# Connecting Embedded Generation to

# Brantford Power's

# Electrical Distribution System

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## Introduction

As the Local Distribution Company (LDC) responsible for supplying, distributing and metering electricity within its licensed area, Brantford Power has prepared this information package for those parties interested in connecting Embedded Generation ("EG[1]") facilities to its Distribution System.

In the past, most electricity generation was provided from centrally located generating plants connected to a provincial high voltage transmission grid that moved electricity around the province to the supply locations where it would be distributed to individual customers.

Today many home, farm and small business owners are considering the installation of alternative forms of electricity generation such as renewable electricity generation (embedded generation) and connecting it to run in parallel with the Local Distribution Company (LDC) electrical system. Examples are the installation of small wind turbines, photovoltaic (solar) systems, micro-hydro turbines or renewable bio-mass, bio-fuel, bio-gas or water power. These systems are intended not only to reduce the amount of power purchased from the local electricity distribution company but also to export electricity to the LDC to generate revenue for the owners/operators. Where these systems are powered from renewable sources such as wind, flowing water or sunlight they also provide environmental benefits.

Technological improvements, regulatory reform, increased environmental consciousness, and Ontario's goal of increasing Renewable Electricity Generation capacity by 8000 Megawatts (MW) before the year 2025 has provided an opportunity to introduce wind, solar, bioenergy, and small hydro generation systems into the provincial energy mix. In order to encourage development of micro, small, and medium sized Renewable Energy Generation facilities, the Ontario Provincial Government introduced first the Standard Offer Program for Renewable Energy Supply (RESOP) which was succeeded by the Feed In Tariff Program (FIT) and in addition Net Metering options are available for those interested in supplying renewable energy through their local electricity distribution system.EG is any type of electrical generator or static inverter producing alternating current that has the capability of parallel operation with Brantford Power's Distribution System, or is designed to operate separately from Brantford Power's Distribution System and can supply a load that can also be fed by Brantford Power's system.

Although this information package primarily addresses the emerging role of EG through the sale of some or all of the electricity generated by exporting it through Brantford Power's electricity Distribution System, some EG is intended to provide electricity solely for a customer's own use, such as stand-by or load displacement generation. Where the

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

EG is not intended to export electricity to a Distribution System only certain sections of this document will apply.

EG also varies in design and fuels and while the Ontario Government's program only includes renewable energy such as wind turbines, photo voltaic cells, biogas and hydroelectric sources this guide is still applicable to generation from diesel or natural gas standby generators and natural gas co-generation. A further variable is size, from very small (micro) wind and photovoltaic units in the under 10 kilowatt (kW) range to larger generation in excess of10 megawatts (MW).

The variability and breadth of scope in potential projects and the range of understanding of EG developers make it a challenge to provide information on connecting EG to Brantford Power's Distribution System and those interested in connecting EG may or may not have an appreciation of the technical requirements and the complexity of electrical systems.

This guide contains an overview of the Ontario electricity transmission system, Brantford Power'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 implications for prospective EG developers generators.
- An overview of the options available for connecting different types of EG to Brantford Power'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 description of the administrative process for connecting EG facilities to Brantford Power's Distribution System.
- A section on the financial compensation process for EG supplied by Brantford Power
- The Initial Consultation Request form that starts the connection process.
- The Application Form to request a more detailed Connection Impact Assessment if a prospective EG developer wishes to pursue a project further.
- 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 EG developers.

This information package is intended as a starting point for those interested in connecting EG to Brantford Power's 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. Some of these documents are included as Appendices; others are available from various agencies and organizations, some of which are listed in Appendix 1. It is recommended

that anyone interested in connecting EG to Brantford Power'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 EG facilities to a Distribution System in Ontario, the rules, regulations, and specific documents shall take precedence.

EG proponents should also visit available websites and information sources to check if updated material is available or if changes have been made. Appendix 2 contains a number of definitions and terms that are used in this document.

If you are interested in connecting an EG facility to Brantford Power's Distribution System or have any questions about the content of this information package please get in touch with the Contact Person named on Page 18 of this document.

## Agencies and Organizations involved with Ontario's Electricity System

Some of the agencies and organizations involved in electricity in Ontario that EG 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<br>• Create other agencies IESO, OPA, OEB, etc., and determine public policy for the existence of Hydro One, OPG and LDCs<br>• 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 is also involved in demand management, conservation and renewable energy activities as directed by its mandate and government. RESOP and FIT contracts are between the OPA and the generator. |
| **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.<br>• The OEB issues licenses for generators, transmitters, distributors, and retailers.<br>• 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. The Province of Ontario owns OPG. |
| **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 LDCs from Transformer Stations (TSs) at 27.6 kV and 44 kV or Distribution Stations (DSs) at lower voltages. EG directly or indirectly connected to Hydro One TSs or DSs may require co-ordination with Hydro One. The Province of Ontario owns Hydro One. |
| **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). |
| **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. |

| | |
|---|---|
| **Brantford Power Inc.** | • 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. 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. The local municipality is the sole shareholder of Brantford Power. |

## Ontario's Electricity Transmission & 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 Brantford Power.

Brantford Power's electricity Distribution System delivers power to end users through 27.6 kV distribution lines. These lines deliver electricity to large (industrial scale), medium (institutional scale) and small (home scale) consumers, respectively.

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 EGs 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.

In general the maximum amount of EG that can be connected to Brantford Power's distribution lines is as follows:

Under 5 kV lines - small amounts of EG possibly up to 500 kW.
27.6 kV lines – up to 10 MW

The above examples presume the existence of three phase primary distribution facilities with sufficient conductor size and load levels to permit the presence of EG. Inadequate conductor size or certain load levels could restrict the amount of EG that can be accommodated. Brantford Power also has many other distribution facilities such as single-phase primary lines and secondary conductors which can handle very small amounts of EG but would need to be upgraded for larger EG installations. The actual ability of Brantford Power's lines to accept EG can only be determined by a thorough engineering review.

An LDC's distribution feeder capacity to accommodate EG can be limited depending on where the EG is to be located along the feeder. There could be a lesser capacity at the end of a long feeder than at the beginning, closer to the supply. At a low capacity site, the impact of the EG can be great enough to disturb other local customers. This is not acceptable. For this reason, it is sometimes necessary to reinforce the network, or connect the EG to a higher voltage or higher capacity part of the network at an alternate location.

The systems required to protect Brantford Power's Distribution System from faults and disturbances that can occur with an EG connected will also vary by EG size and distribution line parameters. This means that similar EG projects connected at different locations could have different protection requirements based on different local load conditions, as well as on Brantford Power's feeder and transformer characteristics.

Depending on the size, type, fuel, and location of an EG project, the Ministry of the Environment (MOE) may require that the EG developer complete an environmental assessment. Please contact the MOE for more information.

Details of Brantford Power's Distribution System are available, on request, to assist a potential EG developer to determine the approximate capacity of Brantford Power's line in the area of interest for an EG location.

## Size classifications for EG facilities

The first step in connecting EG 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 each vary depending on the size of the EG.

### Micro FIT

A Micro generation facility is defined as an EG 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 owners can receive financial benefits by displacing energy consumption from the grid. If it is a renewable energy generation facility, its owners can participate in either Net Metering or the

microFIT Program. The technical and financial requirements of other financial settlement options are often too onerous for Micro generators to consider. Micro generation is often subject to a simplified connection process due to its relatively minimal impacts on the electricity Distribution System when installed and less demanding ESA specifications.

### 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.

Brantford Power is required by the OEB's Distribution System Code to perform a Connection Impact Assessment (CIA) on all EGs greater than 10 kW. The cost is to be paid by the EG developer. Where the CIA process identifies the need for any upgrades, connection costs or metering changes required to connect to the Brantford Power Distribution System the costs are payable by the EG developer less any allowances by Brantford Power per the Distribution System Code.

### 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 require a Connection Impact Assessment to be paid for by EG developer and can anticipate complex technical and financial issues. The EG 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, Brantford Power may require system upgrades, metering changes and protective relaying modifications to be made at the generator's expense. Mid-size generators are not eligible for Net Metering, but can participate in all other financial settlement mechanisms.

### Large

Large distributed EG projects are those with total connected nameplate capacities of over 10 MW. These facilities are typically only connected to the highest voltage distribution lines or transmission lines and are subject to the most complex and costly

connection process involving Brantford Power the IESO and the OEB. 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 Ontario Power Authority for electricity supply.

Large EG projects are multi-million dollar initiatives requiring a high level of technical and financial sophistication. Large sized generators are not eligible for Net Metering or the FIT Program.

## Safety, Power Quality and 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, 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, while not going into extensive technical detail, therefore, where appropriate, references are given for those seeking additional details. A web search of EG interconnection will present a wealth of valuable information. See Appendix 2 for links to a few resources.

The OEB's Distribution System Code Appendix F.2 outlines the technical requirements for connecting a generator to an electricity distributor's system. Appendix 3 of this document specifies the Technical Requirements for an EG that is proposing to connect to Brantford Power's Distribution System. As part of Appendix 3 the relevant sections of Appendix F.2 have been cross-referenced as they relate to safety, power quality and protection.

### 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 EG 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 EG, 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 EG 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.

## Distinctions between types of EG

It is difficult to generalize safety issues with regard to EG 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 3.

Where EG is intended solely for load displacement and it can de demonstrated that it cannot and will never be connected, paralleled or export electricity to the Distribution System Brantford Power must still be advised of its presence but the approvals required are primarily from ESA.

## Islanding

One of the biggest concerns utilities have about EG is to avoid a condition known as islanding. Islanding happens when a section of the utility system containing both loads and an EG 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 EG disconnects from the Distribution System before the first automatic reclosure occurs. The EG must be disconnected automatically before the utility protective device recloses otherwise a) the EG 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 EG resulting in possible equipment damage to the EG, overloading or power quality issues

With central generation, transmission lines and transformer stations a utility knows that if an electrical circuit is isolated “upstream” and is not being fed from an alternative source it is de-energized. With EG, utilities need to come to terms with multiple sources of electricity supply on their systems and to deal with the change in operating conditions that result.

The utility may want to isolate a section of line for maintenance purposes. Opening switches would normally accomplish this. While a utility 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 EG to ensure that it too is isolated and not supplying the line section.

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

## Power Quality

Power quality is a significant technical concern for Brantford Power 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 EG 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 an EG 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 EG’s operating cycle. Whether the utility actively or passively regulates their voltages to maintain an acceptable range, the presence of EG must have no detrimental impact on that regulation. Normally the EG 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.

## 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 3 for specifications.

## Frequency

Frequency variations are a reliability and power quality issue and must be maintained within the range specified in Appendix 3.

## 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 EG 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 Brantford Power's Distribution System in excess of applicable standards. See Appendix 3 for further details and references.

## 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 3 for specifications.

## 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 3 for further details.

## 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 an EG vary, for example with some wind turbines if the wind is gusting or turbulent.

## Protection of EG Facility

The EG developer will be responsible for protecting it's EG 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 EG facility equipment. The equipment protection shall also prevent the EG facility from adversely affecting the Distribution System's capability of providing reliable service to other customers.

## Monitoring

For EG greater than 250 kW Brantford Power may require remote monitoring of the EG connection status, real power output, reactive power output, voltage and select alarms at the point of generator connection. For EG greater than 250 kW the monitoring must be in real time. See Appendix 3 for details.

## Standardized or Certified Equipment

The design for an EG 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 Brantford Power this will expedite and simplify the interconnection process. This is especially applicable at the lower EG output levels and will reduce the amount of technical information required.

## Protective Devices

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

- An interconnection device that is manual, lockable, has visible disconnection and is accessible to Brantford Power staff
- An interrupting device capable of interrupting the maximum available fault current at the EG 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 EG 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 EG parallels with the Distribution System.
- Transfer Trip may be required depending on the loading of the distribution feeder and the output rating of the EG 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 3 for further descriptions and details.

Brantford Power will provide three phase 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.

## Grounding

EG facilities must be grounded in accordance with any equipment manufacturers' requirements, the OESC and Brantford Power's requirements.

The EG must not disrupt any coordination of ground fault protection or cause over-voltages that exceed the rating of equipment connected to the Brantford Power Distribution System.

## Generation Connection Process

The process that Brantford Power is required to follow for connecting an EG to its Distribution System is detailed in the OEB's Distribution System Code, Appendix F. The starting point is for potential EG developers to complete Form A – "Pre-FIT Consultation Application" and return it to Brantford Power.

### Designated Point of Contact

The initial contact person at Brantford Power will be Steve Faulkner, C.Tech., Supervisor of SCADA, DG's & Smart Grid

Contact information is:

Brantford Power
84 Market Street
Brantford ON N3T 5N8

E mail: sfaulkner@brantford.ca

Phone: 519.751.3522 Ext: 3367

## Preliminary Review, Connection Impact Assessment, Technical Review

The following process is described in more detail in the OEB's Distribution System Code and Appendix F of the Code.

### Preliminary Review

In the very early stages where an EG developer is considering site selection, Brantford Power will provide a Preliminary Review and high level advice and guidance based on the limited parameters from your completed Form A – "Pre-FIT Consultation Application" such as:

- 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, Brantford Power will advise on

- The basic feasibility of the project.
- A range of cost estimates that might be encountered if changes or upgrades were required.
- The additional application forms and materials required.

## Brantford Power Connection Impact Assessment

Where the EG project is over 10 kW and where required, Brantford Power will perform a Connection Impact Assessment (CIA) at the EG developer's cost. The CIA looks at:

- The impact of the EG on Distribution System short circuit levels, load flows, current loading, voltage levels and voltage flicker under a variety of Distribution System and EG output conditions to ensure there are no adverse effects.
- The preliminary design of the protection systems being proposed for the EG 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 EG developer submits a completed Form B – "Connection Impact Assessment Brantford Power Inc.". The technical information required for the CIA includes:

### EG Description

- Site
- Type of EG
- 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

Brantford Power will advise the EG developer of the CIA results. If the impact of the EG is within acceptable limits the next step in the connection process can be commenced. If upgrades or changes are required the commencement to the next step will require a Connection Cost Recovery Agreement ("CCRA") between Brantford Power and the EG developer on costs. The EG 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

Where Brantford Power's Distribution Lines are supplied by or are capable of being supplied by a Hydro One Transformer Station, EGs greater than 500 kW and less than 10 MW connected to Brantford Power's Distribution System may have an impact on Hydro One's Transmission Facilities and will require their separate **Connection** Impact Assessment at an additional cost over and above Brantford Power's CIA cost. An EG greater than 10 MW and connected to Brantford Power's Distribution System will also require a **Customer** Impact Assessment from Hydro One to determine the impact on Hydro One's other transmission customers and an assessment of the impact on Hydro One's Transmission facilities.

More details on the process and costs can be obtained from: http://www.hydroone.com/Generators/Pages/ConnectionImpactAssessment.aspx

## IESO Impact Assessment

An EG developer proposing new generation with an output greater than 10 MW requires the IESO to complete a Transmission System Impact Assessment. The EG developer will be responsible for this additional cost.

## Merging Preliminary Review and Connection Impact Assessment

Where an EG developer is confident of the site for development and wishes to expedite the process it can save time to dispense with the formal Preliminary Review and move to the Connection Impact Assessment immediately.

## ESA Approval

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

## Technical Review

Once a location has been determined, a CIA completed, costs have been determined, approvals commenced or received and commitments have been made the project can proceed with a full Technical Review. The Technical Review will establish Brantford Power's requirements for the EG at the specific location expanding on and supplementing the information provided for the CIA. The Technical Review will require the EG 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 is as follows:

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 details
- Grounding studies
- Load interrupter switch or circuit breaker
- Dedicated interconnection transformer
- Isolating device for interconnection
- Protection system and operating procedures including schematics

## Charges

There is no charge for the Preliminary Review. The EG developer will be required to pay for Brantford Power's Connection Impact Assessment. These charges are detailed in Appendix 4. They do not include any of the following charges where required as explained elsewhere in this package

- the cost of a Connection Impact Assessment required by Hydro One or Brant County Power where a Brantford Power feeder is supplied by either of these utilities

- a Hydro One Transmission System Customer Impact Assessment or an IESO Transmission System Impact Assessment.

An estimate for the Technical Review will be provided when the CIA has been completed.

Brantford Power 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, protection upgrades, communications and associated distribution hardware.

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

## Timelines

Brantford Power 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 Brantford Power have been received and all technical information or any other data required for reviews, assessments or studies have been received to the satisfaction of Brantford Power. The queue position with Hydro One will be established when Brantford Power notifies Hydro One of any EG developer that has requested a CIA. Brantford Power accepts no responsibility and makes no guarantees of the time required for other parties to complete their reviews or provide assessments, approvals or inputs.

## Metering

Metering requirements will be determined by Brantford Power and will depend on the type and size of generation and the load, if any, where the EG is also a customer, at the EG location. Where the EG is exporting power a bi-directional meter capable of measuring electricity received from and sent to the Distribution System is required. The cost of all metering cabinets, instrument transformers, meters and if necessary a telephone line will be the responsibility of the EG developer. Brantford Power will supply and own the instrument transformers and meters.

Brantford Power Inc. metering specification

## Generator Licences

The OEB licences and regulates generators

MicroFit Program generators and Feed-in Tariff Program generators with gross nameplate capacity of 500 kilowatts or less are exempt from the need to obtain a generation licence.

Before applying for a licence the applicant must have entered into a contract with the Ontario Power Authority under the Feed-in Tariff program and have received from the Ontario Power Authority a Notice to Proceed for the generation facility/facilities covered by this application.
For details on licencing go to:

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

## Approvals

Before any EG can be connected to Brantford Power'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 Brantford Power and Hydro One:

- Brantford Power's Offer to Connect
- CSA or UL or recognized certification of all equipment installed
- ESA approval
- A Connection Agreement with Brantford Power
- Witnessing and Testing of EG facilities if required by Brantford Power

## Earning revenue from EG facilities

Ontario's electricity market offers a number of different methods for financial settlement with distributed electricity generators depending on their individual choices of generator size, fuel source, technical sophistication, and financial risk tolerance. Prospective EG 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.

### Load displacement

The function of load displacement EG 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 Brantford Power, the Ontario Power Authority, 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. Please visit the Ontario Ministry of Energy and Ontario Power Authority's Conservation Bureau websites for more information about conservation programs. Web links to these sites are contained in Appendix 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.

An EG 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.

## 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, bio-fuel, landfill gas, or water.

Renewable electricity generation facilities are eligible to participate in Net Metering and FIT Programs developed by Ontario's government to encourage the amount of electricity generated by these 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™.

### 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 embedded 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 EG systems up to 500 kW nameplate capacity.

A net metered EG 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 EG 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 EG decides to be net metered after an initial consultation with Brantford Power staff, a simplified connection process may be applicable depending on the size of the EG. For those electricity customers that have electricity supply contracts with licensed retailers other than Brantford Power, consultation with the retailer will be required before any net-metering arrangement can be made.

## Renewable Energy Standard Offer Program (RESOP)

In order to encourage embedded (distributed) renewable electricity generation, the Government of Ontario introduced a "Standard Offer" Program for Renewable Energy Supply. The goal of this program was to give Ontario renewable energy developers the long-term financial security they require to develop facilities under 10 MW in nameplate capacity. The program avoided the complexity, costs, and administrative burdens of a competitive bidding process for provincial energy tenders, providing Ontario businesses, community power groups, farmers, and others the ability to contribute towards the province's energy needs while realizing a reasonable financial return.

If a renewable energy facility fit the Standard Offer Program eligibility criteria, it was entitled to receive a base rate (2007) of 11 ¢/kWh for electricity produced by wind, bio-energy, or water power. There was a 3.52 ¢/kWh premium paid to facilities that could reliably deliver electricity during "on-peak" hours for production during these hours. Solar Photovoltaic projects received a price of 42 ¢/kWh (2007). Once a generator was approved for a Standard Offer Contract, they received a power purchase agreement with the OPA for 20 years.

As a pre-requisite for applying to the OPA for a 20 year power purchase contract, a prospective EG developer had to have progressed through the connection process described later in this document to the point where they have completed a Connection Impact Assessment from Brantford Power, unless their facilities have a capacity of 10kW or less.

Eligibility criteria, program rules, further pricing information, and metering requirements can be found on the OPA's website, listed in Appendix 2.

Once an EG is connected to the Distribution System and is producing electricity, Brantford Power will pay the EG owner the Standard Offer price per kWh delivered. Brantford Power will then settle accounts with the OPA for the difference between the Standard Offer price paid to the generator and the HOEP. This may require more technically complex metering equipment than would be applicable for Net Metered customers.

## Feed In Tariff Program (FIT)

FIT replaced RESOP in 2009. Much of what is described above also applies to FIT but some differences are as follows:

- Power purchase prices vary by project fuel, type and there are adders for community related, aboriginal partners and peak performance
- FIT requires an OPA Contract first then a Connection Impact Assessment for projects greater than 10 kW. Under 10 kW the OPA issues a conditional offer

which is subject to Brantford Power having sufficient distribution system capacity to connect.

Eligibility criteria, program rules, further pricing information, and metering requirements can be found on the OPA's website, listed in Appendix 2.

Once an EG is connected to the Distribution System and is producing electricity, Brantford Power will pay the EG owner the Standard Offer price per kWh delivered. Brantford Power will then settle accounts with the OPA for the difference between the FIT price paid to the generator and the HOEP. This may require more technically complex metering equipment than would be applicable for Net Metered customers.

### Other considerations

Costs and risks for prospective EG developers are not limited to the purchase, installation, and operation of generation equipment. There are costs and risks associated with technical considerations listed previously, connection to Brantford Power'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 EG 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.

## 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

Appendix 2: Definitions

Appendix 3 Technical Requirements for Embedded Generation Applicants requesting connection to Brantford Power's Distribution System

Appendix 4 Brantford Power Connection Impact Assessment Charges

* Where Appendices 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.