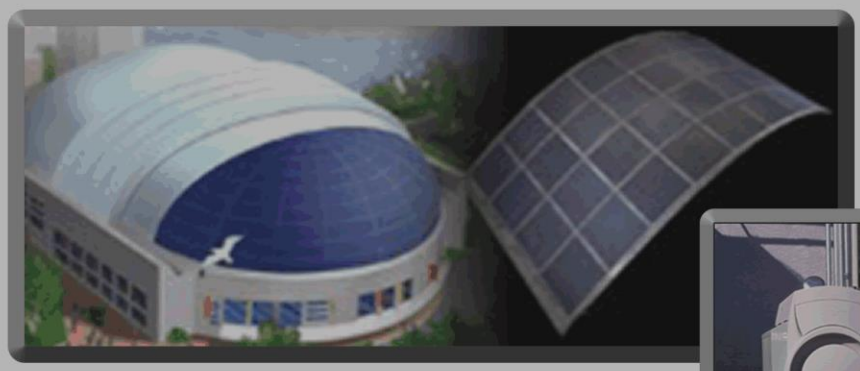
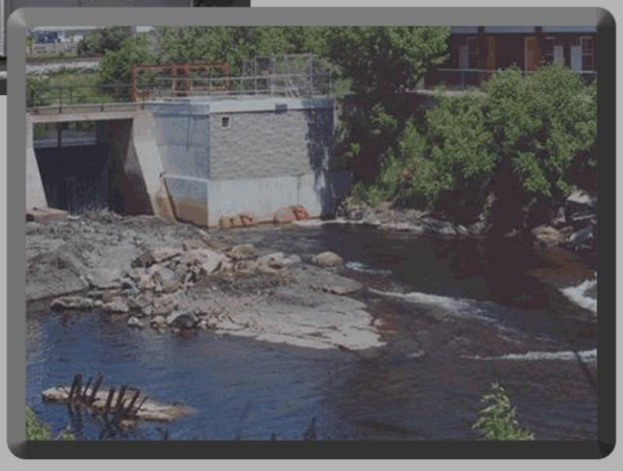


General Customer Information Package:

Connecting Distributed Generation to

Kitchener-Wilmot Hydro's Distribution System

(Rev.3 - Updated by Kitchener Wilmot Hydro in April 2015)



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Kitchener-Wilmot Hydro Inc. purchased this document from AESI and re-wrote the document to Revision 1 in Jan. 2010 to meet Kitchener-Wilmot Hydro's own requirements.

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Table of Contents

1. Introduction

As the Local Distribution Company (LDC) responsible for supplying, distributing and metering electricity within its licensed area, Kitchener-Wilmot Hydro Inc. (Kitchener-Wilmot Hydro) has prepared this general information package for those parties interested in connecting Distributed Generation ("DG[1]") facilities to its Electrical Distribution System.

This information package is intended as a starting point for the potential DG developers interested in connecting DG to Kitchener-Wilmot Hydro's Distribution System who have little background on Ontario's electricity wholesale market and renewable energy incentives. It provides high-level general 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. 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 implications for prospective DG developers.
- An overview of the options available for connecting different types of DG to Kitchener-Wilmot Hydro's 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 general description of the key milestones for connecting DG facilities to Kitchener-Wilmot Hydro's Distribution System.
- Links to publicly available web sites where additional documents, information and self-help materials on electricity generation, applicable standards, regulations etc. are available and other helpful resources for DG developers.

To further help the prospective DG developers follow the step-by-step DG connection process and understand the detailed DG connection requirements, Kitchener-Wilmot Hydro also developed another two customer guidelines:

Doc. KWHDG-1 - How to Connect Your Generation Facility (≤ 10 kW) To Kitchener-Wilmot Hydro's Distribution System
Doc. KWHDG-2 - How to Connect Your Generation Facility (>10 kW, ≤ 10 MW) To Kitchener-Wilmot Hydro's Distribution System

Both documents are available at Kitchener-Wilmot Hydro's website at:

https://www.kwhydro.on.ca/en/residential/customer-owned-generation.asp

More DG information is available from various agencies and organizations, some of which are listed in Appendix 1. Appendix 2 contains a number of definitions and terms that are used in this document.

It is recommended that anyone interested in connecting DG to Kitchener-Wilmot Hydro's distribution system read all relevant documentation carefully. Should there be a conflict between this package and the rules, regulations, and specific information as laid out in relevant documents regarding the connection of DG facilities to a Distribution System in Ontario, the rules, regulations, and specific

[1] Distributed Generation is also referred to as Embedded Generation or ("EG") or Parallel Generation

documents shall take precedence. DG proponents should also visit available websites and information sources to check if updated material is available or if changes have been made.

If you are interested in connecting a DG facility to Kitchener-Wilmot Hydro's Distribution System or have any questions about the content of this information package please get in touch with the Designated Contacts of Kitchener-Wilmot Hydro named below:

For generation facility 10kW and below

John Theriault
Service Design Supervisor
Kitchener-Wilmot Hydro Inc.
Phone: 519-745-4771 Ext 6240
Fax: 519-745-0643
Email: JTheriault@kwhydro.ca

For generation facility above 10kW

Shaun Wang, P. Eng.
System Planning & Projects Engineer
Kitchener-Wilmot Hydro Inc.
Phone: 519-745-4771 Ext 6312
Fax: 519-745-0643
Email: SWang@kwhydro.ca

2. Agencies and Organizations Involved with Ontario's Electricity System

Some of the agencies and organizations involved in electricity in Ontario that DG developers might deal with in projects are:

Agency/Organization	Roles and Responsibilities
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 determine public policy for the existence of Hydro One, OPG and LDCs • Significant legislation: Electricity Act, 1998 and Regulations, Ontario Energy Board Act 1998, Electricity Restructuring Act 2004, Green Energy and Green Economy Act 2009
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 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 load consumers
Ontario Power Generation (OPG)	• Ontario Power Generation (OPG) owns and operates most of Ontario's generating capacity. The Province of Ontario owns OPG.
Hydro One Networks (HONI)	• Hydro One is the province's largest transmission company and owns most of the provincial transmission grid. Hydro One also distributes electricity outside of the major urban centres. It supplies LDCs from Transformer Stations (TSs) at 13.8kV, 27.6 kV and 44 kV or Distribution Stations (DSs) at lower voltages. DG directly or indirectly connected to Hydro One TSs or DSs may require co-ordination with Hydro One. The Province of Ontario owns Hydro One.

Agency/Organization	Roles and Responsibilities
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 (OESC).
Renewable Energy Facilitation Office (REFO)	• Established by the province, the Renewable Energy Facilitation Office is a one-stop access point to assist renewable energy project proponents (developers, communities and municipalities) obtaining information and connecting proponents with the appropriate resources at the partner ministries, agencies and governments.
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 sets environmental standards for electricity projects in Ontario and ensures that generators, distributors and transmitters follow rules and standards when constructing and operating facilities.
Ontario Ministry of Natural Resources (MNR)	• The Ontario Ministry of Natural Resources review projects and make decisions regarding the approval of a renewable energy project where MNR has a legislative responsibility as per approval and permitting requirements and approves renewable development on Crown lands.
Kitchener-Wilmot Hydro	• We are a Local (electricity) Distribution Company (LDC). 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. Our core business is the distribution of electricity; we do not make money by connecting the distributed generators. Since we do not generate electricity and earn our revenue through transporting electricity across our wires we are impartial to the sources of generation. The local municipalities are the sole shareholders of Kitchener-Wilmot Hydro.

3. Kitchener-Wilmot Hydro's Electrical Distribution System

In the past, and predominantly today, Ontario's electricity system consists of large, centrally located generating stations linked with load centres over long distances by high voltage transmission lines. Transmission voltages are greater than 50 kV, which are more efficient for transmitting large amounts of power, but impractical for delivering power to many utilization points therefore, the voltage must be reduced to supply end users of electricity such as homes and businesses. Transformer Stations reduce the voltage to a level suitable for distribution (under 50 kV) at which point the electricity supply becomes distribution lines owned and operated by "Local Distribution Companies" (LDCs) such as Kitchener-Wilmot Hydro.

For those unfamiliar with electricity transmission and distribution systems, it can help to compare them to a system of roads. The transmission system is analogous to Highway 401, carrying large volumes of electricity to an area. The exits off the 401 into our community represent transformer stations that allow electricity to travel safely onto our community's main arterial roads at lower volumes. These main arterial roads in turn are linked to residential streets and deliver smaller quantities of electricity to our residential neighbourhoods.

Unlike roads in our community most electricity lines have in the past been one-way streets. While the system is designed primarily to deliver electricity from the transmission grid to end users, with DGs it is now possible for electricity to be fed into the Distribution System to supply local loads and, in some cases, all the way back to the transmission grid. Just as a residential street can't handle a large volume of traffic without disturbing the local residents, lower voltage distribution lines cannot handle large amounts of electricity generation without disrupting electricity service to other customers.

As a local distribution company, Kitchener-Wilmot Hydro owns 8 transformer stations and 7 Distribution Stations to support its own power distribution system. Kitchener-Wilmot Hydro's distribution system delivers power to end users through about 100 distribution feeders from these stations. All distribution feeders in Kitchener-Wilmot Hydro's distribution system are supplied radially from each station. Kitchener-Wilmot Hydro's distribution feeders operate at the following voltages (Phase-to-Phase/Phase-to-Neutral): 27.6/16kV, 13.8/8kV, 8.32/4.8kV.

The 27.6kV feeders and 8.32kV feeders cover the vast rural area in the Township of Wilmot; and the 13.8kV feeders cover the City of Kitchener and a small portion of Wilmot Township (Mannheim area). Kitchener-Wilmot Hydro has plans to convert the 8.32kV distribution system into 27.6kV distribution system in the next 15 years.

In general, the maximum total generation capacity of all DG connected to Kitchener-Wilmot Hydro's feeders will be limited to:

- 27.6 kV Feeders: 10MW
- 13.8 kV Feeders: 5MW
- 8.32kV Feeders: 0.5MW

The 27.6 kV feeders also supply all distribution stations. The permissible generation at 27.6kV feeders may be reduced by the cumulative DG on the connected distribution stations with all connected 8.32kV feeders. The above maximum allowable DG capacity presumes 3-phase feeder with sufficient conductor size and load levels to permit the DG. The actual ability of Kitchener-Wilmot Hydro's feeders to accept a specific DG may only be determined through a detailed engineering review at the Connection Impact Assessment stage.

For the system service areas of Kitchener-Wilmot Hydro transformer stations and distribution stations and the system capacity available to the potential renewable generation, check Kitchener-Wilmot Hydro's website below or contact Kitchener-Wilmot Hydro.

http://www.kwhydro.on.ca/transmission_and_distribution_system_information.asp

Kitchener-Wilmot Hydro's distribution system typically operates as multi-grounded system (3 phase 4 wire system). The transformer neutral at the station is either solidly grounded (distribution stations supplying 8.32kV feeders) or effectively grounded through a low reactance at the station (transformer stations supplying 27.6kV and 13.8kV feeders) to limit the ground fault level. The fault levels on Kitchener-Wilmot Hydro system vary from location to location and from time to time. The maximum allowable fault levels are listed in Table 1. The actual fault levels at a certain DG site will be provided at the Connection Impact Assessment stage. Both the actual fault levels and the maximum system fault levels shall be considered by the DG proponent.

Kitchener-Wilmot Hydro uses voltage regulating devices in the distribution system in order to maintain an adequate voltage profile along the feeders under various operating conditions. These voltage regulating devices include the under-load tap changers at the transformer stations and the voltage regulators or under-load tap changers at the distribution stations.

Kitchener-Wilmot Hydro uses automatic reclosing to quickly clear the temporary faults on the distribution feeders in order to quickly restore the power supply. 27.6kV and 13.8kV feeders use single-shot reclosing. 8.32kV feeders use multiple-shot reclosing. The DG proponents shall consider the auto-reclosing while designing the DG facility. The DG protection shall coordinate with the auto-reclosing to prevent DG damage.

Abnormal system conditions and normal system maintenance may cause power interruptions or power outages on Kitchener-Wilmot Hydro's distribution feeders. The DG owner shall consider all possible disturbances while designing the protection system to ensure both the DG and other Kitchener-Wilmot Hydro's customers are protected. The DG shall also consider the DG revenue loss due to the power interruptions or power outages. Kitchener-Wilmot Hydro is protected from any claims and demands for loss, damage or injuries to persons or property resulting from the power interruptions and outages.

Table 1: Maximum Fault Levels on Kitchener-Wilmot Hydro Distribution System

Nominal Voltage (kV)	Max. 3-Phase Fault	Max. 1-Phase Ground Fault
27.6/16 kV	17kA	8kA
13.8/8 kV	21kA	8kA
8.32/4.8 kV	4kA	4kA

4. Size Classifications for DG Facilities

The first step in connecting DG to a Distribution System is to determine the size of the facility that is being planned. The connection process, technical considerations for connection, connection costs, and regulatory issues vary depending on the size of the DG.

4.1 Micro

A Micro generation facility is defined as a DG with a nameplate generation capacity of 10kW or less. All but the very largest of home-based energy generation systems will fit into this category. If the generation facility is non-renewable, its owner can receive financial benefits by displacing energy consumption from the grid. The technical and financial requirements of other financial settlement options are often too onerous for Micro generators to consider. Micro generation is subject to a simplified connection process due to its relatively minimal impacts on the electricity Distribution System when installed and less demanding ESA specifications.

4.2 Small

Small generation facilities are defined as having a nameplate capacity of 500 kW or less when connected to Distribution System voltages less than 15 kV, or as having a nameplate capacity of 1 MW or less when connected to Distribution System voltages of more than 15 kV. These facilities can include larger solar arrays, small biogas, wind, and co-generation facilities, commercial scale wind turbines, or industrial sized backup electricity generators. If eligible, small renewable energy generators can participate in any one of the financial settlement options listed in this guide.

Some small generation facility can be further classified as "**Capacity Allocation Exempt Small Embedded Generator**" if it has a name-plate rated capacity of 250 kW or less in the case of a facility connected to a less than 15 kV line and 500 kW or less in the case of a facility connected to a 15 kV or greater line.

Small Generators will have to go through the Connection Impact Assessment process and pay the cost of any upgrades, connection costs or metering changes required to connect to the Kitchener-Wilmot Hydro's Distribution System. Although the Connection Impact Assessment is still required, Capacity Allocation Exempt Small Generators will be exempt from the system capacity allocation process and the feeder capacity limit and can almost be guaranteed to connect from beginning.

4.3 Mid-Sized

Mid-sized generation facilities have total connected nameplate capacities of more than 500 kW when connected to a Distribution System voltage of under 15 kV or more than 1 MW when connected to Distribution System voltages over 15 kV up to 10MW. Mid-Sized generation facilities are typically commercial or industrial scale endeavours. The capital cost for these facilities can range from hundreds of thousands of dollars to the multi-million dollar range.

Mid-sized projects can experience complex technical and financial issues and the DG developer may need to acquire engineering and technical resources with experience in the connection of mid to large-scale generation. In order to connect mid-sized generators, Kitchener-Wilmot Hydro may require system upgrades, metering changes, telemetry telecommunications and protective relaying modifications to be made at the generator's expense.

4.4 Large

Large distributed DG projects are those with total connected nameplate capacities of over 10 MW. These facilities are typically only connected to the highest distribution voltages, are subject to the most complex and costly connection process. They typically earn financial returns by supplying very large energy consumers or retailers, taking the wholesale Hourly Ontario Energy Price, or by bidding into tenders by the Independent Electricity System Operator for electricity supply.

Large DG projects are multi-million dollar initiatives requiring a high level of technical and financial sophistication.

5. Earning Revenue from DG Facilities

Ontario's electricity market offers a number of methods for financial settlement with distributed generators depending on their individual choices of generator size, fuel source, technical sophistication, and financial risk tolerance. Prospective DG developers should become aware of the numerous costs associated with connecting facilities to the grid and the potential earning revenue through the financial settlement methods listed below.

5.1 Load displacement

The function of load displacement DG is to reduce the amount of electricity purchased from the electricity market. Load displacement facilities are not eligible to be net metered. They are also not eligible to receive payments from Kitchener-Wilmot Hydro, the Independent Electricity System Operator, or the wholesale market for the electricity they produce. Since load displacement facilities may qualify under other government programs to encourage energy conservation, they may be eligible for government funding related to conservation and demand management. Please visit the Ontario Ministry of Energy and Infrastructure and Independent Electricity System Operator's Conservation Bureau websites for more information about conservation programs. Web links to these sites are contained in Appendix 1.

5.2 Hourly Ontario Energy Price – the Wholesale Market in Ontario

The wholesale market for electricity is an open market administered by the IESO. Throughout the day and night, Ontario electricity suppliers submit offers to sell electricity. The IESO then uses these offers and bids to match electricity supply with demand, establishing the Hourly Ontario Energy Price (HOEP) paid by wholesale customers. This spot market energy price changes from hour to hour, day to night, from season to season, and for short periods in response to high levels of demand or sudden changes on the IESO-controlled grid. Every five minutes, the IESO calculates a new spot market price by balancing the supply of electricity with demand. As demand increases, more expensive offers from generators are accepted, which raises the price of electricity. As demand drops, only the less expensive offers are accepted, which reduces the price.

A DG facility that is not eligible for other financial settlement options could, perhaps, because of its size or fuel or operating characteristics, offer its energy for sale in the wholesale market in a number of different ways. The wholesale market requires a relatively advanced understanding of Ontario's energy market and the acceptance of increased levels of both risk and reward that correspond with no guarantee of a long term contract for energy supply and no fixed pricing.

5.3 Financial settlement options for renewable electricity generators

Renewable Electricity Generation is electricity generated from any one or a combination of the following sources: wind, solar thermal, solar photovoltaic; renewable biomass; biogas, landfill gas, or water.

Renewable electricity generation facilities are eligible to participate in Net Metering and Feed-in Tariff Programs developed by Ontario's government to encourage the amount of electricity generated by these 'green' sources. Some renewable electricity sources are eligible for additional federal incentives and can generate emission reduction credits for their owners if certified through programs such as EcoLogo™.

5.3.1 Net Metering

Net Metering is a simplified financial settlement process for those who are interested in generating a portion of their own energy needs with distributed renewable electricity generation. Net Metering is convenient for those who are looking to avoid the need for expensive batteries or backup generators often necessary for off-grid renewable electricity systems. Net Metering may also be a good option for those not interested in the more complex application process required to participate in the Standard Offer Program. Net Metering is only available to those who are installing renewable DG systems up to 500 kW nameplate capacity.

A net metered DG will be billed for the difference between the amount of electricity exported to the Distribution System and the amount of electricity taken from the Distribution System each month. Regulated electricity charges will only apply to the net consumption of electricity. If the difference reflects zero energy consumption or a net export of electricity by the customer, only the fixed monthly customer charge will apply and a credit for the value of the energy exported will appear on the Net Metered customer's bill. Energy credits can be carried forward for one year and will be applied to future bills.

Since credits can only be carried forward for one year, there is no incentive for installing DG facilities that consistently export more power to the grid than is consumed by the net metered customer. Net Metering customers cannot participate in other forms of financial settlement, although a Net Metering customer can cancel a Net Metering agreement with 90 days' notice if they wish to expand their systems and/or participate in other programs.

If the prospective DG decides to be net metered after an initial consultation with Kitchener-Wilmot Hydro staff, a simplified connection process may be applied depending on the size of the DG. For those electricity customers that have electricity supply contracts with licensed retailers other than Kitchener-Wilmot Hydro, consultation with the retailer will be required before any net-metering arrangement can be made.

5.3.2 Feed-In Tariff (FIT) / MicroFIT Program

In order to encourage distributed (embedded) renewable electricity generation, the Government of Ontario has introduced Feed-in tariff or FIT program on Oct. 1st 2009 with comprehensive guaranteed pricing structure (10 - 80 ¢/kWh depending on the fuel type and DG size) for renewable electricity production. It offers stable prices under long-term contracts for energy generated from renewable sources, including:

- Biomass / biogas / landfill gas
- On-shore and off-shore wind
- Solar photovoltaic (PV)
- Waterpower.

The FIT / MicroFIT Program was enabled by the *Green Energy and Green Economy Act, 2009* which was passed into law on May 14, 2009. The Independent Electricity System Operator is responsible for implementing the program.

By encouraging the development of renewable energy in Ontario, the FIT Program will:

- help Ontario phase out coal-fired electricity generation - the largest climate change initiative in Canada
- boost economic activity and the development of renewable energy technologies
- create new green industries and jobs.

For program details and the latest price schedule, visit IESO FIT Program website at: www.fit.powerauthority.on.ca or call IESO at 1-888-387-3403.

Once a DG is connected to the Distribution System and is producing electricity under FIT contract, Kitchener-Wilmot Hydro will pay the DG owner the FIT contract price per kWh delivered. Kitchener-Wilmot Hydro will then settle with the IESO for the difference between the contract price paid to the generator and the HOEP.

5.3.3 Renewable Energy Standard Offer Program (Obsolete)

As of October 1, 2009, RESOP has been replaced by the Feed-in Tariff Program (FIT Program). Although the existing RESOP contracts will still be honored and implemented, RESOP is no longer available to all new customers. This section is kept only for information purpose.

In order to encourage distributed (embedded) renewable electricity generation, the IESO introduced a "Standard Offer" Program for Renewable Energy Supply in 2006. If a renewable energy facility fits the Standard Offer Program eligibility criteria, it is entitled to receive a base rate (2007) of 11 ¢/kWh for electricity produced by wind, bio-energy, or water power. There is a 3.52 ¢/kWh premium paid to facilities that can reliably deliver electricity during "on-peak" hours for production during these hours. Solar Photovoltaic projects receive a price of 42 ¢/kWh (2007). Once a generator is approved for a Standard Offer Contract, they receive a power purchase agreement with the IESO for 20 years. The IESO suspended the RESOP in May 2008 and replaced the RESOP with the FIT Program in Oct. 2009.

5.4 Other Financial Considerations

Costs and risks for prospective DG developers are not limited to the purchase, installation, and operation of generation equipment. There are costs and risks associated with connection to Kitchener-Wilmot Hydro's Distribution System, obtaining regulatory approvals, gaining the necessary licences and contracts associated with their preferred financial settlement option, and potential tax and business structuring issues. Prospective DG developers are advised not to purchase or commence installation of any electricity generation equipment until they have fully apprised themselves of all approvals, regulations, licences, costs and risks that may be encountered.

Costs to be considered by the perspective DG developers include but not limited to

- DG equipment and installation;
- Inspections by ESA;
- Permitting and other approvals if required;
- Connection Impact Assessment, Cost Estimate and Design Review costs if required by Kitchener-Wilmot Hydro;
- Connection/Metering costs if required by Kitchener-Wilmot Hydro
- Transfer Trip / Telemetry if required by Kitchener-Wilmot Hydro
- Monthly DG account charge by Kitchener-Wilmot Hydro
- Regular operating / maintenance costs
- Legal and insurance costs
- Tax and accounting costs (municipal property tax may increase; income from generation is taxable.)

6. Technical Considerations for DG

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, ESA, the Institute of Electrical and Electronics Engineers (IEEE), and The Canadian Standards Association (CSA). This section summarizes safety and technical issues to help describe where they fit and why in the context of the interconnection process. The goal here is to provide background and rationale only. For extensive technical details, check Appendix 2 of Kitchener-Wilmot Hydro's **Doc. KWHDG-2** - How to Connect Your Generation Facility (>10 kW, ≤ 10 MW) To Kitchener-Wilmot Hydro's Distribution System.

Link of Appendix A2 on Kitchener-Wilmot Hydro's website:

http://www.kwhydro.ca/pdfs/microfit_fit/Customer_Information_10kW-10MW_Appendix_A2.pdf

Resource links and DG reference are given in Appendix 1 for those seeking additional technical details. A web search of DG interconnection will present a wealth of valuable information.

The OEB's Distribution System Code Appendix F.2 outlines the technical requirements for connecting a generator to an electricity distributor's system. IEEE Standard 1547 and CSA Standard C22.3 No.9 also describe the technical requirements for interconnecting DG with electrical power system. Appendix A2 on Kitchener-Wilmot Hydro's website specifies the technical requirements for a DG that is proposing to connect to Kitchener-Wilmot Hydro's Distribution System. As part of Appendix A2 the relevant sections of DSC Appendix F.2, IEEE 1547 and CSA C22.3 No.9 have been cross-referenced as they relate to safety, power quality and protection.

6.1 Safety

Any system that produces even small amounts of electricity can be potentially dangerous, creating the possibility of electrocution and fire hazards. Improperly installed systems will create serious safety hazards to property owners, their friends, family, employees and local electric distribution company workers and can damage connected electric equipment. For this reason DG systems 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 photo voltaic, wind turbines, co-generation, micro turbines, and other relatively small generation systems to operate in parallel with the grid at residential and commercial locations is an increasing and recent trend. Before installing any type of DG, whether it is stand-alone or connected to the grid, it is important to understand the safety requirements.

Utilities are concerned about the potential for DG 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 and is discussed below.

6.2 Distinctions between types of DG

It is difficult to generalize safety issues with regard to DG because of the variety of types of generators, for example: solid-state or static inverters, induction machines, and synchronous machines.

Many smaller renewable energy systems produce acceptable 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 standalone 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.

In practice, 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. Larger inverter based systems would require supplementary protection devices and breakers as described later and in Appendix A2 on Kitchener-Wilmot Hydro's website.

Where DG is intended solely for emergency backup purpose and it can be demonstrated that it cannot and will never be connected, paralleled or export electricity to the Distribution System Kitchener-Wilmot Hydro must still be advised of its presence but the approvals required are primarily from ESA.

6.3 Islanding

One of the biggest concerns utilities have about DG is to avoid a condition known as islanding. Islanding happens when a section of the utility system containing both loads and a DG source becomes separated from the remainder of the utility system but remains energized.

This could happen 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 DG disconnects from the Distribution System before the first automatic reclosure occurs. The DG must be disconnected automatically before the utility protective device recloses otherwise a) the DG may feed into the fault and b) when the utility protective device tries to reclose it will be closing back in on a line that is being supplied by DG resulting in possible equipment damage to the DG, overloading or power quality issues

With central generation, transmission lines and transformer stations Kitchener-Wilmot Hydro knows that if an electrical circuit is isolated "upstream" and is not being fed from an alternative source it is de-energized. With DG, Kitchener-Wilmot Hydro needs to come to terms with multiple sources of electricity supply on their systems and to deal with the change in operating conditions that result.

Kitchener-Wilmot Hydro may want to isolate a section of line for maintenance purposes. Opening switches would normally accomplish this. While Kitchener-Wilmot Hydro can be sure all of its own electricity sources are either shut down or isolated from the area that needs work they must now factor in the DG to ensure that it too is isolated and not supplying the line section.

DG creates a source of energy inputs to our utility system that we do not control and if the DG is potentially capable of islanding it can back feed electricity to our Distribution System.

6.4 Power Quality

Power quality is a significant technical concern for Kitchener-Wilmot Hydro and its customers. 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 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 DG device has its own output characteristics based on its technology therefore some will have more power quality issues than others.

6.5 Voltage Fluctuations and Voltage Regulation

Voltage fluctuations can result from a DG being connected to or disconnected 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 DG's operating cycle. Whether the utility actively or passively regulates their voltages to maintain an acceptable range, the presence of DG must have no detrimental impact on that regulation. Normally the DG 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.

6.6 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. See Appendix A2 on Kitchener-Wilmot Hydro's website for specifications.

6.7 Frequency

Frequency variations are a reliability and power quality issue and must be maintained within the range specified in Appendix A2 on Kitchener-Wilmot Hydro's website.

6.8 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 DG 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 Kitchener-Wilmot Hydro's Distribution System in excess of applicable standards. See Appendix A2 on Kitchener-Wilmot Hydro's website for further details and references.

6.9 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. See Appendix A2 on Kitchener-Wilmot Hydro’s website for specifications.

6.10 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. See Appendix A2 on Kitchener-Wilmot Hydro’s website for further details.

6.11 Voltage Flicker

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

6.12 Protection of DG Facility

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

6.13 Monitoring

For DG greater than 250 kW Kitchener-Wilmot Hydro may require remote monitoring of the DG connection status, real power output, reactive power output and voltage at the point of generator connection. See Appendix A2 on Kitchener-Wilmot Hydro’s website for further details.

6.14Standardized or Certified Equipment

The design for a DG installation must be approved by a professional engineer and all equipment must be CSA approved and inspected by the ESA. If the interface equipment used is a standard package or certified for use (by Underwriter’s Laboratories (UL) or CSA or some other recognized approving body) as is the case with some inverters and the certification and certifying body are acceptable to Kitchener-Wilmot Hydro this will expedite and simplify the interconnection process. This is especially applicable at the lower DG output levels and will reduce the amount of technical information required.

6.15 Protective Devices

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

- An interconnection device that is manual, lockable, has visible disconnection and is accessible to Kitchener-Wilmot Hydro staff
- An interrupting device capable of interrupting the maximum available fault current at the DG location
- A generator disconnect device including disconnect device failure protection
- A protective relay that will operate the main load interruption device with the following features
  - Over-voltage trip.
  - Under-voltage trip.
  - Over/under frequency trip
  - Over current protection
  - Ground fault protection.
- Reclosing co-ordination to ensure that the DG ceases to energize prior to the reclosure of an upstream LDC device including lock out protection.
- Anti-islanding protection.
- Power Factor correction (if required).
- Synchronizing equipment that will limit voltage fluctuation, frequency variation and phase angle when the DG parallels with the Distribution System.
- Transfer Trip may be required depending on the loading of the distribution feeder and the output rating of the DG 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.
- Protection against power swings

See Appendix A2 on Kitchener-Wilmot Hydro's website for further descriptions and details.

Kitchener-Wilmot Hydro will provide the specific fault levels at the preliminary review stage or Connection Impact Assessment 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.

6.16 Grounding

DG facilities must be grounded in accordance with any equipment manufacturers' requirements, the OESC and Kitchener-Wilmot Hydro's requirements.

The DG must not disrupt any coordination of ground fault protection or cause over-voltages that exceed the rating of equipment connected to the Kitchener-Wilmot Hydro Distribution System.

7. DG Connection Process

This section summarizes the key milestones and connection approvals that may be required to connect the prospective DG to Kitchener-Wilmot Hydro's distribution system. The scope and complexity of the process depend on the size and type of the DG facility. The goal here is to provide background and rationale only. To explain the step-by-step connection process, the application forms and the detailed technical requirements, Kitchener-Wilmot Hydro has developed the following two customer guidelines for the prospective DG developers, following the OEB's Distribution System Code.

Doc. KWHDG-1 - How to Connect Your Generation Facility (≤ 10 kW) To Kitchener-Wilmot Hydro's Distribution System
Doc. KWHDG-2 - How to Connect Your Generation Facility (>10 kW, ≤ 10 MW) To Kitchener-Wilmot Hydro's Distribution System
For details, check Kitchener-Wilmot Hydro's website below or contact Kitchener-Wilmot Hydro.

http://www.kwhydro.on.ca/generation_connection.asp

7.1 Key Milestones in DG Connection Process

The key milestones discussed below are only applicable to DG facility above 10kW.

The micro generation facility 10KW and below is subject to a more simplified connection process. Check Kitchener-Wilmot Hydro's Document **No. KWHDG-1** for details.

7.1.1 Kitchener-Wilmot Hydro's Preliminary Review

In the very early stages where a DG developer is considering site selection, Kitchener-Wilmot Hydro will provide a Preliminary Review and high level advice and guidance based on the limited parameters from the completed Form DG02 on Kitchener-Wilmot Hydro's website - "Application for Preliminary Review of a request to connect Distributed Generation to Kitchener-Wilmot Hydro's Distribution System" including:

- Potential sites
- The name-plate rated capacity of each unit of the proposed generation facility and the total name-plate rated capacity of the proposed generation facility at the connection point
- Type of technology to be used
- Fuel type
- Generator generic description and design type

And considering:

- Voltage, capacity and loading of distribution lines adjacent to potential sites

After receiving and reviewing the application, Kitchener-Wilmot Hydro will advise on

- The basic feasibility of the project.
- The additional application form for Connection Impact Assessment and materials required.

If the DG developer is confident on the feasibility of the perspective DG project, he can pass this step and request that Kitchener-Wilmot Hydro perform the Connection Impact Assessment directly.

7.1.2 Kitchener-Wilmot Hydro's Connection Impact Assessment

Where the DG project is over 10 kW and where required, Kitchener-Wilmot Hydro will perform a Connection Impact Assessment (CIA) at the DG developer's cost. The CIA looks at:

- The impact of the DG on Distribution System short circuit levels, load flows, current loading, voltage levels and voltage flicker under a variety of Distribution System and DG output conditions to ensure there are no adverse effects.
- The preliminary design of the protection systems being proposed for the DG 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.
- A more detailed assessment and cost estimate of the connection feasibility and any upgrades required.

The DG developer submits a completed Form DG03 on Kitchener-Wilmot Hydro's website – "Request for a Connection Impact Assessment Review/Update to Connect Distributed Generation to Kitchener-Wilmot Hydro's Electrical Distribution System". The technical information required for the CIA includes the following:

DG Description

- Site
- Type of DG
- 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
- Manual interconnection disconnection device
- Generator
- Generator disconnect device
- Protective relaying and functions and description of how the protection relaying will interface with the generation and the Distribution System under fault or transient events
- Interface Transformer
- Protective isolating device(s)
- Generator breaker
- Voltage levels
- Fusing

Kitchener-Wilmot Hydro will advise the DG developer of the CIA results. If the impact of the DG is within acceptable limits the next step in the connection process – connection cost estimate can be commenced. The DG developer should not order any equipment or make commitments to the project until the CIA has been satisfactorily completed.

7.1.3 Kitchener-Wilmot Hydro's Cost Estimate

If the DG developer is satisfied with the CIA results and would like to proceed, the DG developer will request Kitchener-Wilmot Hydro to perform a Connection Cost Estimate. This cost estimate will provide the DG developer the estimated costs for Kitchener-Wilmot Hydro to connect the proposed DG facility. If upgrades or changes on Kitchener-Wilmot Hydro's Distribution System are required the commencement to the next step will require a Connection Cost Agreement ("CCA") between Kitchener-Wilmot Hydro and the DG developer on costs.

For DG project up to 500kW, Kitchener-Wilmot Hydro will perform the cost estimate with no charge. Kitchener-Wilmot Hydro will combine steps in 7.2.1 and 7.2.2 and issue a draft CCA with cost estimate information along with the CIA report. The draft CCA will outline the system modification/upgrade requirements, metering requirements, transfer trip and telemetry requirements, the detailed connection costs and timing.

For DG project above 500kW, Kitchener-Wilmot Hydro will issue a draft Cost Estimate Study Agreement along with the CIA report if the DG connection is acceptable. If the DG developer feels that the CIA result is manageable, the Customer returns the signed Cost Estimate Study Agreement with the payment as required by Kitchener-Wilmot Hydro. Kitchener-Wilmot Hydro will then perform the connection cost estimate and returns the Customer a draft CCA. The rates and timing of Cost Estimate are listed on Kitchener-Wilmot Hydro's website.

7.1.4 Kitchener-Wilmot Hydro's Design Review

Once a CIA has been completed, the CCA has been signed, and all approvals commenced or received, the project can proceed with a full Design Review. The Design Review will establish Kitchener-Wilmot Hydro's requirements for the DG at the specific location expanding on and supplementing the information provided for the CIA. The Design Review will require the DG developer to confirm and finalize the technical information provided for the CIA.

Additional information that may be requested or need to be confirmed at this stage will be clarified in the CCA and may include following:

- Updated single-line drawings showing ratings of all electrical equipment.
- Ground Potential Rise (GPR) study and associated station ground design.
- DC station service single line showing ratings of all electrical equipment such as batteries, chargers, etc.
- Switchgear fault ratings
- HV surge arrestor specification
- Transformer protection, AC and DC wiring diagram
- Disconnect switch or HV breaker AC and DC wiring diagram
- LV breaker (transformer & bus tie breakers) AC and DC wiring diagram
- Breaker Failure (transformer & bus tie breakers) AC and DC wiring diagram
- HV equipment operating and protection philosophy and schematics
- Power transformer and generator nameplate ratings
- Relay settings including relay logic diagrams, coordination studies and fault calculations.
- Commissioning Procedure
- Preliminary and final generator data, including excitation system performance, automatic voltage regulator (AVR), power factor regulator, power system stabilizer, static exciter and speed governor to ensure compliance with all applicable reliability standards required under the IESO Market Rules.

7.1.5 COVER required by Kitchener-Wilmot Hydro

Once the DG developer completes the installation and Kitchener-Wilmot Hydro completes the system upgrades, the DG developer will perform commissioning and testing on the generation facility, including DG off-line test and DG on-line test.

During the commissioning, the Customer is responsible for completing Form DG06 on Kitchener-Wilmot Hydro's website - 'Confirmation of Verification Evidence Report" (COVER) and submitting it to Kitchener-Wilmot Hydro. The results from COVER should provide complete assurance that the

generation facility has been proven to function properly and be in compliance with Kitchener-Wilmot Hydro's design review.

After the off-line test is completed and before the on-line testing starts, the Customer arranges ESA site inspection and receives a Temporary Authorization to Connect from ESA. The Customer submits the Temporary Authorization to Connect along with the partially completed COVER (signed and sealed by a licensed Ontario Professional Engineer) for Kitchener-Wilmot Hydro's review before the DG facility is temporarily allowed in parallel with Kitchener-Wilmot Hydro's distribution system for on-line testing. Kitchener-Wilmot Hydro may request site witnessing and verification during DG commissioning at Kitchener-Wilmot Hydro's discretion.

Kitchener-Wilmot Hydro will request the DG developer sign a Connection Agreement before the final DG connection is approved.

7.2 Other Required Connection Approvals

7.2.1 IESO System Impact Assessment / Hydro One Customer Impact Assessment

If a DG developer proposes a new generation with an output greater than 10 MW, the project will require the IESO to complete a Transmission System impact assessment and Hydro One to complete a Transmission Customer Impact Assessment. Kitchener-Wilmot Hydro will represent the DG developer to submit IESO / Hydro One the applications. The DG developer will be responsible for the additional costs.

7.2.2 ESA Authorization to Connect

For all DG projects, the DG developer must submit plans to the ESA for project approval. The timing is up to the developer and may depend on the level of confidence and finality of the design but no DG project can be connected without ESA approval.

7.2.3 Minimum Requirements for DG Connection

Before any DG can be connected to Kitchener-Wilmot Hydro's Distribution System it must have received as a minimum the following approvals plus any additional approvals identified in the Preliminary or Design Reviews, or the Connection Impact Assessments by Kitchener-Wilmot Hydro:

- A Confirmation of Verification and Evidence Report (COVER) of the DG facility is signed and approved if required by Kitchener-Wilmot Hydro
- The ESA Authorization to Connect is received
- A signed Form DG05 - New Account Application if required by Kitchener-Wilmot Hydro
- A Connection Agreement with Kitchener-Wilmot Hydro is signed.
- All outstanding payment is clear.

7.3 Charges

There is no charge for the Preliminary Review. The DG developer will be required to pay a fixed cost for Kitchener-Wilmot Hydro's Connection Impact Assessment. For DG projects above 500kW, the DG developer will be required to pay a fixed cost for Kitchener-Wilmot Hydro's cost estimate.

In accordance with OEB's Distribution System Code, the DG developer will be required to pay actual costs for labour and materials for the Distribution System upgrades and connection costs including

but not limited to increased transformer capacity requirement, primary or secondary conductor, line extensions, switches and associated distribution hardware, metering, transfer trip equipment, and telemetry if required by Kitchener-Wilmot Hydro.

After the connection, the DG customer will be required to pay Kitchener-Wilmot Hydro a monthly DG account charge for meter reading and account administration. Where the EG is used for load displacement of existing load a standby charge may be applicable as approved by the OEB.

See the link below for rates information.

Link: http://www.kwhydro.ca/generation_rates.asp

7.4 Timeline

Kitchener-Wilmot Hydro will comply with the timelines laid down in the OEB Distribution System Code for tasks for which it is responsible but the elapsed time will only start when any payments required by Kitchener-Wilmot Hydro have been received and all technical information or any other data required for reviews, assessments or studies have been received to the satisfaction of Kitchener-Wilmot Hydro. Kitchener-Wilmot Hydro accepts no responsibility and makes no guarantees of the time required for other parties to complete their reviews or provide assessments, approvals or inputs.

8. Back-Up Generators and Other Off-Grid Generators

Customers with portable or permanently connected emergency generation capability are required to comply with all applicable criteria of the Ontario Electrical Safety Code Section 28, and particularly rule 75-613 preventing feedback on Kitchener-Wilmot hydro's distribution system.

Customers with permanently connected emergency backup generation equipment or other off-grid generation facility shall notify Kitchener-Wilmot Hydro regarding the presence of said equipment.

Customers considering installing a Closed-Transfer switch ('make before break' switching) for the back-up generation facility shall notify Kitchener-Wilmot Hydro and shall submit a protection study that satisfies Kitchener-Wilmot Hydro. The Closed-Transfer switches must not parallel the generator with Kitchener-Wilmot Hydro's distribution system for longer than 100 ms under any circumstances.

9. Acknowledgements

In compiling this document, AESI acknowledges the incorporation of material from the following sources which, to the best of AESI's knowledge, is publicly available reference information:

Hydro One Networks Inc.
Toronto Hydro-Electric System Ltd.
Kingston Electricity Distribution Limited
The Interstate Renewable Energy Council, and
The Wisconsin Interconnection Co-operative

Appendices

Appendix 1: Resource Links and DG Reference

Appendix 2: Definitions

Appendix 1: Resource Links and DG Reference

Resource Links:

* Where resource links are provided from external sources they are to demonstrate the scope of what is covered. They should be checked for accuracy and current revisions before they are used or relied on for information.

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

Net Metering Program: http://www.e-laws.gov.on.ca/html/source/regs/english/2005/elaws_src_regs_r05541_e.htm

The Renewable Energy Facilitation Office:
http://www.energy.gov.on.ca/en/renewable-energy-facilitation-office
Toll-free: 1-877-440-REFO (7336)

The Ontario Energy Board - http://www.oeb.gov.on.ca/OEB/

Distribution System Code & Retail Settlement Code
http://www.ontarioenergyboard.ca/oeb/_Documents/Regulatory/Distribution_System_Code.pdf

Licensing Information for Generators
http://www.ontarioenergyboard.ca/OEB/Industry/Licences/Apply+for+a+Licence/Apply+for+a+Licence+-+Electricity+Generation

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

Hydro One Networks Inc. - http://www.hydroone.com/

Electrical Safety Authority http://www.esasafe.com/

Electrical Guidelines for Inverter-Based Micro-Generator Facility (10kW and Smaller)
http://www.esasafe.com/assets/files/esasafe/pdf/Electrical_Guidelines_for_Inverter-Based_Micro_Generation_Facilities.pdf

Ontario Ministry of the Environment - https://www.ontario.ca/ministry-environment

Guide to Renewable Energy Approval
https://www.ontario.ca/environment-and-energy/renewable-energy-approvals

Ontario Ministry of Natural Resources - http://www.mnr.gov.on.ca/en/

Guide to Renewable Energy Approval
http://www.mnr.gov.on.ca/en/Business/Renewable/STEL01_129890.html

Measurement Canada - http://www.ic.gc.ca/eic/site/mc-mc.nsf/Intro

Industry Associations and Other Resources

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

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.csagroup.org/ca/en/home

DG Reference

OEB	Ontario Energy Board – Distribution System Code (DSC)
Ontario Regulation	Ontario Electric Safety Code (OESC)
CSA 22.3 No.9	Interconnection of Distributed Resources and Electricity Supply Systems
IEEE 1547	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.1	Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.2	IEEE Application Guide for IEEE Std 1547, Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.3	IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
CSA CAN3-C235	Preferred Voltage Levels for AC Systems, 0 to 50,000kV
Hydro One Networks	Distributed Generation Technical Interconnection Requirements
NPCC D12	Northeast Power Coordinating Council, Regional Reliability Reference Directory #12 – Under frequency Load Shedding Program Requirements
IEEE 1453	IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems
IEEE C37.119	IEEE Guide for Breaker Failure Protection of Power Circuit Breakers

Appendix 2: Definitions

Anti-Islanding (See Islanding) — The generator shall cease to generate power in the event of loss of LDC supply, and will not provide backup power in the event of loss of LDC supply

Applicant — same as EG Developer

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

CSA – Canadian Safety Association, Canada's nationally recognized testing and certification body.

Certified Equipment — A generating, control or protective system that has been certified by a nationally recognized testing laboratory or standard, such as CSA, Underwriters Laboratory (UL), IEEE, as meeting acceptable safety and reliability standards.

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

Conductor – An electrical wire that carries electricity

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

Connection Impact Assessment (CIA) – a review done by the LDC to determine what impact an EG will have on its distribution facilities with respect to voltage, equipment loading, short circuits up to and including the transmission system which may be owned and operated by others requiring additional and separate assessments.

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 embedded 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 — same as Embedded Generation

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 (DSC) — 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 embedded generation facilities and F.2 is an overview of the technical requirements.

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

Embedded Generation (EG) Developer — The legally responsible person applying to an LDC to interconnect an embedded generation facility to the LDC's distribution system.

Embedded Generation (EG) Facility — A facility for the generation of electricity 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. Also known as Distributed Generation ("DG") and Parallel Generation

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.

Feeder – a common term to describe an electrical distribution line.

Grid – a generic term that describes the electricity system. While normally referring to the transmission system it is occasionally used to refer to the distribution system.

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.

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 an embedded generation facility to the distribution system so that parallel operation can occur.

Interconnection Disconnect Switch — A mechanical device used to disconnect an embedded 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 an embedded 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)

Load displacement: - a generation facility which connected on the customer side of the electricity meter generates power for their own use and not for the purpose of sale. The EG systems that provide load displacement are intended to reduce the amount of electricity purchased from the LDC and are not intended to provide surplus electricity into the LDC's electricity system.

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 an embedded 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 UL or CSA 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 EG facilities can offset their associated load consumption and are compensated for any extra energy delivered to the electricity system. In Ontario, legislation permits embedded 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 an embedded generation facility while the facility is connected to the energized distribution system.

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

Point of Common Coupling (PCC) — 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 embedded generation facility is electrically connected to the customer's electrical system.

Preliminary Review — A review at the feasibility stage to determine the suitability of an embedded generation site and the LDC distribution facilities available for connection

Protective Equipment — Devices used on a Distribution System or at an EG facility that, using hardware and software, are designed to prevent unsafe operating conditions from occurring and to protect personnel and equipment from electrical faults on the distribution system or within the EG.

Single Phase Electricity – Single phase electricity is where the alternating current power is carried by two wires – a "live" and a neutral. More wires are visible on many residences because the single phase is split.

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).

Design Review — A more comprehensive evaluation of the embedded 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 embedded generation operating data using telecommunications techniques.

Three Phase Electricity - Three phase electricity is where the alternating current power is carried by three wires and the waveforms of current and voltage are 120 degrees apart.

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

Transformer – a piece of electrical equipment that converts electricity from one voltage to another, usually down in a distribution system.

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.

Transmission Lines/System – the network of wires and towers that operate at over 50 kV to move electricity over long distances form generating station to large load centres.

UL — Underwriters Laboratories.

Unit — same as embedded generation facility.