INTRODUCTION

Currently, much of the energy produced by generators in Ontario is generated by large centralized plants connected to the high voltage transmission system. Distributed generation (DG) is a term used to describe the small scale production of power, typically located close to electricity consumers. In Ontario, the market rules describe distributed generation as "embedded generation". In this document, the terms distributed generation and embedded generation are synonymous. Technologies used for embedded generation include combined heat and power, solar, wind, biomass and gas. In Ontario, these plants are often located "behind the meter" at sites such as hospitals, greenhouses and industrial sites. Other stand alone embedded generation sites are connected directly to distribution systems and are settled in the retail market.

In August 2005, the Minister of Energy requested that the Ontario Power Authority (OPA) and the Ontario Energy Board (OEB) work together to address barriers to the development of small electricity generating projects using clean or renewable energy sources within the electricity distribution system in the Province.

In November 2006, the OPA launched a Renewable Energy Standard Offer Program (RESOP) for the Province, and will be launching the Clean Energy Standard Offer Program (CESOP) in early 2008. RESOP contracts presently total greater than 840 MW. Both these programs focus on generators less than 10 MW which are connected to the distribution system. More information on these programs can be found at www.powerauthority.on.ca

These smaller projects, when connected to the distribution system, can make a significant aggregate contribution to security of supply for Ontario consumers and to achieving the Government's objectives for a clean and renewable energy supply in the future.

The IESO has prepared this paper to facilitate discussion with stakeholders on the integration of these and other embedded generators into the reliable operation of the IESO controlled grid (ICG) and the efficient administration of the markets.

The IESO has held some preliminary discussion with the OEB, EDA and OPA on the issues presented below. The OEB, OPA and IESO have agreed to move forward in a coordinated manner with each agency managing its area of responsibility. It must be recognized that each agency and the LDCs, as a whole, may have differing requirements because they face different challenges within their area of responsibility.

PRINCIPLES

The principle issues that will drive the successful integration of increased embedded generation in Ontario are:

1. Reliability – Embedded generation must not degrade the quality and reliability of supply to distribution-connected consumers.
2. Visibility – Embedded generation must be visible to the IESO so that the IESO can efficiently operate the wholesale market and make real time decisions for the reliable operation of the grid.
3. Standards – Technical standards for embedded generation must support the reliable operation of the IESO controlled grid and the distribution system. Standards may apply to embedded generation or to the distribution systems to which this generation is connected.

BACKGROUND

At the time of market opening it was estimated by the IESO that there were over 1400 MW of installed capacity of embedded generation in the province that was not participating directly in the IESO administered markets. The capacity factor of these resources is not known, nor is their production pattern.

The Ontario Power Authority report on the Renewable Energy Standard Offer Program details over 560 MW of signed contracts for embedded generation with about 22 MW already in service. Other OPA programs for embedded generation, such as the Clean Energy Standard Offer Program, have not indicated targets at this time.

In September of 2005, the IESO implemented market rule changes to lower the entry barriers for small embedded generators who wished to enter the wholesale market. These changes involved a lesser standard for providing telemetry to the IESO and reduced requirements for revenue meters. These requirements are detailed below in a summary of existing obligations for embedded generation participating in the wholesale market and for those who choose not to participate.

EXISTING MARKET RULE REQUIREMENTS FOR EMBEDDED GENERATORS

The market rules already set out some obligations on embedded generators who are market participants, embedded generators who are not registered, or set out obligations on generator "hosts" such as Connected Wholesale Customers or Local Distribution Companies (LDCs). Generators larger than 500 kW require a licence from the OEB which obligates that generator to follow the market rules. Since Standard Offer Program generators are not market participants, the enforcement of the market rules would fall to the OEB through generator licence obligations. Table 1 below summarizes the requirements for embedded generators.

Requirement	Embedded within a distribution system (could include an industrial or generator host) Generator chooses to be a Wholesale Market Participant	Embedded within a distribution system (could include an industrial or generator host) Generator is <u>not</u> a Wholesale Market Participant
Revenue Meter	Market Rules allow for lesser standard for embedded generators smaller than 2 MW (Market Rules Chapter 6, Section 4.6) Some requirements may arise under Transmission tariff regulation for embedded generation built after 1998. (Ontario Transmission Rate Schedules, Ontario Energy Board sections F, G & H.)	Retail standards apply. (Ontario Energy Board Distribution System Code section 5) Some requirements may arise under Transmission tariff regulation for embedded generation built after 1998.
Modelling Data	All registered generators must be modelled in IESO dispatch and system tools. Detailed model data including dynamic data may be required for generators greater than 10 MVA as designated by the IESO for reliability (Market Rules Appendix 4.6).	Detailed model data including dynamic data can be requested by the IESO through the connected host for generators greater than 10 MVA where required for reliability.
Connection Assessment	The host market participant must apply for a system impact assessment when the DG connecting to its distribution system is greater than 10 MW.	The host market participant must apply for a system impact assessment when the DG connecting to its distribution system is greater than 10 MW.
Performance Standards	Chapter 4 Appendix 4.2 applies to embedded generators greater than 10 MVA or facilities greater than 50 MVA. (Market Rules Chapter 4, Section 3.1.3.)	Chapter 4 Appendix 4.2 applies to embedded generators greater than 10 MVA or facilities greater than 50 MVA. (Market Rules Chapter 4, Section 3.1.3.)
Telemetry	If a generator is registered as dispatchable, market rules allow lesser standard using internet protocol for provision of MW and unit status for units under 20 MW. Embedded generators greater than 20 MW who are dispatchable would fully comply with telemetry requirements. Self Scheduling or Intermittent Generators would provide telemetry as requested by the IESO for reliability purposes (Market Rules Chapter 4, Appendices 4.15 and 4.19).	Non market participant generators may be required to provide telemetry such as MW, MVAr, unit and breaker status for reliability purposes. These requests are made via the host market participant, e.g. industrial site, LDC.
Report Outages	Dispatchable embedded generators report on outages to auxiliary equipment such as dispatch workstation, Remote Terminal Unit. All embedded generator types greater than 10 MW report deratings and outages according to the materiality.	LDCs or host entity report outages on embedded non participant generators via reporting on their own consumption according to the materiality (Market Manual 7.3: Outage Management, Sections 1.3.6 & 1.9).
Synch, De sync Procedures	No requirements under 20 MVA.	No requirements.
Direct Output Down	All market participant embedded generators may be directed to reduce output when required for reliability purposes (Market Rules Chapter 5, Section 3.6.1.6).	Market Rules Chapter 5, Section 3.7.14 obligates distributors and other type of hosts to follow the direction of the IESO, which includes directions to disconnect facilities or equipment from the ICG or its distribution system for reliability purposes.

Requirement	Embedded within a distribution system (could include an industrial or generator host) Generator chooses to be a Wholesale Market Participant	Embedded within a distribution system (could include an industrial or generator host) Generator is <u>not</u> a Wholesale Market Participant
Direct Output Up	All dispatchable market participant embedded generators may be directed to increase output when required for reliability purposes through the constrained dispatch (Market Rules Chapter 7, Sections, 3.3.10, 3.3.13 & 6.3).	No requirements.
Voice Communication	Self scheduling and intermittent generators must provide a Publicly Switched Telephone Network (PSTN – regular telephone line). Dispatchable generators must provide a Normal priority (regular telephone line dedicated to the use of the IESO and answered live 24/7).	No requirements.
Submit Dispatch Data – offers, schedule or forecast	All registered generators provide dispatch data according to market timelines.	No requirements.
Long Term Forecast Data	Market participants provide long term forecasts for the use of the IESO in assessments.	LDC or host submissions incorporate the output of load displacement generators in their long term forecasts to the IESO.
IESO Reliability Compliance Program	Some requirements on embedded generators (e.g. underfrequency trip settings).	Some requirements on embedded generators carried out via host LDCs or connected wholesale customers.
MACD	MACE may enforce market rule requirements on LDC and embedded generators choosing to be a market participant.	MACD can only enforce requirements on LDCs registered as market participants. SOP generators are obliged to follow the market rules but enforcement is handled by OEB.

This table summarizes requirements set out at the time of market opening and those that have evolved since that time. The increasing market penetration of embedded generation means that these requirements should be re-evaluated to ensure the reliable operation of the IESO controlled grid and the efficient operation of the IESO administered markets.

DISCUSSION OF CURRENT REQUIREMENTS

The following sections will provide a preliminary assessment of whether current requirements are adequate for increasing amounts of embedded generation and identify areas for review, as well as topics that will require a coordinated approach among various stakeholders and authorities.

Revenue Metering

No changes are required to the market rules for non market participant embedded generation. Units built after 1998 are subject to metering requirements under the Ontario Transmission Rate Schedules, Ontario Energy Board sections F, G & H. The Retail Settlement Code sets requirements for generation participating in the retail market.

Modelling Data

A limited amount of data is currently provided for embedded generation above 10 MW during market entry, but it does not seem practical to expect detailed model data and supporting test data from small generators under 10 MW.

In order to support Connection Assessment processes, manufacturer's dynamic data may be required to maintain system reliability as the penetration of embedded generation increases and approaches the amount of local loads.

Connection Assessment Process

To ensure the successful integration of embedded generation in Ontario, system reliability must be maintained. Appropriate processes must be in place to allow both the IESO and transmitters to assess the effect on system reliability of significant embedded generation penetration. At some threshold, the connection of new generators to the distribution system might require major equipment upgrades on the distribution system, and possibly on the transmission system. This could include major station equipment such as power transformers, reactive support devices, protection relays and other equipment.

Presently, a number of processes are in place to allow the reliable connection of individual embedded generation projects. Through the OEB Distribution System Code, LDCs require that each embedded generation facility apply for a Connection Impact Assessment. Under the Connection Assessment and Approval (CAA) Process, the IESO requires that LDCs apply for System Impact Assessment on behalf of any embedded generating facility larger than 10 MW seeking to connect to their distribution systems. The transmitter also undertakes a Customer Impact Assessment to determine the effect of the new generating facility on other transmission customers already connected.

Currently, Hydro One has several transformer stations where the total capacity of projects applying for connection assessments to the distribution system could cause a net injection (back feed) into the transmission system. In many of these cases, the individual projects are of a size that a System Impact Assessment would not be triggered, but the resulting back feed may require an assessment to determine the effects on the transmission system. The IESO has held discussions with the OPA and LDCs about options to trigger an assessment under these types of situations. The options include:

- The use of the IESO's Connection Assessment and Approval (CAA) Process where the generation aggregate behind a transformer station approaches a 10 MW injection into the ICG at the connection facility. For each of these situations, the IESO will perform a System Impact Assessment to determine the effects on the transmission system and the reinforcements required to mitigate any negative impacts.

  This option would require amendments to market rules and processes to obligate LDCs to bring forward requests for System Impact Studies once the aggregate amount of DG proposed reaches the designated threshold.

- The OPA could require proponents through their contracts to request a System Impact Assessment from the IESO when their proposed connection resulted in some specified outcome such as the above noted 10 MW back feed.

The second option would only be applicable to Standard Offer Program participants, and may be difficult to implement. Proponents would need to work with their LDC to determine their placement in a "queue" in order to determine whether they needed to proceed with a request to the IESO.

The first option would include all embedded generation projects, regardless of their origins. For this reason, as well as ease of implementation as noted above, the IESO recommends that this option be pursued.

During the course of this stakeholder effort and the recommended rule amendments, supporting changes needed to OEB Codes and OPA contracts may be identified. For example, the Distribution System Code currently sets a threshold of 10 MW for projects requiring a System Impact Assessment. Resolution of these issues will be outside the scope of this effort and will result in referral to the appropriate agency.

Performance Standards

Performance standards for generation and load facilities are well established and specified in the market rules.

Performance standards applicable to medium to large size generating facilities are included in the market rules and used to assess the performance of all new generation proposals. The standards listed in Chapter 4 Appendix 4.2, however, only apply to embedded single generators greater than 10 MVA or generating facilities greater than 50 MVA.

Performance standards for wholesale customers and distributors applicable at the connection point to the IESO controlled grid are also included in the Market Rules. The standards listed in Chapter 4, Appendices 4.7, 4.17, and 4.22 apply to distributors and connected wholesale customers.

From the ICG perspective, an LDC with a large aggregate of distributed generators appears as a new type of facility that sometimes behaves like a load and other times like a generator, and the current performance standards may not be adequate, or consistently applied.

Performance standards may need to be developed or reviewed for both the embedded generation and the host facility to which they are connected. These standards may include:

- Power factor requirements for host distribution systems or connected wholesale customer stations connected to the IESO controlled grid,
- Reactive power control requirements for net power injection into the ICG,

- Dynamic reactive power compensation requirements,
- Review and coordination of under frequency generator tripping requirements for embedded generators connected behind a transformer station and under frequency load shedding requirements for host distribution systems,
- over frequency tripping and automatic reconnection,
- Coordination of IESO low voltage ride through (LVRT) requirements with LDCs requirements to prevent islanding through use of low voltage trip settings.

The IESO, through market rules and connection requirements can develop performance standards to maintain the reliability of the IESO controlled grid. It should be noted however, that requirements placed on connected market participants or the embedded generators that connect to their facilities will create costs that will have to be allocated. The means of allocating these costs are generally laid out in the OEB Codes and decisions. Any discussion of new or revised performance standards will have to identify to the OEB where issues may need to be resolved for the successful integration of embedded generation into the Ontario electricity system.

In addition to IESO performance standards, LDCs may also have requirements that may need to be addressed to successfully integrate increasing amounts of embedded generation into the reliable operation of the distribution system. Some examples include the use of soft start for embedded generation and transfer trip schemes. The IESO will identify these LDC requirements as part of this stakeholder effort.

Telemetry

Once embedded generation is in service and exceeds some threshold amount, the IESO's ability to efficiently operate the market may be impacted. For example, the IESO uses a "Similar Day Load Forecast" methodology to feed the market dispatch. Inaccuracies in the forecast can lead to inefficient unit commitment day ahead or three hours ahead of real time, and can lead to inefficient setting of import and export schedules. The visibility of embedded generation would allow the IESO to modify forecast methodologies to accommodate the uncertainty of generation not under our dispatch control.

In addition, real time visibility of embedded generation would assist the IESO in maintaining the reliability of the IESO controlled grid, where the real time visibility of the net load at connected transformer stations may not be sufficient.

Since this telemetry would not be directly used for calculation of security limits or dispatch of the system, a lesser telemetry standard (such as that in the market rules Chapter 4 Section 7.3.2.3. and Appendix 4.19) will be sufficient and would apply only where high speed internet facilities exist. The threshold for provision of this data would need stakeholder input, and would need to be coordinated with requirements that distributors have for telemetry through the OEB Distribution System Code.

In order to obtain telemetry representative of embedded generation, there are two options for the IESO to evaluate with stakeholders:

Options:

1. OPA could specify requirements in contracts. Generators would need to provide an "internet gateway" connection to communicate the number of MWs being generated. Standard protocols would be used (TCP/IP). Generators would be responsible for the standard communication costs (e.g., high speed Internet Service Provider). The IESO would need to provide an aggregation server in order to integrate the data into IESO systems.

2. Connected hosts such as Connected Wholesale Customers or LDCs would provide a telemetered value of the total MWs per service territory or connection point. These values would be provided to the IESO within less than one minute from change in field monitored quantity (reference Chapter 4, Appendix 4.23 for Minor Dispatchable Load Facility and Non-Dispatchable Load Facility performance standards). LDCs would need to mandate participation through their connection agreements. Both Connected Wholesale Customers and LDCs would need to be obligated to provide this telemetry through market rule changes. As above, the standards can be met through the provision of an "internet gateway" connection to communicate the number of MWs and MVAr being generated behind the meter. Standard protocols would be used (TCP/IP). Hosts would be responsible for the standard communication costs (e.g., high speed Internet Service Provider). IESO would need to provide an aggregation server.

Option 2 has benefits if the implementation is coordinated with LDC requirements for telemetry arising from their own system operation and the OEB Distribution System Code. The Code currently allows LDCs to request real time date from embedded generators larger than 250 kVA (Appendix F2, Section 9).

Outage Reporting

Currently connected LDCs and host sites report on generation outages via their reporting of load consumed. For LDCs that have embedded LDCs or loads that host generation, this presents practical problems. If the IESO has visibility of embedded generation, we could develop history of generation patterns that would assist in forecasting Ontario demand.

Synch, De-Synch Procedures

No changes are needed at this time to this requirement, particularly if the IESO gains visibility of embedded generation in an aggregate format.

Direct Output Up or Down

No changes are needed at this time to this requirement. In some instances, LDCs may seek the ability to curtail embedded generation for their own system operation needs. This would be carried out through changes to the OEB Distribution System Code.

Voice Communication

No changes are needed at this time if the IESO has visibility of embedded generation.

Submit Dispatch Data

No changes are needed at this time if the IESO has visibility of embedded generation.

Submit Long term Forecast Data

No changes are needed at this time if the IESO has visibility of embedded generation. The IESO could develop models from historical information derived from telemetered data.

IESO Reliability Compliance Program

No changes are anticipated in IRCP requirements. All requirements for participation in the IRCP are derived from standards authorities, and so are outside this review.

Market Assessment and Compliance Division (MACD)

No changes are required. Enforcement on any LDC requirements will be carried out by MACD while any enforcement on SOP generators would require OEB intervention as the generators not market participants.

RECOMMENDATIONS

1. IESO should work with LDCs, the OPA and the OEB to develop an effective and inexpensive means of providing Real Time visibility of embedded generators to the IESO, and possibly to distributors for effective market and system operation, including the operation of the distribution system.

2. The IESO should work with all interested stakeholders to review and revise Connection Assessment and Approval requirements and rules including:

    - Trigger level for an system impact assessment due to aggregate installed embedded generation.
    - Provision for obligations on participants to bring forward aggregate embedded generation for system impact assessment, allocation of study costs.

3. The IESO should work with all interested stakeholders in evaluating the effectiveness of existing performance standards for embedded generation. Particular attention should be given to the coordination of requirements for embedded generation and their host connected load facilities. Standards include:

- Power factor requirements for host distribution systems or connected wholesale customer stations connected to the IESO controlled grid,
- Reactive power control requirements for net power injection into the ICG,
- Dynamic reactive power compensation requirements,
- Review and coordination of under frequency generator tripping requirements for embedded generators connected behind a transformer station and under frequency load shedding requirements for host distribution systems,
- Over frequency tripping and automatic reconnection,
- Coordination of IESO low voltage ride through (LVRT) requirements with LDCs requirements to prevent islanding through use of low voltage trip settings.