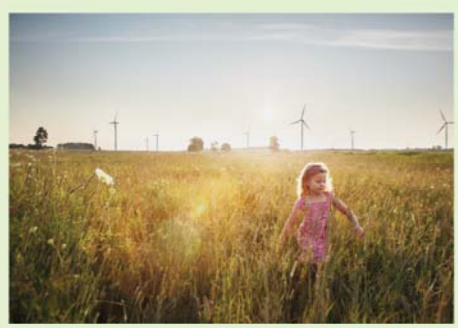

Southwestern Ontario

Reactive Compensation
Milton SVC

March, 2012

ONTARIO POWER AUTHORITY

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Southwestern Ontario Reactive Compensation – Milton SVC

1 Summary and Purpose

This document provides information from the OPA with respect to the Southwestern Ontario Reactive Compensation project (Milton SVC) as proposed in Hydro One's 2013-2014 Transmission Rate Application.

The OPA recommends that Hydro One install a static var compensator ("SVC") with a capacitive capacity of 350 MVAr at the Milton switching station ("SS"). The purpose of the project is to support the Government's policy objectives relating to renewable resource incorporation and provide local voltage support and regulation to the west GTA area.

This project was also referenced in the Ontario Government's Long Term Energy Plan ("LTEP") and Supply Mix Directive ("SMD") as one of five priority transmission projects required for, among other things, renewable generation incorporation; and directed the OPA to define and make recommendations on the scope and timing of this upgrade.

2 The Bruce Electric System

Existing Transmission System in the Bruce Area

The existing bulk transmission system in the Bruce area consists of a 500 kV network connecting the Bruce Nuclear Complex and the Greater Toronto Area ("GTA"), and an underlying 230 kV network, as shown in Figure 1 below. The 500 kV network consists of two main transmission paths: one between the Bruce Nuclear Complex and the Milton SS in the western part of the GTA (which will include the new double-circuit 500 kV Bruce-to-Milton transmission line expected to be in service by the end of 2012) and another connecting the Bruce Nuclear Complex to the GTA via the Longwood transformer station ("TS") near London, the Nanticoke TS on the shore of Lake Erie, and the Milton SS. The 230 kV network consists of three double-circuit transmission lines between the Bruce Nuclear Complex and the Kitchener, Orangeville, and Owen Sound areas, and provides connection points for many of the individual generation projects in the Bruce area.

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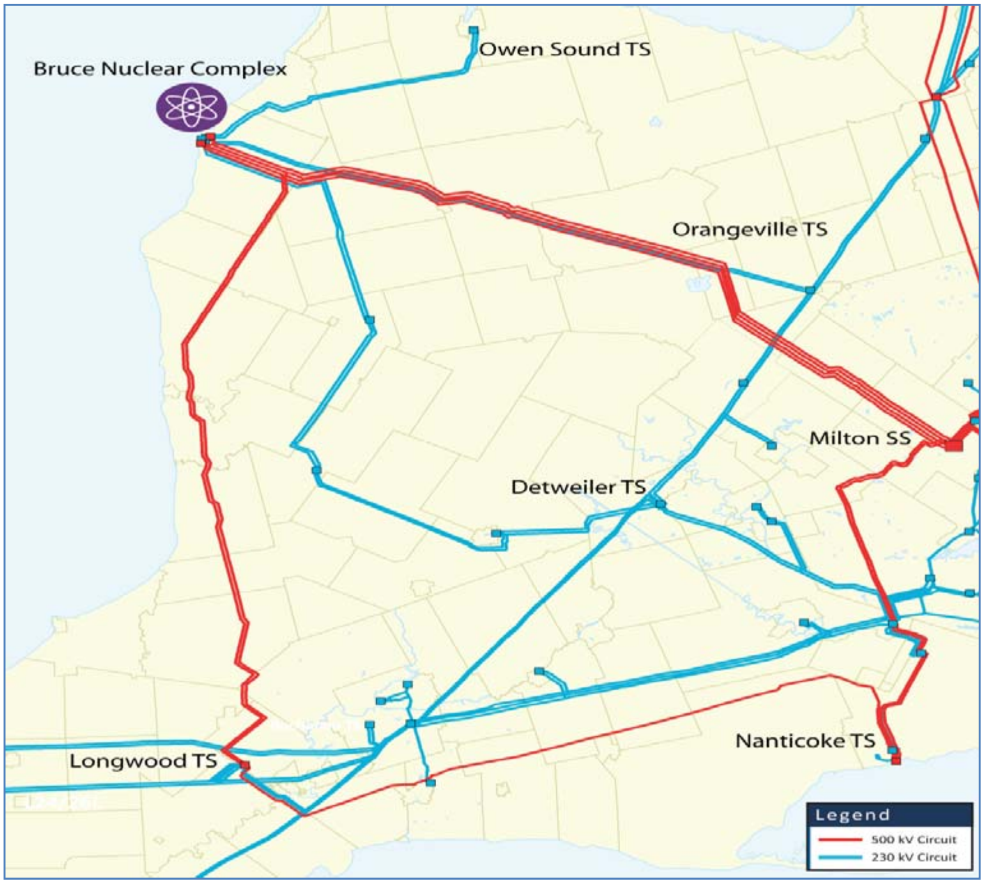
Figure 1: Bruce Area Transmission System



Source: OPA

Existing Bruce Area Resources

The Bruce area is a resource-rich area with significant electricity generation capacity. The area includes the Bruce nuclear complex, located on the shore of Lake Huron. Today, the Bruce nuclear complex has the capacity to generate approximately 5,000 MW. This capacity will increase to approximately 6,500 MW once the remaining refurbished units return to service in 2012.

The Bruce area also contains significant renewable generation resources (predominantly wind). To date there are approximately 1,700 MW of existing and contracted wind generation projects in the Bruce area. Figure 2 provides an overview of the installed resources based on existing and contracted generation.

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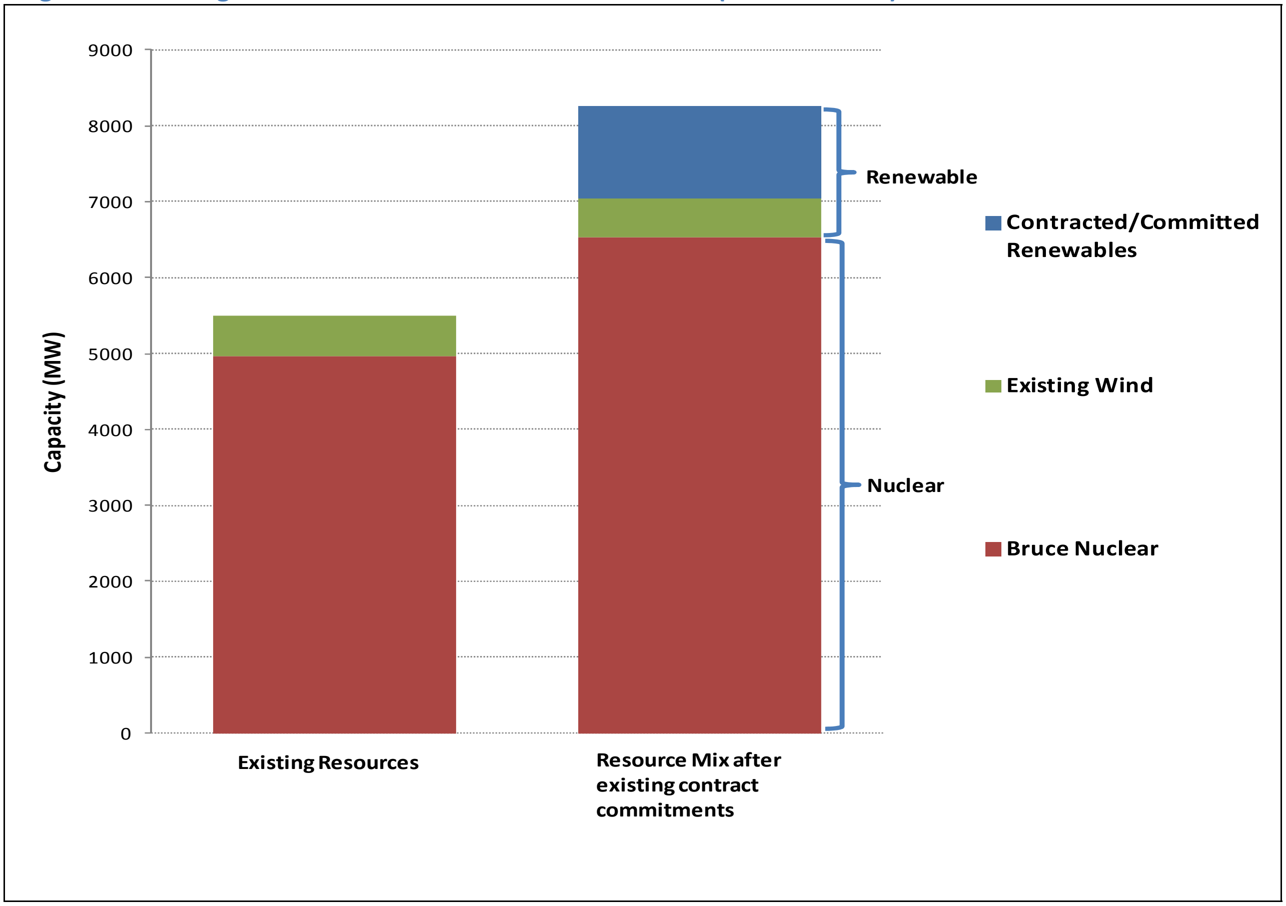
Figure 2: Existing and Contracted Bruce Area Generation (Installed MW)



Source: OPA

3 Need Assessment

Policy Objectives and Renewable Potential in the Bruce Area

The LTEP and SMD established goals for the level of installed generation resources in the Province, which includes a target for non-hydroelectric renewable generation (i.e. wind, solar, and bioenergy) by 2018. This target stated that "the OPA shall plan for 10,700 MW of renewable energy capacity, excluding hydroelectric, by 2018".[1]

The OPA estimates that approximately 3,300 MW of additional non-hydroelectric renewable generation will be required in order to achieve the 10,700 MW target. Further, the OPA expects that this remaining 3,300 MW will be satisfied in part through the Feed-in Tariff ("FIT") program (approximately 1,900 MW) and in part through the implementation of the remaining three phases of the Government's agreement with the Korean Consortium (approximately 1,400 MW).

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[1] February 17, 2011 Supply Mix Directive issued to the OPA by the Minister of Energy

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The Ontario wind atlas indicates a great density of high wind speeds in the Bruce area. Given the high quality wind resources and the significant FIT interest expressed in the region, it is anticipated that the Bruce area will play an important role in meeting the 10,700 MW non-hydroelectric renewable generation target.

Need to Enhance Transfer Capability out of the Bruce Area

After accounting for existing and contracted generation, the existing Bruce system will be nearly fully utilized, with about 200 MW of transmission transfer capability remaining. The amount of additional generation that can be accommodated in the Bruce area will be limited by the potential voltage instability that could occur on the Bruce transmission system following the outage of one of the double-circuit Bruce to Milton 500 kV lines.

Because the Bruce capability is limited by the voltage stability issue, reactive compensation is needed to enhance the transfer capability out of the Bruce area and enable the accommodation of additional generation in the area.

Need to Provide Voltage Support to the west GTA

With a large amount of power transferring from the Bruce area to the GTA, reactive power support is needed to maintain voltage stability. Currently there is gas generation located in the Milton/west GTA, (Sithe-Goreway GS and Halton Hills GS) which can provide reactive support when they are generating. However, when this local generation is not available, such as during off-peak periods or when they are on maintenance, alternate reactive compensation is needed for maintaining voltage regulation and system stability in the western part of the GTA.

4 Alternative Evaluation and Recommendations

Assessment of Options for Reactive Compensation to enhance transfer capability out of the Bruce area

The OPA assessed two industry standard technologies for providing reactive compensation: static var compensation and series compensation. Either of these technologies may be implemented to provide reactive compensation in the Bruce area.

Static var compensators are dynamic capacitors that automatically adjust to system conditions to regulate the voltage at a pre-set point on the system; they are typically installed at an existing station. SVCs are a proven technology that has been implemented in Ontario at Nanticoke TS, Detweiler TS, and in northern Ontario. Several locations in southwestern Ontario have been studied with respect to the installation of SVCs. The results indicate that installing SVCs at Milton SS would provide maximum capability to accommodate generation and also provide the added benefit of providing local voltage support and regulation to the west GTA.

Series compensation involves the insertion of static capacitors along a transmission line to regulate voltage. Like SVCs, series compensation is a proven technology that has been applied in Ontario. Series

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compensation options on the Bruce-to-Longwood and Longwood-to-Nanticoke circuits are being considered as options to provide reactive compensation in the Bruce area. Unlike SVCs, series compensation would require development of a new site to host the equipment. Interaction between series capacitors and nearby turbine generators could also result in sub-synchronous resonance, creating vibrations that could damage equipment.

Based on the above technologies, the OPA identified five alternatives for consideration. These alternatives, which are summarized in Table 1 below, were evaluated based on the incremental capacity they would add and their estimated cost.

Table 1: Southwestern Ontario Reactive Compensation Alternatives

Alternatives	Alternatives Description	Incremental Capacity (MW)	Cost Estimates (M$)
1	**350MVar SVC at Milton**	**250**	**100**
2	**30% Series Compensation on B562/563L and N582L**	**210**	**150**
3	**350MVar SVC at Milton + 30% Series Compensation on B562/563L**	**260**	**200**
4	**350MVar SVC at Milton + 30% Series Compensation on N582L**	**330**	**150**
5	**350MVar SVC at Milton + 30% Series Compensation on B562/563L and N582L**	**410**	**250**

Source: OPA

Recommendation of the Milton SVC Project

Based on cost effectiveness, land use, and technical considerations, the OPA identified the Milton SVC as the recommended project. Moreover, as described above, the addition of SVCs does not create sub-synchronous resonance issues and, as they would be installed at an existing station, this option would minimize adverse impact on transmission system and land-use/environmental impacts.

This project will increase the capability of the Bruce transmission system by approximately 250 MW, depending on where future projects may be connected.

As Milton SS is located in the west GTA area, adding an SVC into the station will also provide local voltage support and regulation to this area. When both Sithe-Goreway GS and Halton Hills GS are not available, there is a need to replace the voltage support and regulation functions of those local generating units with other types of reactive power sources. The proposed SVC at Milton SS provides these capabilities.

In October 2011, the OPA provided Hydro One with a recommendation for the scope and timing of the Southwestern Ontario Reactive Compensation upgrade project in accordance with Hydro One's licence conditions. The recommended project consists of adding an SVC with a capacitive capacity of 350 MVAr and connecting to the 500 kV voltage level at the Milton station. Based on discussions with Hydro One, an in-service date of spring 2015 has been established for this project.

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