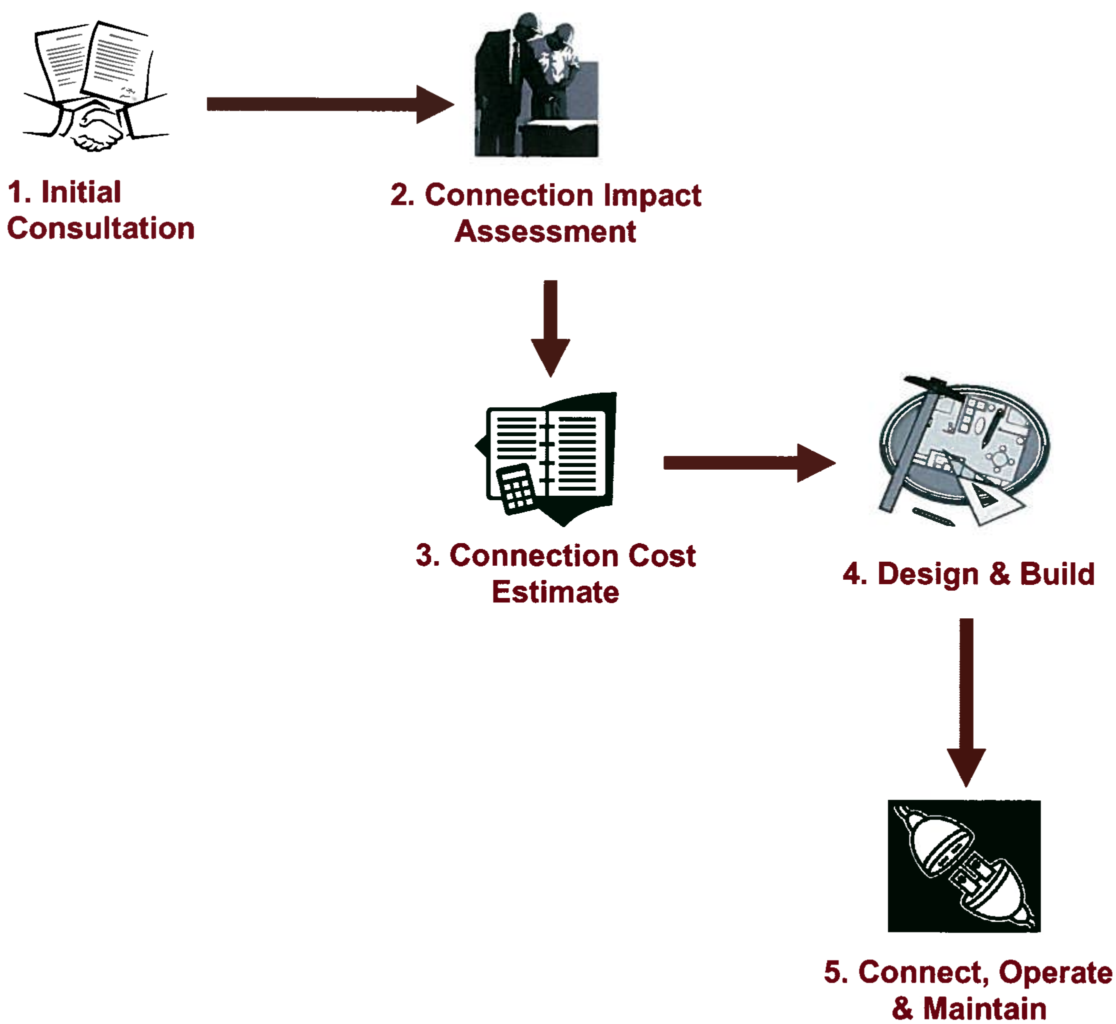
Connection Process Flowchart

Connection Process



The process that the LDC will follow for connecting a distributed generator to the LDC's distribution system is detailed in the Ontario Energy Board's (OEB) Distribution System Code, Appendix F. (http://www.oeb.gov.on.ca/documents/dscappf_100304.pdf)

Connection Process Overview

Initial Consultation

LDC meets with the prospective Generator to discuss their plans, provide preliminary information on the connection options and explain the connection process. The Generator is required to complete and submit the Connection Review Application Form (Appendix 3) and provide other supporting documents to the LDC.

Connection Impact Assessment

After reviewing the Connection Review Application Form and other technical data submitted during the initial consultation, the project will then be discussed with the Generator in a face-to-face meeting. The aim of this meeting is to discuss issues of mutual interest early in the Generator's review of the feasibility of the project. The Generator is then required to submit a completed Generator Connection Assessment Review Form. (Appendix 4 for a generator of 10kW or less or Appendix 5 for a generator rated at between 10kW to 10MW).

Connection Cost Estimate

After all required assessments are complete (including assessment by Hydro One, if required), the scope of work required to connect new generation can be developed and estimates prepared. The Generator is required to make the appropriate payment to the LDC that could include fees for: processing and reviewing the application; technical review and impact assessment; and production and commissioning testing as necessary.

Design and Build

Once agreement of the scope, cost and timing are reached, the Generator is required to sign a Connection Cost Recovery Agreement. After submitting the agreement and payment, detailed design and construction may begin.

Connect, Operate and Maintain

After all of the required work and approvals are completed, the LDC and the Generator executes the Distribution Connection Agreement. This Agreement provides an outline of the connection as well as the roles and responsibilities of each party.

The Ontario Electricity Transmission & Distribution System

In general, Ontario's electricity system consists of large centrally located generating stations linked by high voltage transmission lines over long distances at 500 kV, 230 kV and 115 kV. As the electricity is moved around the province the voltage is reduced as the electricity gets closer to the point of end use. Transformer stations reduce the voltage to 27.6 kV and 44 kV lines which transfer the electricity to distribution stations that reduce voltage again down to as low as 4 kV for routing electricity around city streets.

It is likely that the location for distributed generation will be at the lower voltage levels and the ability of the distribution network to accommodate the distributed generation will depend on the "strength" of the network at that point and the normal loads that it supplies. A proxy for the "strength" of the network is the fault current.

The fault current is how much current that will flow when there is a fault on a network. The fault level at the end of a long electricity circuit is much lower than closer in to the upstream supply. At a low fault level site, the impact of the distributed generation can be great enough to disturb other local consumers. For this reason, it is sometimes necessary to reinforce the network, or connect the distributed generation to a higher voltage or stronger part of the network further away.

Higher-voltage systems such as the 230 kV or 500 kV transmission systems have high fault levels. In general, the lower the voltage, the weaker the system. The weaker the system the less distributed generation can be connected. LDC distribution systems operate at 27.6 kV, 44 kV, 12.5 kV, 8 kV and 4 kV. As a rule of thumb the voltage levels might have capacity for the maximum following amounts of distributed generation.

- 4 kV possibly between 500 kW and 1 MW
- 8 kV possibly between 1 MW and 3 MW
- 12 kV possibly between 3 MW to 5 MW
- 27.6 kV possibly between 6 MW and 10 MW
- 44 kV possibly between 15 MW and 20 MW

The above examples assume the presence of three-phase lines with adequate conductor size and inherent load levels. LDCs also have many single-phase lines, which would not be suitable for anything but the smallest distributed generation without upgrade. The actual capacity of LDC lines to accept distributed generation can only be determined by an engineering review.

The necessary protection systems to protect an LDC's distribution system from events that can occur with distributed generation connected will also vary by distributed generation size and distribution line characteristics. Therefore, similar units connected at different locations could have different protection requirements based on varying load conditions, as well as on the LDC's Hydro One feeder and transformer characteristics.

Depending on the size, type, fuel, and location of generation facilities, the Ministry of the Environment (MOE) may require that the customer carry out an environmental assessment. Please contact the MOE for more information.

Maps of the LDC distribution system are available to assist a potential distributed generation developer to determine the approximate capacity of an LDC line in the area of interest for distributed generation location.

Distinctions between types of Distributed Generation

There are a number of distinct types of generators as far as the distribution system is concerned: (a) solid-state or static inverters, (b) induction machines, and (c) synchronous machines.

Many smaller renewable energy systems produce grid quality AC power through an inverter and are therefore typically grouped together.

Induction and synchronous generators, on the other hand, are generally grouped together as "rotating machines," but their different configurations do give them different start-up and operational characteristics. For example, induction machines cannot operate in stand-alone mode and generally require the presence of the grid for rotor excitation and normally have a lagging power factor. Synchronous machines on the other hand can operate without the grid and can have a zero or leading power factor.

As a practical matter, it is much more difficult for inverter-based generators to power an island and inverters can feed far less current into a fault. This means that inverter-based and rotating generators are treated differently in the codes and standards, with very small inverter-based devices requiring less – if any – additional protection equipment.

Safety, Power Quality & Protection

Technical details are the heart of the interconnection process with safety, power quality, and system reliability being the primary utility concerns and responsibilities. Reference materials that determine the requirements for these interconnections have been prepared by a number of bodies and agencies including the OEB, IEEE, CSA and ESA. This section therefore addresses safety and technical issues in the abstract and how they can streamline the interconnection process. The goal here is to provide background and rationale, while not going into great technical detail, so where appropriate, references are given for those seeking additional details.

The OEB's Distribution System Code Appendix F.2 outlines the technical requirements for connecting a generator to an electricity distributor's system. We have identified specific sections of Appendix F.2 as it relates to safety, power quality and protection.

The link to the OEB DSC is at http://www.oeb.gov.on.ca/documents/dscappf_100304.pdf

A list of references where potential distributed generation developers can go to obtain more information can be found in Appendix 2.

Safety

Like any source of electricity, distributed generation systems have the potential to be dangerous to both people and property, and require protection devices to protect the distribution system, utility workers, utility customers and the general public. Large industrial customers have been generating power on-site for many years, but interconnecting photovoltaic, wind turbines, co-generation, microturbines, and other relatively small generation systems to operate in parallel with the grid at residential and commercial locations is an increasing and recent trend. Utilities are primarily concerned about the potential for distributed generation sources – not under their control – supplying energy to one of their lines that is otherwise thought to be de-energized. This is known as islanding.

Islanding

One of the most important issues for distributed generation is to avoid a condition known as islanding. Islanding is a situation where a portion of the utility system that contains both loads and a distributed generation source becomes separated from the remainder of the utility system but remains energized.

The primary concern is a situation where a fault occurs on the distribution system and automatic isolation of a utility protective device occurs. Since automatic reclosing is normally used on distribution systems to clear temporary faults it is essential that the distributed generation disconnects from the distribution system before the first automatic reclose occurs. The concern is that if the distributed generation does not disconnect fast enough a) the distributed generation may feed the fault; and b) when the utility protective device(s) tries to reclose it will be closing back in on a line that is being supplied by distributed generation resulting in possible equipment damage, overloading or power quality issues.

Historically with central generation and transmission a utility could be sure that if an electrical circuit was isolated "upstream" and was not being fed from an alternative source that it was de-energized.

The utility may want to isolate the section of line for maintenance purposes and would normally do that through opening switches. While a utility can be sure that all of its own electricity sources are either shut down or isolated from the area that needs work they must now factor in distributed generation to ensure that it too is isolated and not supplying the line section.

Distributed generation creates a source of energy inputs to the utility system that the LDC does not control and if the distributed generation is potentially capable of islanding can backfeed electricity to the LDC's distribution system.

Grounding

Distributed generators must be grounded in accordance with any equipment manufacturers' requirements, the OESC and LDC requirements.

The distributed generation must not disrupt any coordination of ground fault protection or cause over-voltages that exceed the rating of equipment connected to the LDC distribution system.

Power Quality

Power quality is another significant technical concern for utilities and customer-generators. Utility power is consistently supplied at a standard voltage and frequency. In North America, residences receive single-phase alternating current (AC) power at 120/240 Volts at 60 cycles per second (60 Hz), and commercial buildings typically receive either 120/240 Volts single phase or three-phase power depending on the size of the building and the types of loads in the building.

Power quality is important because electronic devices and appliances have been designed to receive power at or near rated voltage and frequency standards and deviations may cause appliance malfunction or damage. Additional power quality considerations include harmonics, power factor, DC injection, and voltage flicker.

Each type of distributed generation device has its own output characteristics based on its technology therefore some will have more power quality issues than others.

Voltage Fluctuations and Voltage Regulation

Voltage fluctuations can result from a distributed generator connecting to or disconnecting from the utility system or because of its generation operating characteristics. The standards set certain limits, which must be achieved for events that occur within the distributed generation's operating cycle. Whether the utility actively or passively regulates their voltages to maintain an acceptable range, the presence of a distributed generation should have no detrimental impact on that regulation. The distributed generation must not try to regulate the voltage and frequency on the utility line but instead must follow the utility voltage and frequency and disconnect for any abnormality.

Ref: OEB DSC, F.2, Section 3

Voltage Unbalance

Utilities try to operate their three phase lines with voltages in the three phases balanced as closely as possible. The presence of a distributed generator should not contribute to additional voltage unbalance.

Ref: OEB DSC, F.2, Section 3.2

Frequency

As with voltage fluctuations frequency variations are a reliability and power quality issue. Distributed generation shall operate within the range of 59.3 to 60.5 Hz.

Ref: OEB DSC, F.2, Section 6.5

Harmonics

Harmonics generically refer to distortions in the voltage and current waveforms caused by the overlapping of the standard sinusoidal waveforms at 60 hertz (Hz) with waves at other frequencies that are other multiples of 60 Hz. Harmonics can be caused by the electronic equipment used in some distributed generators such as soft start units and inverters. Harmonics can cause equipment to fail or overheat and to degrade the service of other customers. Distributed generators must not impose harmonic distortions on the LDC's distribution system in excess of applicable standards.

Ref: OEB DSC, F.2, Section 10.2, CAN/CSA-C61000-3-6, IEEE 1547

Power Factor

Power factor is a measure of apparent power delivered when the voltage and current waveforms are out of synch. Power factor is the ratio of true electric power, as measured in kilowatts (kW), to the apparent power, as measured in kilovolt-amperes (kVA). The power factor can range from a worst case of zero when the current and voltage are completely out of synch to the optimal value of 100% when the current and voltage are entirely in synch. The terms "leading" and "lagging" refer to whether the current wave is ahead of or behind the voltage wave and are a contributor to the efficiency or inefficiency of the utility's electrical system. Distributed generators connected to the distribution system must operate in the range 0.9 lagging to 0.95 leading power factor.

Ref: OEB DSC, F.2, Section 4

DC Injection

DC Injection is a potential issue for inverters where an inverter passes unwanted DC current into the AC or output side. This can be prevented by the incorporation of equipment and design to prevent or limit the effect.

Ref: OEB DSC, F.2, Section 10.3

Voltage Flicker

Somewhat like voltage fluctuations, voltage flicker refers to short-lived spikes or dips in the line voltage that are noticeable to the eye and annoying. It can occur when the outputs from a distributed generator vary for example with some wind turbines if the wind is gusting or turbulent.

Ref: OEB DSC, F.2, Section 10.1

Protection of Distributed Generation Facility

The distributed generation developer will be responsible for protecting its distributed generation facility equipment in such a manner that distribution system faults - such as outages, short circuits, automatic reclosing of distribution circuits, or other disturbances - do not damage the distributed generation facility equipment. The equipment protection shall also prevent the distributed generation facility from adversely affecting the distribution system's capability of providing reliable service to other customers.

Ref: OEB DSC, F.2, Section 2

Monitoring

For distributed generation greater than 250 kW the LDC may require remote monitoring of the distributed generation connection status, real power output, reactive power output and voltage at the point of generator connection. For distributed generation greater than 10 MW the monitoring must be in real time.

Ref OEB DSC F.2, Section 9

Standardized or Certified Equipment

While it is a requirement that the design for a distributed generation installation be approved by a professional engineer and that all equipment be CSA approved and inspected by the ESA, if the interface equipment used is a standard package or certified for use (by UL or CSA or some other recognized approving body) as is the case with some

inverters this will expedite and simplify the interconnection process. This is especially applicable at the lower distributed generation output levels and will reduce the amount of technical information required.

The safety, power quality and reliability of interconnected distributed generation is ensured through design, standards, inspection, testing and the provision of switches, breakers and protective relaying incorporated into the distributed generation or as auxiliary equipment. A brief summary is as follows:

- An interrupting device capable of interrupting the maximum available fault current at the distributed generation location. Ref OEB DSC F.2, Section 1
- An interconnection device that is manual, lockable, has visible disconnection and is accessible to LDC staff. Ref OEB DSC F.2, Section 1
- A generator disconnect device. Ref OEB DSC F.2, Section 1
- Anti islanding protection. Ref OEB DSC F.2, Section 6.1.2
- A protective relay that will operate the load interruption device with the following features
    - Over-voltage trip. Ref OEB DSC F.2, Section 1
    - Under-voltage trip. Ref OEB DSC F.2, Section 1
    - Over/underfrequency trip. Ref OEB DSC F.2, Section 6.5
    - Over current protection. Ref OEB DSC F.2, Section 6.4
    - Ground fault protection. Ref OEB DSC F.2, Section 2

- Reclosing co-ordination to ensure that the distributed generation ceases to energize prior to the reclosure of an upstream LDC device. Ref OEB DSC F.2, Section 6
- Power Factor correction (if required). Ref OEB DSC F.2, Section 4
- Synchronizing equipment that will limit voltage fluctuation, frequency variation and phase angle when the distributed generation parallels with the distribution system. Ref OEB DSC F.2, Section 3.2
- Transfer Trip may be required depending on the loading of the distribution feeder and the output rating of the distributed generation relative to the feeder loading.
- Feeder Relay Directioning to prevent inadvertent tripping of a protective device for faults not associated with the protection zone of the device.

Your LDC will provide three phase fault levels at the preliminary review stage. A protection co-ordination study will be required which may involve alternate supplies from different sources. Protection design and ratings should account for these variables.

Preliminary Review, Connection Impact Assessment, Technical Review

Generation Connection Process

The process that your LDC will follow for connecting a distributed generator to the LDC's distribution system is detailed in the OEB's Distribution System Code, Appendix F. The starting point is for potential distributed generation developers to complete the form attached as Appendix 3 and return it to the LDC.

Preliminary Review

In the very early stages where a distributed generation developer may be considering site selection, the LDC will provide a preliminary review and high level advice and guidance based on limited parameters such as:

- Potential sites
- Output capacity of distributed generation
- Fuel type
- Generator generic description and design type

Technical Review

Once a location has been determined, the distributed generation developer must complete an application form requesting a full Technical Review. The Technical Review will establish the LDC's requirements for the distributed generation at the specific location expanding on and supplementing the information provided for the CIA. The Technical Review will require the distributed generation developer to provide the following details of the project certified by a licensed professional engineer, along with three copies:

Distributed Generation Description

- Site
- Type of distributed generation
- Output including seasonal and daily variations
- Number of units initially and ultimately, if future expansion is applicable
- Time line for construction and commissioning

Single Line Electrical Diagrams (with ratings or sizes detailing)

- Point of connection to the distribution system
- Generator
- Generator disconnect device
- Protective relaying and functions
- Transformer
- Protective isolating device
- Generator breaker
- Manual interconnection disconnection device
- Voltage levels
- Fusing

Nameplate data or manufacturers specs on:

- Protective relays
- Synchronizing device
- Fault calculations, protective relay settings, fuse specification
- Short circuit and voltage drop studies
- Station service and battery system
- Grounding studies
- Load interrupter switch or circuit breaker
- Dedicated interconnection transformer
- Isolating device for interconnection
- Protection system and operating procedures including schematics

LDC Power Connection Impact Assessment

Where required, the LDC will perform a Connection Impact Assessment (CIA). The CIA looks at:

- the impact of the distributed generation on distribution system short circuit levels, load flows, current loading, voltage levels and voltage flicker under a variety of distribution system and distributed generation conditions to ensure there are no adverse effects.
- the preliminary design of the protection systems being proposed for the distributed generation to assess their adequacy to protect the public, utility employees working on the distribution system and distribution system equipment under a variety of fault and operational circumstances.
- whether a more detailed assessment and cost estimate of the connection feasibility is required.

The LDC will advise the distributed generation developer of the CIA results. If the impact of the distributed generation is within acceptable limits the LDC will advise the distributed generation developer that the next step in the connection process can be commenced.

The distributed generation developer should not order any equipment or make commitments to the project until the CIA has been satisfactorily completed and an Offer to Connect has been made.

Hydro One Impact Assessment

Distributed generation greater than 1 MW and less than 10 MW connected to an LDC's 27.6 kV or 44 kV system may have an impact on Hydro One's Transmission Facilities and will require their separate impact assessment.

Distributed generation greater than 10 MW and connected to an LDC's 27.6 kV or 44 kV distribution system will require a Customer Impact Assessment from Hydro One and an assessment of the impact on Hydro One's Transmission facilities.

IESO Impact Assessment

Distributed generation greater than 10 MW will require a transmission system impact assessment by the Independent Electricity System Operator.

Costs

The generator will be required to pay the LDC for the LDC's Connection Impact Assessment.

The LDC will charge actual costs for labour and materials for any distribution system upgrades or line extensions required including but not limited to increased transformer capacity requirement, primary or secondary conductor, line extensions, switches and associated distribution hardware.

Where the distributed generation is used for load displacement of existing load a standby charge may be applicable as approved by the OEB.

Timing

LDC's will comply with the timelines laid down in the OEB Distribution System Code but the elapsed time will only start when any payments required by the LDC have been paid by the distributed generator and all technical information or any other data required for reviews, assessments or studies have been received to the satisfaction of the LDC.

Metering

Metering requirements will be determined by the LDC and will depend on the type and size of generation and the load, if any, where the distributed generator is also a customer, at the distributed generation location. Where the distributed generator is exporting power a bi-directional meter capable of measuring electricity received from and sent to the distribution system is required. All metering cabinets, instrument transformers, meters and if necessary a telephone line will be supplied by the Generator and owned by the LDC.

The metering shall be installed at the Demarcation Point of connection of the Distributed Generation Facility to the Distribution System. The point of demarcation for a Distributed Generation Facility is the primary live line clamp or lines switch that is installed on or at the LDC's Distribution line. If this is not practical, the LDC shall apply loss factors to the generation output in accordance with the loss factors applied for Retail settlements and billing. Appendix 6 shows the metering location and configuration options under the Standard Offer Program.

Any Generator has the right to be a participant in the IESO-controlled wholesale market for settlements. Participants in the wholesale market must meet the requirements as specified in Chapter 6 Wholesale Metering of the Market Rules. In general, the metering requirements for wholesale market participants are more stringent that those required for LDC retail revenue purposes. In both wholesale and retail markets, all meters and instrument transformers must be Measurement Canada approved and connected in accordance with Measurement Canada and OEB policies and procedures. However, in the wholesale market, the IESO requires that market participants engage the services of a Meter Service Provider (MSP) to install and maintain the metering system. In addition, the IESO specifies the number and types of meters that must be used for revenue purposes and requires the submission of an emergency instrument transformer restoration plan.

In 2005, the IESO revised the Market Rules to include relaxed polices for embedded generation facilities under 2 MVA or injecting less than 17 GWh per annum. These relaxed rules allow for the installation of a single meter only and no requirement to submit an emergency instrument transformer restoration plan.

Generation Connection Matrices

The range of potential distributed generation applications, sizes and fuels results in different circumstances under which they operate both technically and commercially. For example, a very small distributed generator fuelled by a renewable resource connected to a residential home may output to the distribution system but if the monthly energy output is less than total monthly customer energy consumption the owner may opt for net metering.

A similar distributed generator with energy output greater than the monthly energy consumption may opt for Standard Offer Contracts (SOC). A larger distributed generator fuelled by a non renewable resource may be used for load displacement and not export to the distribution system. Another larger distributed generator fuelled by a non renewable resource may export to the distribution system and while not eligible for SOC could receive the HOEP for the energy.

We have attempted to summarize the permutations and combinations in the matrices which are attached as Appendix 7. We believe the data to be accurate but we caution that these matrices are the LDC's interpretation of rules and regulations that are in existence. Distributed generators should confirm applicability and eligibility in their own circumstances.

Approvals

Before any distributed generation can be connected to the LDC's distribution system it must have received as a minimum the following approvals plus any additional approvals identified in the Preliminary or Technical Reviews, or the Impact Assessments by the LDC and Hydro One:

- LDC Offer to Connect
- CSA or UL or recognized certification of all equipment installed
- ESA approval

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Appendices

Appendix 1: (a) Definitions

Appendix 1: (b) Who's Who in Ontario Electricity

Appendix 2: Resource Links

Appendix 3: Connection Review – Application Form

Appendix 4: Distributed Generation – Application Form – Under 10 kW

Appendix 5: Application Form – Connection Impact Assessment under 10 MW

Appendix 6: Standard Offer Program Metering Options

Appendix 7: (a) Interconnection Matrices (Summary Load Displacement)

Appendix 7: (b) Interconnection Matrices (Summary Standard Offer Contracts)

Appendices

Appendix 1(a): Definitions

APPENDIX 1 (a)

Definitions

Applicant — The legally responsible person applying to an LDC to interconnect a distributed generation facility to the LDC's distribution system.

Application Review — A review by the LDC of the completed standard interconnection application form for interconnection, to determine if an engineering review or distribution system study is needed.

Back-up Power — Electric energy or capacity supplied by an LDC to replace energy ordinarily generated by distributed generation facility equipment during an unscheduled outage of the distribution system.

Certified Equipment — A generating, control or protective system that has been certified by a nationally recognized testing laboratory (NRTL) as meeting acceptable safety and reliability standards.

Commissioning Test — The initial process of documenting and verifying the performance of a distributed generation facility so that it operates in conformity with the design specifications.

Customer — Any person who is receiving electric service from an LDC's distribution system.

Designated Point of Contact — Each LDC shall designate one point of contact for all customer inquiries related to distributed generation facilities and from which interested parties can obtain a copy of interconnection guidelines - which include the appropriate application forms and interconnection agreements.

Distributed Generation (DG) Facility — A facility for the generation of electricity with a capacity of no more than 15 megawatts that is located near the point where the electricity will be used or is in a location that will support the functioning of the electric power distribution grid.

Distributed Generation Developer — same as Applicant.

Distribution Feeder/Line — An electric line from an LDC substation or other supply point to customers that is operated at 50 kV or less, or as determined by the LDC.

Distribution Substation — A facility that reduces the voltage of the electricity supply from sub transmission voltages less than 50 kV to even lower distribution voltages less than 50 kV.

Distribution System — All electrical wires, equipment, and other facilities owned or provided by an LDC that are normally operated at 50 kV or less.

Distribution System Code — A code issued by the Ontario Energy Board that prescribes the requirements for local distribution companies and customers who are served by the distribution system. Specifically, Appendices F of the code outlines the procedures to be followed for processing and connecting distributed generation facilities and F.2 is an overview of the technical requirements. http://www.oeb.gov.on.ca/documents/dscappf_100304.pdf

Distribution System Study — A study to determine if a distribution system upgrade is needed to accommodate the proposed distributed generation facility and to determine the cost of any such upgrade.

Engineering Review — A study that may be undertaken by an LDC, in response to its receipt of a completed standard application form for interconnection, to determine the suitability of the installation.

ESA - Electrical Safety Authority

Fault — An equipment failure, conductor failure, short circuit, or other condition resulting from abnormally high amounts of current from the power source.

HOEP — The Hourly Ontario Energy Price is an average of the market price set at each five-minute interval within that hour.

IEEE — Institute of Electrical and Electronics Engineers.

Impact Assessments — if warranted by the size, type, location or other factors impact assessments may be required by an LDC and in some cases Hydro One where the distribution lines connect to Hydro One transformer stations.

Independent Electricity System Operator (IESO) — An entity supervising the collective transmission facilities of a power region; the IESO is charged with nondiscriminatory coordination of market transactions, system-wide transmission operation, and network reliability.

Interconnection — The physical connection of a distributed generation facility to the distribution system so that parallel operation can occur.

Interconnection Agreement — a written set of operating procedures to specify how the distributed generator facility will interact with an LDC's distribution system and the responsibilities and accountabilities of the parties

Interconnection Disconnect Switch — A mechanical device used to disconnect a distributed generation facility from a distribution system. Also known as an isolation device.

Inverter — A machine, device or system that converts direct current power to alternating current power.

Islanding — A condition on the distribution system in which a distributed generation facility delivers power to customers using a portion of the distribution system that is electrically isolated from the remainder of the distribution system.

kV - kilovolt (1000 volts)

kW – kilowatt (1000 watts)

Local Distribution Company — A local distribution company or LDC manages and operates the electricity distribution system and currently bills for electricity services at the retail level in Ontario.

MW – megawatt (1000 kW)

Material Modification – Any modification that changes the maximum electrical output of a distributed generation facility or changes the interconnection equipment, including:
a) Changing from certified to non-certified devices.
b) Replacing a component with a component of different functionality or Underwriters Laboratories listing.
c) Changes to the Interconnection Point

Nationally Recognized Testing Laboratory — Any testing laboratory recognized by the ESA, or CSA as having an approved equipment accreditation program.

Net metering — An arrangement where distributed generation facilities can offset their associated load consumption and are compensated for any extra energy delivered to the electricity system. In Ontario, legislation permits distributed generation facilities using renewable resources with a capacity of 500 kW or less to be eligible for net metering.

OEB — Ontario Energy Board

Parallel Operation — The operation, for a finite time, of a distributed generation facility while the facility is connected to the energized distribution system.

Paralleling Equipment — The generating and protective equipment system that interfaces and synchronizes a distributed generation facility with the distribution system.

Point of Common Coupling — The point where the electrical conductors of the distribution system are connected to the customer's conductors and where any transfer of electric power between the customer and the distribution system takes place.

Point of Interconnection — The point where the distributed generation facility is electrically connected to the customer's electrical system.

Preliminary Review — A review at the feasibility stage to determine the suitability of a distributed generation site and the LDC's facilities available for connection

Protective Function — A function of a distributed generation facility, carried out using hardware and software, designed to prevent unsafe operating conditions from occurring before, during, and after the interconnection to a distribution system.

Supervisory Control and Data Acquisition (SCADA) — A system of remote control and telemetry used to monitor and control the electric system.

Switchgear — Components for switching, protecting, monitoring and controlling electric power systems.

Synchronize — The process of connecting two previously separated alternating current apparatuses after matching frequency, voltage, phase angles, etc. (e.g., paralleling a generator to the electric system).

Technical Review — a more comprehensive evaluation of the distributed generation proposal than the preliminary review to establish that the proposal and the equipment meet the technical guidelines for safety, power quality and reliability.

Telemetry — The transmission of distributed generation operating data using telecommunications techniques.

Transfer Switch — A switch designed so that it will disconnect the load from one power source and reconnect it to another source.

Transformer Station — A facility that reduces the voltage of the electricity supply from transmission voltages greater than 50 kV to distribution voltages less than 50 kV.

UL — Underwriters Laboratories.

Unit — same as distributed generation facility.

Appendix 1(b): Who's Who in Ontario Electricity

APPENDIX 1 (b)

Who's Who in Ontario Electricity

Sometimes it's difficult to figure out who's who and what they do in Ontario's electricity system. Here's a brief overview:

The Ontario Government and the Ontario Ministry of Energy	• Establish public policy; pass legislation and regulations relating to electricity. • Create other agencies IESO, OPA, OEB, etc., and establish raison d'etre for Hydro One, OPG and LDC's • Significant legislation: Electricity Act, 1998 and Regulations, Ontario Energy Board Act 1998, Electricity Restructuring Act 2004
Independent Electricity System Operator (IESO)	• The Independent Electricity System Operator (IESO) operates and manages Ontario's electricity system at the generation and transmission level. It does not design, build or own the system; it coordinates how the system interacts and performs and it monitors the performance, reliability and future adequacy of the system to provide electricity to Ontarians. The IESO creates electricity market rules, matches generation with load 24/7, establishes the Hourly Ontario Energy Price (HOEP) and settles wholesale electricity payments.
Ontario Power Authority (OPA)	• Although, the IESO operates the electricity system the Ontario Power Authority (OPA) forecasts, plans and is responsible for bringing new resources onto the system in the medium and long term so that the IESO has adequate resources to manage. It can also be involved in demand management, conservation and renewable energy activities as directed by its mandate and government.
Ontario Energy Board (OEB)	• The Ontario Energy Board (OEB) is the province's electricity regulator and is responsible for protecting the interests of consumers with respect to prices, reliability, adequacy and quality of electricity service and to promote economic efficiency of generation, transmission and distribution. The OEB approves the rates charged by transmitters (greater than 50 kV) and distributors (less than 50 kV) and creates codes and regulations for certain aspects of how transmitters and distributors conduct their business. • The OEB issues licenses for generators, transmitters, distributors, and retailers. • The OEB does not set rates for generation; that is a competitive process either through the Hourly Ontario Energy Price or third party contracts, but it has set prices for small consumers.

Ontario Power Generation (OPG)	• Ontario Power Generation (OPG) owns and operates most of Ontario's generating capacity. It is owned by the Province of Ontario.
Hydro One Networks (HONI)	• Hydro One is the province's largest transmission company and owns the provincial transmission grid. Hydro One also distributes electricity outside of the major urban centres. It supplies LDC's from TSs at 27.6 kV and 44 kV or DSs at lower voltages. Some distributed generation connected to Hydro One TSs or DSs will require co-ordination with Hydro One. Hydro One is owned by the Province of Ontario.
Electrical Safety Authority (ESA)	• The Electrical Safety Authority (ESA) is responsible for ensuring that electrical equipment is installed safely and meets required standards in accordance with the Ontario Electrical Safety Code.
Measurement Canada (MC)	• Measurement Canada (MC) is a federal agency of Industry Canada with the mandate of regulating meters and metering throughout the country. MC administers the Electricity and Gas Inspection Act. R.S. 1985, C.E-4.
Ontario Ministry of Environment (MOE)	• The Ontario Ministry of Environment (MOE) sets environmental standards for electricity projects in Ontario and ensures that generators, distributors and transmitters follow rules and standards when constructing and operating facilities.
Your LDC	• We are local distribution companies. We are regulated by the Ontario Energy Board and operate under all of the legislation, codes, rules and regulations set by the agencies, authorities and companies listed above. An LDC's core business is the distribution of electricity. Since we do not generate electricity and earn our revenue through transporting electricity across our wires we are impartial to the source of generation. LDC's are owned by their municipalities.

Appendix 2: Resource Links for Distributed Generators

APPENDIX 2

Resource Links for Distributed Generators

The Ontario Energy Board
http://www.oeb.gov.on.ca/index.html

Distribution System Code & Retail Settlement Code
http://www.oeb.gov.on.ca/html/en/industryrelations/rulesguidesandforms_reg latory.htm#electricity

Licensing Information for Generators
http://www.oeb.gov.on.ca/html/en/licences/applyforalicence.htm#electricity

The Ontario Power Authority
http://www.powerauthority.on.ca/

Requests for Proposals for Electricity Supply
http://www.ontarioelectricityrfp.ca/

Standard Offer Program for Renewable Energy
http://www.powerauthority.on.ca/Page.asp?PageID=924&SiteNodeID=132

Conservation Bureau & Conservation Requests for Proposals
http://www.conservationbureau.on.ca/

The Ontario Ministry of Energy
http://www.energy.gov.on.ca/

Information on Ontario's electricity markets, government programs, and the Net Metering Option.

Independent Electricity System Operator
http://www.ieso.ca/

Ontario's wholesale market operator – information about selling distributed energy generation to the grid at the Hourly Ontario Electricity Price.

Electrical Safety Authority
http://www.esa-safe.com/

Safe Generator Installation – Vital information for prospective distributed generators
http://www.esa-safe.com/GeneralPublic/sgi_001.php?s=22

Ontario Ministry of the Environment
http://www.ene.gov.on.ca/index.htm

Guide to Environmental Assessment Requirements for Electricity Projects
http://www.ene.gov.on.ca/envision/gp/4021e.pdf

Industry Associations and Other Resources

Ontario Sustainable Energy Association
http://www.ontario-sea.org

Power Connect – information for distributed generators
http://www.powerconnect.ca

Canadian Solar Industries Association
http://www.cansia.ca

Canadian Wind Energy Association
http://www.canwea.ca

Ontario Water Power Association
http://www.owa.ca

Association of Power Producers of Ontario
http://www.appro.org

Canadian Standards Association
http://www.csa.ca

Appendix 3

Connection Review Application Form

Appendix 3
Connection Review Application Form

Application for Preliminary Review of a request to connect Distributed Generation to Greater Sudbury Hydro's Electrical Distribution System

1. Applicant's Contact Information (the party that will be contractually obligated for this generating facility)

Name ______________________________

Company (if any) ______________________________

Mailing Address ______________________________

Phone Number (Main) ______________ Cell ______________

Fax Number ______________ Email ______________

2. Location of Interest for Distribution Generation

Street Address or Closest Location Description ______________________________

3. Generator Information

Generation Type: (Check One) ☐ Synchronous ☐ Induction ☐ Inverter ☐ Other:____________

Number of Phases: (Check One) ☐ Single Phase ☐ Three Phase

Primary Energy Source: Renewable:________________ Non Renewable_____________ Type:____________________

Do you intend to participate in any OPA programs? ☐ Yes ☐ No
Details: ______________________________

Output capacity: _____________ kW

Load displacement? ☐ Yes ☐ No Existing or New Load? _______

4. Other Information that may be relevant or assist in preliminary review. Use additional sheet if more information is required.

____

____

____

____

____

*** Return this form to the LDC**

Appendix 4

Generator Connection Assessment Review Form

10 kW or Less

Appendix 4
Distributed Generation Application Form to connect 10 kW or less to Greater Sudbury Hydro's Electrical Distribution System

1. Applicant's Contact Information (the party that will be contractually obligated for this generating facility)

Name ______________________________

Company (if any) ______________________________

Mailing Address ______________________________

Phone Number (Main) ______________ Cell ______________

Fax Number ______________ Email ______________

2. Location of the Generation System ______________________________

Street Address ______________________________

Lot ______________________________

Concession ______________________________

County ______________________________

Orangeville Hydro Account Number (if any) ______________________________

3. Applicant's Ownership Interest in the Generation System

☐ Owner ☐ Co-owner ☐ Lease ☐ Other

4. Primary Intent of the Generation System

☐ On-site Use of Power ☐ Net Metering ☐ Ontario Power Authority Standard Offer Program ☐ Other

5. Electricity Use, production and Purchases

(A) Anticipated annual electricity consumption of the facility or site ______________ kWh/yr

(B) Anticipated annual electricity production of the generation system. ______________ kWh/yr

(C) Anticipated annual electricity exports (i.e. (B) minus (A) ______________ kWh/yr

Value will be negative if there are no net sales to the distribution system.

6. Installing Contractor Information

Contractor Name ______________________________

Mailing Address ______________________________

Name of Contractor Contact ______________________________

Phone Number (Main) ______________ Cell ______________

Fax Number ______________ Email ______________

7. Requested In-Service Date ______________________________

8. Provide One-Line Schematic Diagram of the System:

☐ Schematic is attached

Number of Pages ____________

Appendix 4
Distributed Generation Application Form to connect 10 kW or less to Greater Sudbury Hydro's Electrical Distribution System

9. Generator Information (complete for each generator)

Manufacturer ______________________ Model No. ______________________

Version No. ______________________ Serial No. ______________________

Generation Type:

☐ Single Phase ☐ Three Phase ☐ Synchronous ☐ Induction ☐ Inverter ☐ Other:__________

Primary Energy Source:

Renewable:________________ Type:________________

Eligible for standard offer contract? ☐ Yes ☐ No

Non-Renewable ________________ Type ________________

NOTE: If there is more than one generator and/or inverter, attach an additional sheet describing each.

10. Site Plan Showing Location of the External Disconnect Switch (attach additional sheets as needed)

11. Design Requirements

a) Has the proposed distribution generation paralleling equipment been certified?

☐ Yes ☐ No

b) If not certified, does the proposed distributed generator meet the operating limits defined in Greater Sudbury Hydro's DG Technical Specifications?

☐ Yes ☐ No

For items 11(a) and 11(b), if your answer is yes, please furnish details (e.g., copies of manufacturer's specifications). If your answer is no, it is recommended you contact the equipment manufacturer and determine the status.

Appendix 4
Distributed Generation Application Form to connect 10 kW or less to Greater Sudbury Hydro's Electrical Distribution System

Status of certification and compliance with operating limits where answer to 11 (a) and/or (b) is no.

12. Other Comments, Specifications and Exceptions (attach additional sheets if needed)

13. Applicant and Installer Signature

To the best of my knowledge, all the information provided in this Application Form is complete and correct.

Applicant Signature Date

Installer Date

*** Return this form to the LDC.**

Appendix 5

Generator Connection Assessment Review Form

10 kW to 10 MW

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

Section 1: General Connection Information

Note: ALL of the information in "*Section 1: General Connection Information*" must be completed in full. Failure to provide complete information may delay the processing of the data.

All technical documents must be signed and sealed by a licensed Ontario Professional Engineer.

Date: (dd/mm/yyyy) ______________ Contact Person Name: ______________________

Signature: ______________________

1. Project Name: ______________________________________

2. Project Dates: (dd/mm/yyyy)

Proposed Start of Construction: ______________________

Proposed In-Service: ______________________

3. Project Size:

Number of Units ______________________

Nameplate Rating of Each Unit (kW) ______________________

Number of Phases (1 or 3) ______________________

Proposed Total Capacity (kW) ______________________

4. Applicant Contact Information: (the party that will be contractually obligated for this generating facility)

Company Name ______________________________________

Street Address ______________________________________

Mailing Address (if different) ______________________________________

Representative Name ______________________________________

Representative Title ______________________________________

Phone Number (Main) ______________________ Cell ______________________

Fax Number ______________________ Email ______________________

5. Facility Contact Information: (where the generating facility will be installed)

Company Name ______________________________________

Street Address ______________________________________

Mailing Address (if different) ______________________________________

Representative Name ______________________________________

Representative Title ______________________________________

Phone Number (Main) ______________________ Cell ______________________

Fax Number ______________________ Email ______________________

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

6. Consultant:

Company ____________________

Street Address ____________________

Mailing Address (if different) ____________________

Representative Name ____________________

Representative Title ____________________

Phone Number (Main) ____________________ Cell ____________________

Fax Number ____________________ Email ____________________

7. Intent of Generation:

☐ Sale of Power ☐ Load Displacement

8. Project Type:

☐ Wind Turbine ☐ Hydraulic Turbine ☐ Steam Turbine ☐ Solar

☐ Diesel Engine ☐ Gas Turbine ☐ Fuel Cell ☐ Biomass

☐ Co-generation/CHP (Combined Heat & Power)

☐ Other (Please Specify) ____________________

9. Generator Facility Type:

Generation Facility Voltage (Volts): ____________________ ☐ AC ☐ DC

Type: Rotating generators: ☐ Synchronous ☐ Induction ☐ N/A

☐ Other (Please Specify) ____________________

Non-Rotating DC generation: ☐ Photovoltaic Arrays ☐ Fuel Cells ☐ Batteries

☐ Other (Please Specify) ____________________

10. Location and Site Plan:

Provide Site Plan with approximate line routings for connection to nearby Hydro One's facilities. The Site Plan should include roads, concession and lot numbers and nearby power lines.

Drawing / Sketch No. ____________________ Rev. __________

11. Location and Site Plan:

Proposed connection voltage to the LDC's distribution system (if known): ______________ kV

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

Section 2: Impact Assessment Information

Note:

(a) It is important that the Generator provides ALL the information requested below, if applicable. All information is required to complete the first step of the process to move to the new Queue structure. Indicate "Not Applicable" where appropriate.

(b) In certain circumstances the LDC may require additional information to conduct the Impact Assessment. Should this be the case the Generator will be duly advised.

Date: (dd/mm/yyyy) ______________ Contact Person Name: ______________________________

Signature: ______________________________

1. Single Line Diagram (SLD):

Provide a SLD of the Generating Facility including the Interface Point/Point of Common Coupling ("PCC") to Hydro One's distribution system.

Drawing / Sketch No. ______________________________ Rev. __________

☐ Attached
☐ Mailed Separately

2. Generator Facility Fault Contributions for Faults at the Interface Point/PCC

All values to be at the nominal connection voltage to Hydro One's distribution system, i.e. the high voltage side of the Facility interface (step-up) transformer.

Maximum Symmetrical (all generators online)

- Three phase fault (kA) ______________________
- Phase-to-phase fault (kA) ______________________
- Single Phase to ground fault (kA) ______________________

3. Generator Facility Characteristics:

a. Number of generating unit(s): ______________________________

b. Manufacturer / Type or Model No.: ______________________________

c. Rated capacity of each unit: Gross: ________ kW ________ kVA

Net: ________ kW ________ kVA

If unit outputs are different, please fill in additional sheets to provide the information.

d. Type of generating unit: ☐ Synchronous ☐ Induction ☐ Static Power Converters (SPC) ☐ Other (Please Specify) ______________________________

e. Rated frequency (Hz): ______________________

f. Number of phases: ☐ One ☐ Three

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

g. For Synchronous Units:
   i) Generation facility voltage (kV): ______________________
   ii) Rated current (A): ______________________
   iii) Rated power factor of generating unit (s): ____________ p.u.
   iv) Power factor operating range. (Specify lag or lead): from ______ p.u. to ______ p.u.
   v) Unsaturated reactances on: ______ kVA base, ______ kV base
      Direct axis synchronous reactance, Xd ______ p.u.
      Direct axis transient reactance, Xd' ______ p.u.
      Direct axis subtransient reactance, Xd" ______ p.u.
   vi) Time Constants:
      Direct axis open circuit transient, T' ______ seconds
      Direct axis open circuit subtransient, T" ______ seconds
   vii) Provide a plot of generator capability curve: (MW output vs MVAR)
      Document Number: ______________ Rev. ______
      - ☐ Attached
      - ☐ Separate Mailing
   viii) Generator Inertia constant (on machine base), if available
      H = ______________ seconds (generator only)
      H = ______________ seconds (generator & turbine)

h. For Induction Units:
   i) Generation facility voltage (kV): ______________________
   ii) Rated current (A): ______________________
   iii) Rated power factor of generating unit (s): ____________ p.u.
   iv) Power factor operating range. (Specify lag or lead): from ______ p.u. to ______ p.u.
   v) Unsaturated reactances on: ______ kVA base, ______ kV base
      Direct axis synchronous reactance, Xd ______ p.u.
      Direct axis transient reactance, Xd' ______ p.u.
      Direct axis subtransient reactance, Xd" ______ p.u.
   vi) Time Constants:
      Direct axis open circuit transient, T' ______ seconds
      Direct axis open circuit subtransient, T" ______ seconds
   vii) Actual power factor at PCC (after p.f. correction):
      Full output: ______________ p.u.
      No output: ______________ p.u.
   viii) Generator reactive power requirements:
      Full output: ______________ kVAR
      No output: ______________ kVAR
   ix) Total power factor correction installed: ______ kVAR
      Number of regulating steps: ______
      Power factor correction switched per step: ______ kVAR

Power factor correction capacitors are automatically switched off when generator breaker open:

☐ Yes ☐ No

x) Maximum starting inrush current (multiple of full load current): ________ p.u.

xi) Generator Inertia constant (on machine base), if available

H = ________________ seconds (generator only)

H = ________________ seconds (generator & turbine)

i. For SPC / Inverter type units:

i. Manufacturer / Type or Model No.: ____________ / ____________

ii. Inverter AC output voltage: ____________ Volts

iii. Inverter AC output current: ____________ Amps

iv. Number of phases: ☐ One ☐ Three

v. Inverter output frequency: ____________ Hz

vi. Type of inverter: ☐ Self-Commutated ☐ Line Commutated

☐ Other (Please Specify):

vii. Inverter rated power factor: ____________ %

viii. Inverter power factor adjustment range, if applicable (specify lag or lead:

from ________ p.u. to ________ p.u.

ix. Are power factor correction capacitors used? ☐ Yes ☐ No

x. If yes, total power factor correction installed: ____________ kVAR

xi. Number of capacitor steps:

xii. Are power factor correction capacitors automatically switched off when inverter breaker opens?

☐ Yes ☐ No

xiii. Is the inverter paralleling equipment and / or design pre-certified? ☐ Yes ☐ No

xiv. If yes, to which standard(s), e.g. CSA C22.2 No. 107.1-01, UL 1741: ____________

xv. Maximum inrush current upon inverter start-up (multiple of full-load current): ________ p.u.

xvi. Modelling parameters recommended by SPC/Inverter/Converter Manufacturer.

Describe how your equipment should be modeled for load flow, voltage study and short circuit analysis.

____

____

____

____

4. Interface (Step-Up) Transformer Characteristics:

a. Transformer rating: ____________ kVA

b. Manufacturer (if known): ____________

c. Number of phases: ☐ Yes ☐ No

d. Nominal voltage of high voltage winding: ____________ kV

e. Nominal voltage of low voltage winding: ____________ kV

f. High voltage winding connection: ______________

g. Grounding method of star connected high voltage winding neutral; if applicable

☐ Solid ☐ Ungrounded ☐ Impedance: R ________ X ________ ohms

h. Low voltage winding connection: ______________

i. Grounding method of star connected low voltage winding neutral; if applicable

☐ Solid ☐ Ungrounded ☐ Impedance: R ________ X ________ ohms

j. Impedances on: ________ kVA base ________ kV base

R: ________ p.u. X: ________ p.u.

Note:

(a) The term "High Voltage", used above, refers to the connection voltage to Hydro One's distribution system, and "Low Voltage", used above, refers to the generation or any other intermediate voltage.

(b) Studies will be conducted at nominal voltages (i.e. tap changer at neutral position)

5. Intermediate Transformer Characteristics (if applicable):

a. Transformer rating: ________ kVA

b. Manufacturer (if known): ______________

c. Number of phases: ☐ Yes ☐ No

d. Nominal voltage of high voltage winding: ______________ KV

e. Nominal voltage of low voltage winding: ______________ kV

f. High voltage winding connection: ______________

g. Grounding method of star connected high voltage winding neutral; if applicable

☐ Solid ☐ Ungrounded ☐ Impedance: R ________ X ________ ohms

h. Low voltage winding connection: ______________

i. Grounding method of star connected low voltage winding neutral; if applicable

☐ Solid ☐ Ungrounded ☐ Impedance: R ________ X ________ ohms

j. Impedances on: ________ kVA base ________ kV base

R: ________ p.u. X: ________ p.u.

Note:

(a) The term "High Voltage", used above, refers to the intermediate voltage that is input to the interface step-up transformer, and "Low Voltage", used above, refers to the generation voltage.

6. Generating Facility Load Information

a. Maximum continuous load:

- Total: ________ kVA ________ kW
- Generator Auxiliary Load Only: ________ kVA ________ kW

b. Maximum start up load: ________ kVA ________ kW

c. Largest motor size that would be started: ________ HP ________ kW

d. Maximum inrush current of the motor (multiple of full-load current): ________ p.u.

e. For load displacement generators:

- Max. present load at Generator's facility: ________ kVA ________ kW

- Max. future load at Generator's facility (excluding Auxiliary Loads):

  ________ kVA ________ kW

- Indicate the means by which injection of power into Hydro One's system will be prevented.

____

7. Operation Information:

- Mode of Operation: ____________________
- Annual Capacity Factor: ____________________ %
- Prospective number of annual scheduled starts / stops, and timing thereof: ____________________

8. Expected Monthly Generation, Consumption and Output From the Facility:

Expected:	**Total Generation (a)**		**Total Internal Consumption (b)**		**Total Output (To the LDC's Distribution System) (a-b)***	
	kWh	**Peak kW**	**kWh**	**Peak kW**	**kWh**	**Peak kW**
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

* This value would be negative when the generators are not in operation or when the internal consumption exceeds generation.

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

9. Protection Design, Philosophy and Logic

Either at the CIA stage or the design review stage it will be necessary to determine the protection philosophy, co-ordination and trip logic. If it is available now please provide it. If it is not, it can be deferred and submitted if the project goes ahead. Please do not feel inhibited by the space provided here. Use as much space and as many additional sheets as are required to describe how the Generator protection will deal with faults, outages, disturbances or other events on the distribution system and for the generator itself.

Protective Device	Range of Available Settings	Trip Time	Trip Set Point	Describe operation for disconnecting the generator or inverter in the event of a distribution system outage	Describe operation for disconnecting the generator or inverter in the event of a distribution system short circuit (three phase and single phase to ground)
27 Phase Undervoltage Instantaneous					
27 Phase Undervoltage					
50 Phase Instantaneous Overcurrent					
50Gground Instantaneous Overcurrent					
51 Phase Time Overcurrent					
51G Ground Time Overcurrent					
59 Phase Overvoltage Instantaneous					
59 Phase Overvoltage					
81 Under Frequency					
81 Over Frequency					
87 Transformer Differential					
Other					

Appendix 5
Distributed Generation Connection Impact Assessment Review to connect 10kW – 10MW to Greater Sudbury Hydro's Electrical Distribution System

10. Other Comments, Specifications and Exceptions (attach additional sheets if needed)

11. Applicant and Project Design / Engineering Signature

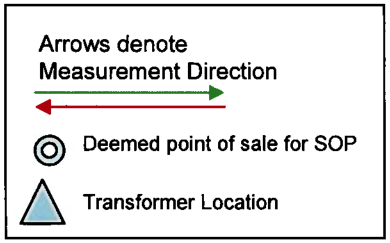
To the best of my knowledge, all the information provided in this Application Form is complete and correct.

Applicant Signature Date

Project Design / Engineering Date

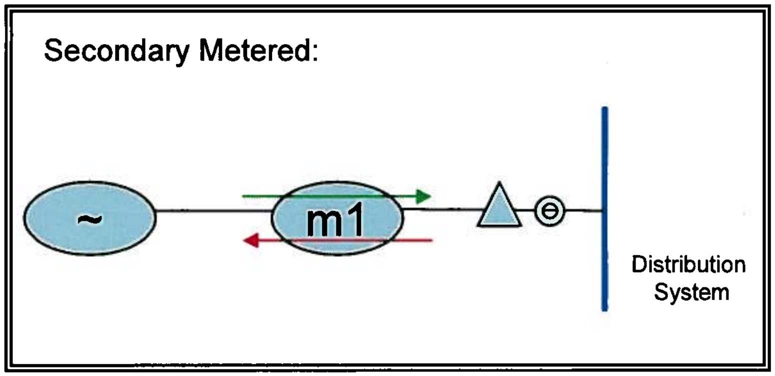
* R**eturn this form to the LDC.**

Appendix 6 : Standard Offer Program Meter Configuration Options



Standard Offer Program
Meter Configuration Options

1. Pure Generator Customer



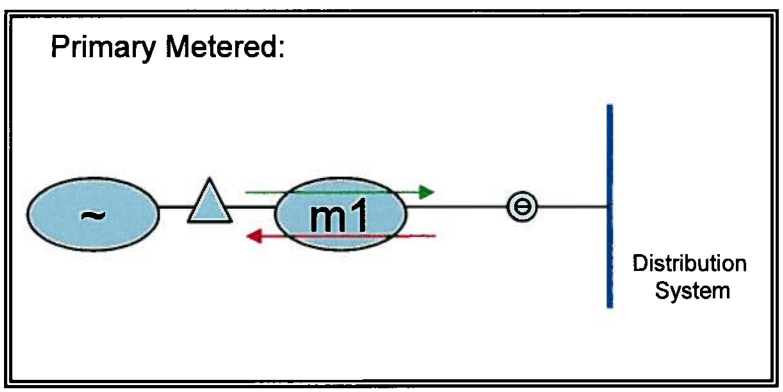
Settlements:

Energy delivered reduced by Site Specific Losses. Paid @ SOP Rate

(Kwh / (1+SSL)) x SOP Rate

Energy consumed increased by LDC approved loss factor. Billed at HOEP.

(Kwh x (1+LDCL)) x HOEP



Settlements:

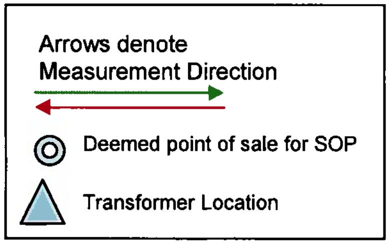
Energy delivered- No adjustment required. Paid @ SOP Rate.

Kwh x SOP Rate

Energy consumed increased by LDC approved loss factor less 1% for primary metering discount. Billed @ HOEP.

(Kwh x (1+LDCL)) x .99 x HOEP

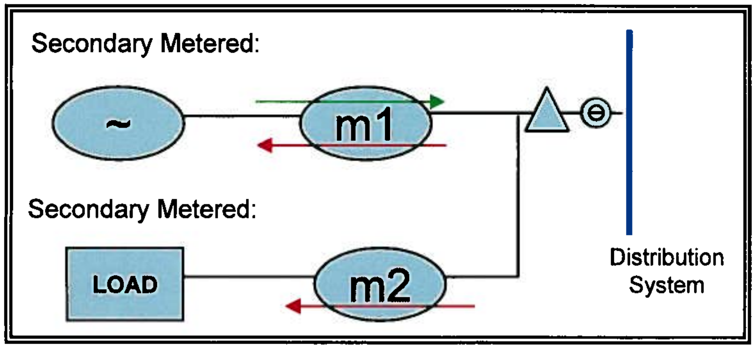
Note: Load Customer (Station Service) is also required to pay for additional energy related charges: WMSC, DRC, Network Service, Line & Transformation, and Distribution Variable Charges.



Note: Load Customer is also required to pay for additional energy related charges: WMSC, DRC, Network Service, Line & Transformation, and Distribution Variable Charges.

Standard Offer Program Meter Configuration Options

2. Generator and Load Customer – 2 Meters



Settlements - Generator:

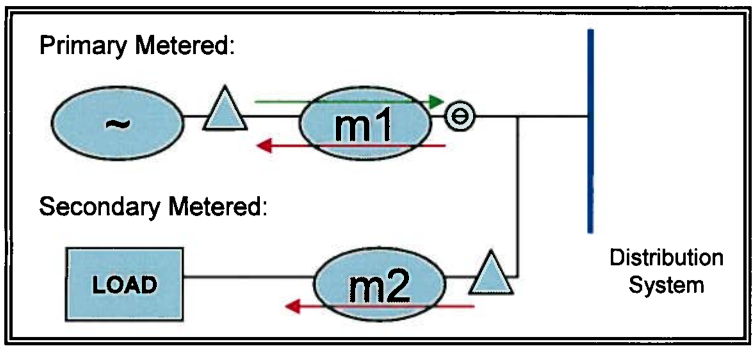
Energy delivered reduced by Site Specific Losses (Kwh / (1+SSL)) x SOP Rate

Energy consumed increased by LDC approved loss factor (Kwh x (1+LDCL)) x HOEP

Settlements - Load:

Energy consumed increased by LDC approved loss factor.

(Kwh x (1+LDCL)) x HOEP or (Kwh x (1+LDCL)) x RPP



Settlements - Generator:

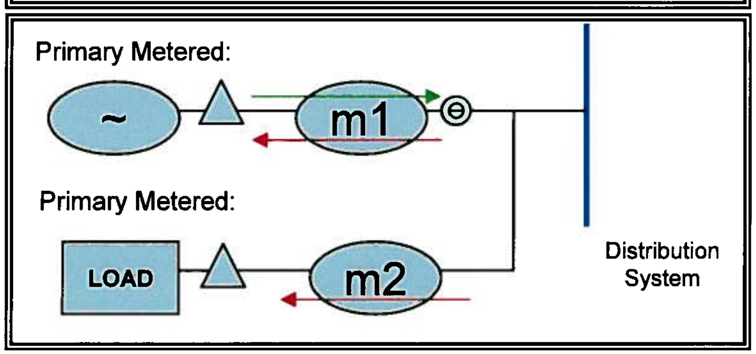
Energy delivered no adjustment required Kwh x SOP Rate

Energy consumed increased by LDC approved loss factor less 1% Primary Metering discount. (Kwh x (1+LDCL)) x .99 x HOEP

Settlements - Load:

Energy consumed increased by LDC approved loss factor.

(Kwh x (1+LDCL)) x HOEP or (Kwh x (1+LDCL)) x RPP



Settlements - Generator:

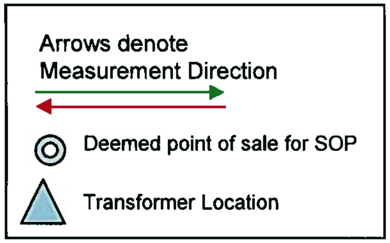
Energy delivered no adjustment required Kwh x SOP Rate

Energy consumed increased by LDC approved loss factor less 1% Primary Metering discount. (Kwh x (1+LDCL)) x .99 x HOEP

Settlements - Load:

Energy consumed increased by LDC approved loss factor less 1% Primary Metering Discount.

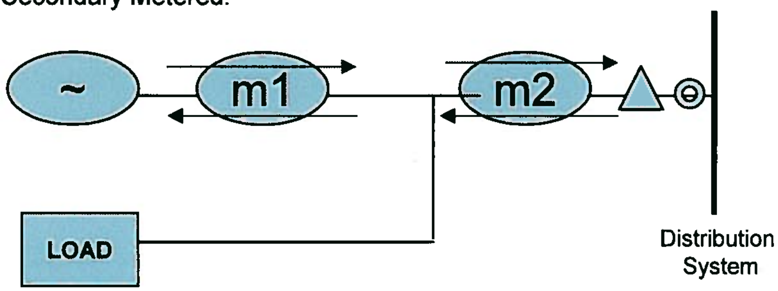
(Kwh x (1+LDCL)) x .99 x HOEP or (Kwh x (1+LDCL)) x .99 x RPP



Standard Offer Program
Meter Configuration Options

Embedded Generator and Load Customer (under exceptional circumstances only)
(See spreadsheet for calculation formulas and methodology)

Secondary Metered:



Settlements - Generator:

Energy delivered reduced by Site Specific Losses Energy consumed increased by LDC approved loss factor

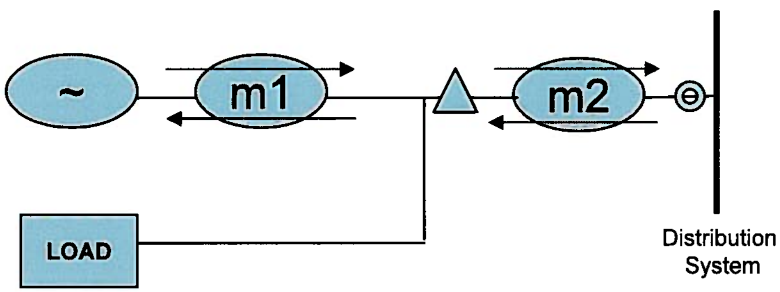
Settlements – Load:

Energy consumed increased by LDC approved loss factor.

Settlements – Load: (when m1 delivered coincident with m2 consumed or m2 consumed = 0 coincident with m1 delivered)

Energy consumed increased by LDC approved loss factor.

Primary Metered:



Settlements – Generator: (same as above)

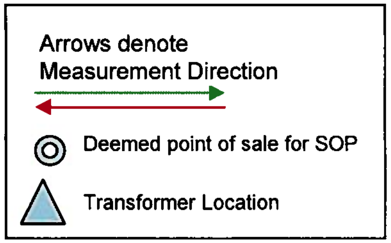
Settlements – Load

Energy consumed increased by LDC approved loss factor.

Settlements – Load: (when m1 delivered coincident with m2 consumed or m2 consumed = 0 coincident with m1 delivered)

Energy consumed increased by LDC approved loss factor.

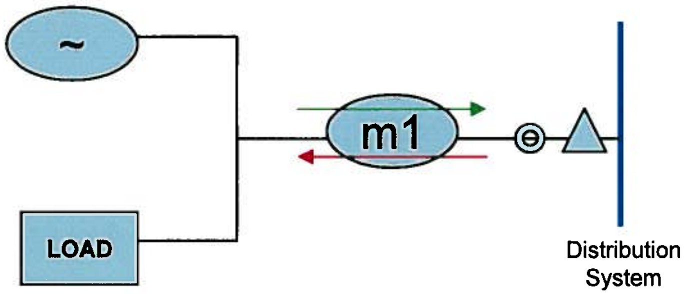
Note: Load Customer is also required to pay for additional energy related charges: WMSC, DRC, Network Service, Line & Transformation, and Distribution Variable Charges.



Standard Offer Program
Meter Configuration Options

4. Generator and Load Customer – 1 Meter (Simple Net Metering)

Secondary Metered:



Settlements:

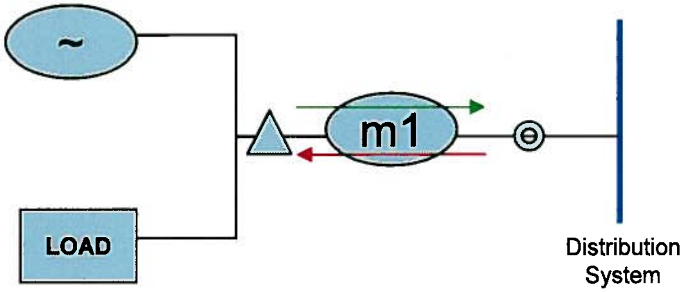
Energy delivered with no adjustment for Losses. (*O. Reg. 541/05, s. 8 (2)*)

Kwh x (RPP or HOEP) Rate

Energy consumed increased by LDC approved loss factor.

(Kwh x (1+LDCL)) x (RPP or HOEP) Rate

Primary Metered:



Settlements:

Energy delivered with no adjustment for losses. (*O. Reg. 541/05, s. 8 (2)*)

Kwh x (RPP or HOEP) Rate

Energy consumed increased by LDC approved loss factor less 1% for primary metering discount. Billed @ HOEP.

(Kwh x (1+LDCL)) x .99 x (RPP or HOEP) Rate

Note: Net Metering Regulations also require calculating credit to customer on Additional Charges: WMSC, DRC, Network Service, Line & Transformation, and Distribution Variable Charges.

Appendix 7(a): Interconnection Matrices (Summary Load Displacement)

Appendix 7 (a) Interconnection Matrices

SUMMARY LOAD DISPLACEMENT GENERATION

Description >	Embedded Load Displacement primarily for own use*****	Micro Embedded Load Displacement	Small Embedded Load Displacement	Mid Size Embedded Load Displacement	Large Embedded Load Displacement	Embedded Load Displacement Generation that displaces New Load
Fuel >	Fuel is solely from a renewable resource*	Non renewable resource	Non renewable resource	Non renewable resource	Non renewable resource	Non renewable resource
Size >	Less than 500 kW**	Less than 10 kW	10 kW to 500 kW connected at less than 15 kV	500 kW to 10 MW connected at less than 15 kV	Greater than 10 MW	Any size
			Up to 1 MW connected at greater than 15 kV	Greater than 1 MW to 10 MW connected at greater than 15 kV		
Net metering allowed**	Yes	No	No	No	No	No
Connection Agreement with LDC or Supply Authority Required	Yes	Yes	Yes	Yes	Yes	Yes
All equipment must be CSA approved or have ESA special approval	Yes	Yes	Yes	Yes	Yes	Yes
ESA Inspection Required	Yes	Yes	Yes	Yes	Yes	Yes
OEB Generation Licence Required if exporting to distribution system	No	Yes	Yes	Yes	Yes	Yes
IESO Market Participant***	No	No	No	No	No	No
Relay Protection required	Yes - Disconnect	Yes - Disconnect	Yes - Disconnect	Yes - Disconnect or Transfer Trip	Yes - Disconnect or Transfer Trip	Yes - Disconnect or Transfer Trip
Monthly Distribution Fixed Charge	No reduction	No reduction	No reduction	No reduction	No reduction	No reduction
Distribution Variable Charge	Net	Net	Net	Net	Net	Net
Commodity (Electricity) Charge paid for electricity delivered	Net (where eligible)	Gross	Gross	Gross	Gross	Gross
Commodity (Electricity) Charge received for generation		HOEP	HOEP	HOEP	HOEP	HOEP
Payment for generation received from		LDC	LDC	LDC	LDC	LDC
Regulatory Charges	Net	Net	Net	Net	Net	Net
Debt Retirement Charge	Net	Gross	Gross	Gross	Gross	Net
				500 kW to 1 MW		
Transmission Charges - Network	Net	Net	Net	Net	Net	Net
				Over 1 MW		Over 1 MW
Transmission Charges - Connection	Net	Gross	Gross	Gross	Gross	Gross
			Over 50 kW	Over 5 MW		Over 50 kW
Fixed Standby Charge****	No	No	Yes	Yes	Yes	Yes
Variable Standby Charge****	No	No	Yes	Yes	Yes	Yes

Notes:
* Wind, drop in water elevation, solar radiation, agricultural bio mass or any combination
** The LDC has a limit on its obligation to connect net metering on a first come, first served basis
*** Any generator has the right to be a market participant. Some may be required to be a market participant for technical reasons. Assumed for these smaller examples that generators would prefer to be embedded
**** If an OEB Rate Order exists
***** If distributed generator elects not to pursue standard offer contract.

Appendix 7(b): Interconnection Matrices (Summary Standard Offer Contracts)

Appendix 7 (b) Interconnection Matrices

SUMMARY STANDARD OFFER CONTRACTS (SOC)

Description >	Micro Embedded	Small Embedded	Mid Size
Fuel >	Fuel is solely from a renewable resource*	Fuel is solely from a renewable resource*	Fuel is solely from a renewable resource*
Size >	Less than 10 kW	10 kW to 500 kW connected at less than 15 kV	500 kW to 10 MW connected at less than 15 kV
		Up to 1 MW connected at greater than 15 kV	Greater than 1 MW to 10 MW connected at greater than 15 kV
Bi-directional Metering Required*****	Yes	Yes	Yes
Connection Agreement with LDC or Supply Authority Required	Yes	Yes	Yes
All equipment must be CSA approved or have ESA special approval	Yes	Yes	Yes
ESA Inspection Required	Yes	Yes	Yes
OEB Generation Licence Required	Yes	Yes	Yes
IESO Market Participant**	No	No	No
Commodity (Electricity) Charge received for generation	SOC	SOC	SOC
Payment for generation received from***	LDC	LDC	LDC
Relay Protection required	Yes - Disconnect	Yes - Disconnect	Yes - Disconnect or Transfer Trip
Monthly Distribution Fixed Charge****	No reduction	No reduction	No reduction

Notes:

* Wind, drop in water elevation, solar radiation, agricultural bio mass or any combination

** Any generator has the right to be an IESO Market Participant. Some may be required to be a Market Participant for technical reasons. Assumed for these smaller examples that generators would prefer to be embedded

*** While the payment will likely be received from the LDC the LDC will in turn settle with either the IESO or the OPA for the variance between the SOC price and the HOEP

**** Where the distributed generation is connected at the LDC's member distribution service account and is not a free standing facility

***** Bi-directional metering could also include two uni directional meters measuring power flow in and power flow out