

Technical Study
of a High Capacity Interconnection
between
TransÉnergie (TÉ)
and
Ontario Hydro Services Company (OHSC)

Prepared by
TÉ-OHSC Technical Studies and Planning Working Group



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1. Introduction

1.1 Background

Following the January, 1998 ice storm, which resulted in numerous transmission line outages and load interruptions to customers in southwestern Québec, the Québec Government directed Hydro-Québec to submit a recommendation to improve the security of power supply.

Hydro-Québec's recommendations to improve the security of power supply with two projects in the Outaouais Area consisted of:

1. Establish a temporary interconnection with Ontario, capable of providing 400 MW of emergency support to the Outaouais area with a proposed in-service date of December 1998.
2. Construct a 315 kV double-circuit line between Grand-Brûlé and Vignan substations to reinforce the supply to the Outaouais Region with a proposed in service date of December 1999.
3. Establish a permanent interconnection with Ontario to reinforce the overall system using the temporary interconnection facilities with a proposed in service date of December 2000.

On January 28, 1998, the Québec Government granted decrees to Hydro-Québec to carry out the recommended projects, including the three recommendations above, to improve the security of power supply mainly for the areas affected by the ice storm.

1.2 Subsequent Activities in Hydro-Québec and Ontario Hydro

Following a senior management meeting between HQ and OH held on March 5, 1998, a Joint OH-HQ Technical team was established to assess the proposed temporary and permanent interconnection. As shown its Preliminary Feasibility Report dated May 1998, the Technical Team concluded that the optimal solution to fulfill items (1) and (3) in 1.1 above was:

- Establish the temporary interconnection by building a 230 kV double-circuit line from a new "Outaouais" substation to the Masson River crossing to connect with the 230 kV circuit D5A into Ottawa.
- Convert the temporary interconnection into a permanent interconnection by installing a 1000 MW back-to-back converter at the Outaouais substation in Québec and build a double-circuit 230 kV line from the Masson River crossing to connect with 500/230 kV Hawthorne TS in Ottawa.
- Carry out additional system studies to ascertain the feasibility of expanding the interconnection capacity to 1250 MW.

The temporary interconnection, capable of supplying 400 MW of load from Ontario to Québec or vice versa under emergency conditions, was completed and declared in service in December, 1998.

A Memorandum of Understanding was executed on February 18, 1999 by TransÉnergie, une division d'Hydro-Québec and Ontario Hydro (whose role in the M.O.U. has been taken over by Ontario Hydro Services Company) to carry out the development work and studies on the permanent interconnection required for decision making by their respective management and regulatory bodies. The preliminary work schedule has a tentative in-service date of December 2001.

Three TE-OHSC working groups have been established with various mandates, among which the Technical Studies and Planning Working Group (TSPWG) was charged with the following:

- Technical system studies;
- Equipment performance requirements;
- Operating agreement; and
- Activities related to compliance with Northeast Power Reliability Council criteria.

1.3 Current Development in Québec

On February 23, 1999, the Québec Superior Court ruled all decrees associated with the ice storm projects for reinforcing the transmission network in Québec unconstitutional since these projects did not follow the due process of Environmental Assessment.

These ice storm projects will now have to be under the Environmental Impact Assessment (EIA) process. TransÉnergie has initiated the Environmental Assessment process and the associated public hearings on an accelerated schedule. With the time required for the EIA process, it is expected that the earliest possible completion date for the interconnection project is December 2002.

1.4 Purpose of the Report

The purpose of this TSPWG report is to provide an update on the rating of the converter station and interconnection, the transfer capabilities between the two systems with the planned transmission reinforcement between Grand-Brûlé and Vignan. In addition, this report addresses the interconnection capabilities without the planned reinforcement.

2. *Characteristics of the Power Systems in the Outaouais Area and Ottawa Area*

2.1 Outaouais Area

The Outaouais Area is connected to the 735/315 kV bulk network via a 315 kV double-circuit line from Vignan to Chénier. This line supplies the Outaouais Area with a peak load of about 1150 MW with about 600 MW of local generation as shown in the attached Figure 1.

2.2 Ottawa Area

The Ottawa Area has a peak load of about 1700 MW, an installed hydroelectric generation capacity of 300 MW and non-utility generation of 70 MW. The bulk transmission facilities supplying the Ottawa Area consists of:

- two 500 kV single-circuit lines from Lennox GS;
- a 230 kV circuit from Chats Falls GS;
- two single-circuit lines from St. Lawrence TS; and
- a 230 kV circuit from Toronto.

The attached Figure 2 shows the bulk power transmission system in Eastern Ontario.

3. *Project Description*

3.1 Facilities in Québec

To improve the security of supply to the Outaouais Area, it is proposed to construct a 315 kV double circuit line from the Grand-Brûlé 735-120/315 kV substation to the Vignan 315/120 kV substation (see Figure 1).

To establish a permanent interconnection with Ontario, it is proposed to terminate the 315 kV line between Chénier and Vignan into the new Outaouais substation. At the Outaouais substation, a back-to-back converter station with a 1250 MW capacity will be installed and connected with Ontario via a double-circuit 230 kV line about 15 km to the existing Masson river crossing. About 12 km of the line was installed for the temporary interconnection which was declared in-service in December, 1998.

3.2 Facilities in Ontario

In Ontario, it is proposed to build about 20 km of a double-circuit line from the Masson river crossing to terminate into Hawthorne TS with the associated station facilities.

4. *Study Criteria and System Conditions*

4.1 Study Criteria

TransÉnergie and OHSC are members of the Northeast Power Coordinating Council, which is one of the ten regional reliability councils constituting the North America Electric Reliability Council. The design and operation of the planned interconnection between Outaouais and Ottawa will be in full compliance of the NPCC Basic Criteria of Design and Operation of Interconnected Power System.

The normal criteria contingencies applicable to this project are as follows:

Stability Assessment

- A permanent three-phase fault on any transmission circuit, transformer or bus section with normal fault clearing.
- Simultaneous permanent phase to ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit tower, with normal fault clearing.
- A permanent phase to ground fault on any transmission circuit, transformer, or bus section with delayed fault clearing.

- Loss of any element without a fault
- A permanent phase to ground fault on a circuit breaker with normal fault clearing.
- Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault.

Steady State Assessment

- Reactive power capability with adequate reserves and appropriate controls shall be installed in each Area to maintain voltages within normal limits for pre-disturbance conditions, and within applicable emergency limits for the system conditions that exist following the contingencies specified above.
- Line and equipment loadings shall be within normal limits for pre-disturbance conditions and within applicable emergency limits for the system conditions that exist following the contingencies specified above.

4.2 System Conditions

Quebec System

The Québec system simulated represents an expected 2002 winter peak demand of 34,260 MW that include 400 MW of firm contract. A sensitivity study was carried out for different load levels therefore, a spring light load with 17,240 MW of total demand (about 50% of peak demand) has been also simulated.

These system conditions have been simulated with an additional bilateral exchanges of 1250 MW, with and without the planned reinforcement between Grand Brûlé and Vignan stations.

Ontario System

The expected year 2002 peak primary demand in Ontario served by OHSC is 23,360 MW. The spring light load of 12,200 MW is used in the studies to match the 50% Québec load condition. Since the transmission capabilities into the Ottawa area could be more limiting during some off-peak conditions with a reduced output from the local peaking hydraulic generating stations, sensitivity studies were carried in the assessment.

5. Summaries of Transfer Capabilities of the Proposed Interconnection

System studies consisting of load flows and transient stability studies were carried out to ascertain the transfer capabilities of the proposed interconnection under various system conditions. Two scenarios, one with the proposed Grand-Brûlé to Vignan reinforcement and one without were also studied. The two tables below show the transfer capabilities over the proposed interconnection following the critical contingencies.

With the Grand-Brûlé to Vignan 315 kV Transmission Reinforcement

| | TÉ to OHSC (MW) | | OHSC to TÉ (MW) | |
|---|--------------------|-------------------------|--------------------|-------------------------|
| | Peak | 50% Peak/ Light Load | Peak | 50% Peak/ Light Load |
| All elements i/s in TÉ & OHSC | 1250 | 1250 | 1250 | 1250 |
| Loss of 2-cct 315 kV line Chénier x Outaouais in Québec | 1000 | 1075 | 1200 | 1100 |
| Loss of 1-cct 315 kV line Chénier x Outaouais in Québec | 1250 | 1250 | 1250 | 1250 |
| Loss of 1-500 kV line from Lennox and 1-750MVA auto at Hawthorne in Ontario | 1250 | 1250 | 1100 | 1150 |
| Loss of 1 circuit of the 2-cct tie line | 900 | 900 | 900 | 900 |
| Loss of the 2-cct tie line | 0 | 0 | 0 | 0 |

Without the Grand-Brûlé to Vignan 315 kV Transmission Reinforcement

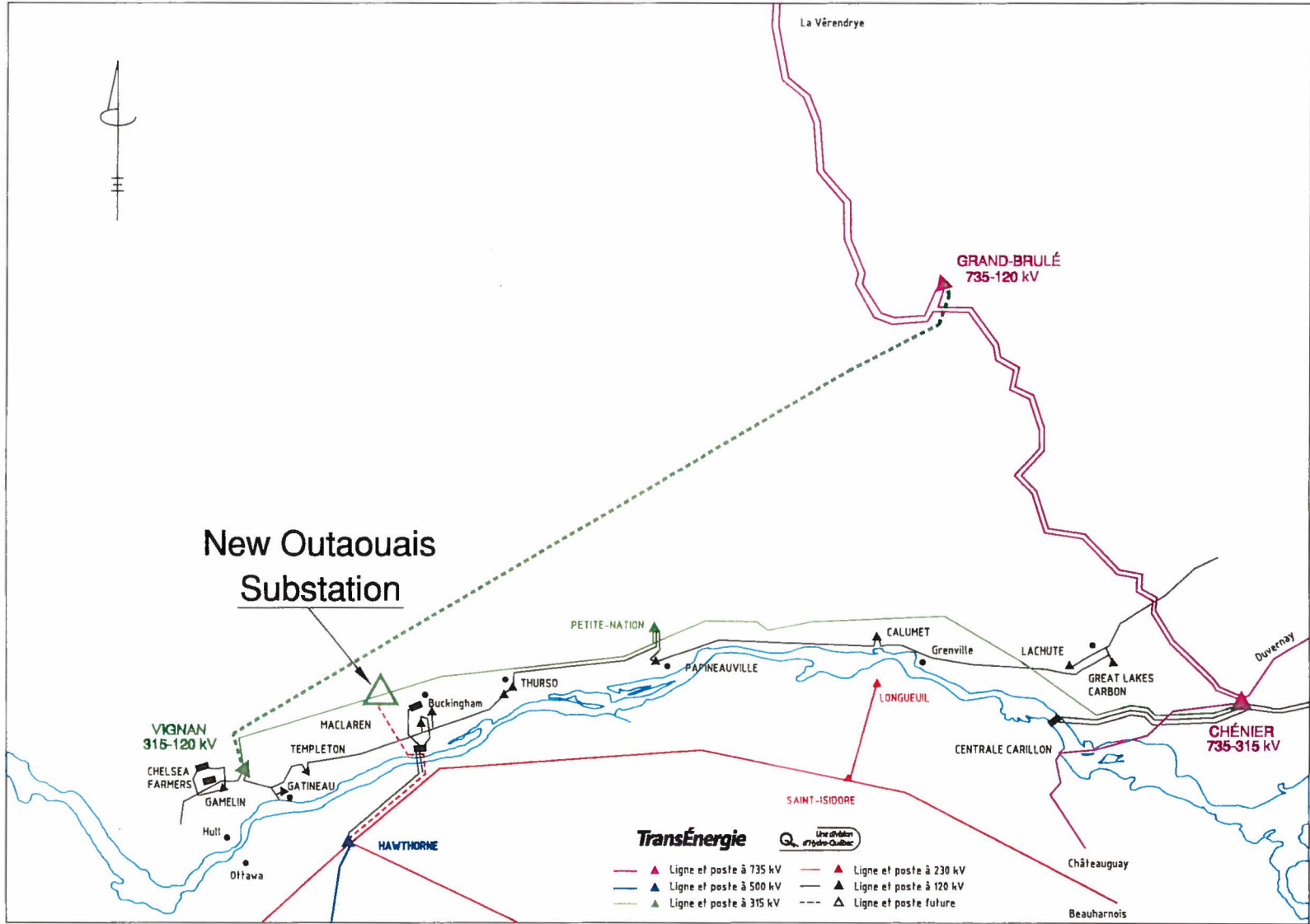
| | TE to OHSC | | OHSC to TE | |
|---|------------|-------------------------|------------|-------------------------|
| | Peak | 50% Peak/ Light Load | Peak | 50% Peak/ Light Load |
| All elements i/s in TÉ and OHSC | 1250 | 1250 | 1250 | 1250 |
| Loss of 2-cct 315 kV line Chénier x Outaouais in Québec | 0 | 0 | 0 | 0 |
| Loss of 1-cct 315 kV line Chénier x Outaouais in Québec | 900 | 800 | 1250 | 1250 |
| Loss of 1-500 kV line from Lennox and 1-750MVA auto at Hawthorne in Ontario | 1250 | 1250 | 1100 | 1150 |
| Loss of 1 circuit of the 2-cct tie line | 900 | 900 | 900 | 900 |
| Loss of the 2-cct tie line | 0 | 0 | 0 | 0 |

6. Conclusions

The Technical Studies and Planning Working Group has completed its assessment on the proposed interconnection between Québec and Ontario required to proceed with the next phase of the development work, with the following conclusions:

- Expanding the capacity of the converter station and interconnection line from 1000 MW to 1250 MW, as recommended by the OH-HQ Technical Team, has been ascertained to be an achievable and practical rating.
- With the Grand-Brûlé and Vignan Reinforcement in place, both the TÉ and OHSC systems are capable of supporting bi-directional transfers of 1250 MW with all facilities in service. Following normal criteria contingencies in Québec and Ontario (other than contingencies on the 2-cct tie line), the maximum reduction in transfer could be about 250 MW.
- Without the Grand-Brûlé and Vignan Reinforcement in place, both the TÉ and OHSC systems are capable of supporting bi-directional transfers of 1250 MW with all facilities in service. There is an additional requirement of shunt reactive compensation at Petite Nation of about 330 MVAR and a fourth 735/315 kV transformer at the Chénier substation. Following normal criteria contingencies, there would be a requirement for major power reduction on the proposed interconnection. For the most severe contingencies involving the loss of the Chenier-Outaouais line or the loss of the two interconnection circuits, it would be necessary to reduce the transfer to zero MW.
- Following the loss of one of the two interconnection circuits, the loading on the remaining circuit would be restricted to about 900 MW. This capability is not dependent on the Grand-Brûlé to Vignan transmission reinforcement. Losing both circuits of the proposed interconnection would result in zero transfer.
- Additional system study for NPCC review and approval are ongoing to meet the revised in-service date of December, 2002.

Figure 1
 Outaouais Loop Reinforcement and
 High Capacity Interconnection between Québec and Ontario



QUEBEC

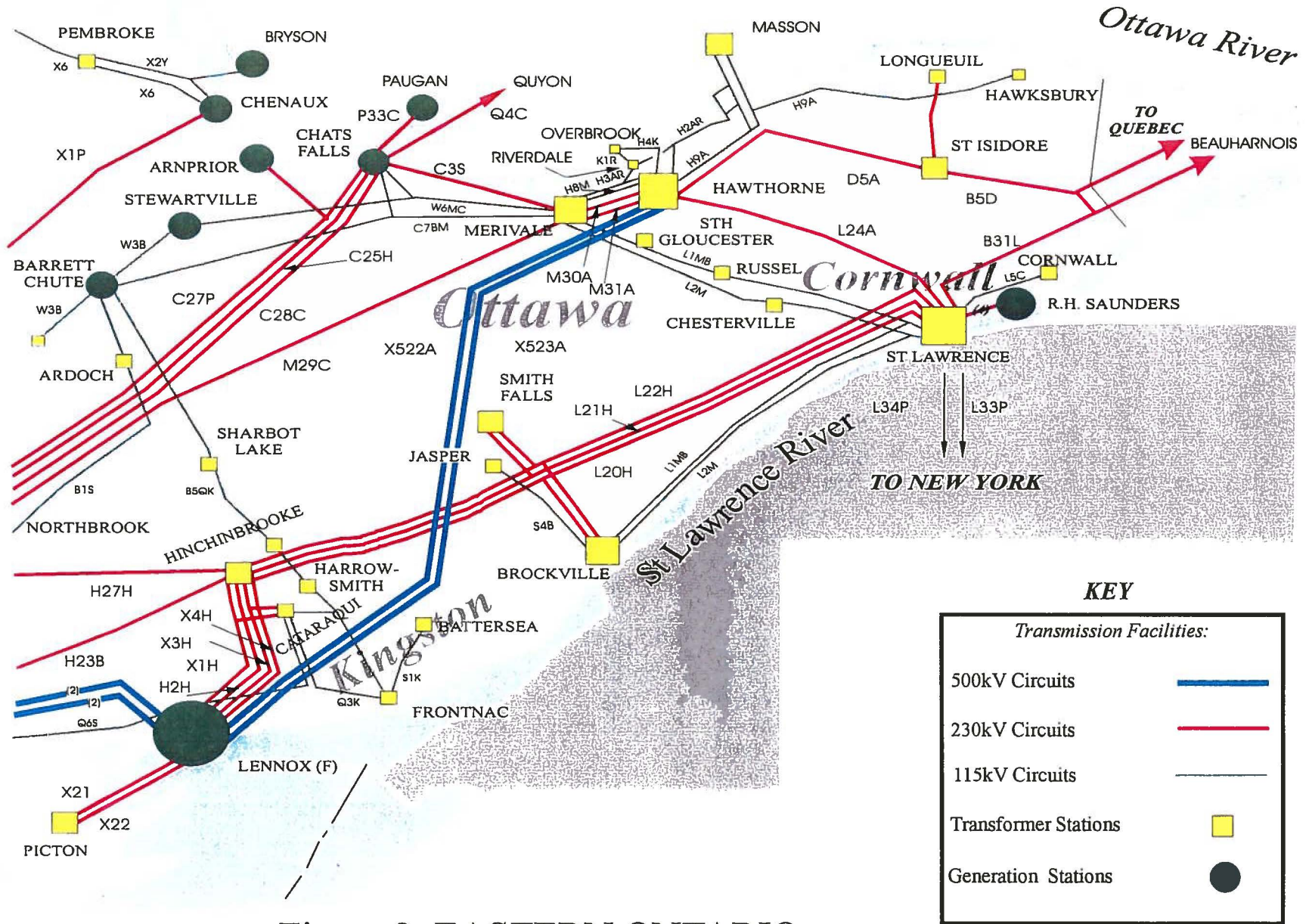


Figure 2: EASTERN ONTARIO
500/230/115 kV TRANSMISSION SYSTEM