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August 31, 2011

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL
A1A 5B2

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Newfoundland and Labrador Hydro (Hydro) – 2012 Capital Budget Application

Hydro's 2012 Capital Budget Application (CBA) contained two projects for which reports were not available at the time of filing. These were:

- Upgrade Transmission Line Corridor - Bay d'Espoir To Western Avalon; and
- Install Additional 230 kV Transformer - Oxen Pond Terminal Station.

Please find enclosed ten copies of the reports entitled "Install Additional 230 kV Transformer - Oxen Pond Terminal Station". This report should be filed in Volume II of Hydro's 2012 CBA, at Tab 11. The report entitled "Upgrade Transmission Line Corridor - Bay d'Espoir To Western Avalon" will be filed at a later date.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Geoffrey P. Young
Senior Legal Counsel

GPY/mmcd

cc: Peter Alteen – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Dean Porter – Poole Althouse
Thomas Johnson – Consumer Advocate

A REPORT TO

THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

	Electrical
	Mechanical
	Civil
	Protection & Control
	Transmission & Distribution
	Telecontrol
	System Planning

INSTALL ADDITIONAL 230 KV TRANSFORMER

Oxen Pond Terminal Station

August 2011

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Table of Contents

1 INTRODUCTION

Newfoundland and Labrador Hydro operates two 230/66 kV terminal stations (Hardwoods and Oxen Pond) to provide bulk power deliveries to the northeast Avalon Peninsula, a area referred to as the St. John's Region. A looped 66 kV transmission system owned and operated by Newfoundland Power is used to transmit electrical power and energy from the Hardwoods and Oxen Pond Terminal Stations throughout a region spanning from the town of Seal Cove in the west to Pouch Cove in the northeast and Cappahayden in the southeast.

Based upon the 2010 Energy Supply Forecast from Newfoundland Power, the 2014 peak load for the Oxen Pond Terminal Station will exceed the installed transformer capacity in the station. Further, given the looped nature of the underlying 66 kV transmission system, the established transformer back-up criterion for the Hardwoods – Oxen Pond Loop stipulates that Hydro must be able to supply the peak load during the loss of the largest transformer in the looped system. With the continued load growth in the region, the load has increased to the point where the installed 230/66 kV transformer capacity is insufficient to meet the peak load requirements during loss of a single transformer. Consequently additional transformer capacity is required within the Hardwoods – Oxen Pond Loop.

Table 1 provides an overview of the forecast station loadings versus the installed transformer capacity at each station. The Energy Supply Forecast provides the station loading in megawatts. For comparative purposes a peak load power factor of 0.975 is applied to the forecast values to obtain a station MVA load value that can be readily compared to the total installed MVA capacity of the 230/66 kV transformers in each station. The table indicates that the forecast load for the Oxen Pond Terminal Station will reach the installed transformer capacity in the 2013 – 2014 timeframe. As a result, an increase in installed transformer capacity is required at Oxen Pond Terminal Station in the 2013 – 2014 timeframe.

Table 1: Hardwoods and Oxen Pond Station Loads versus Installed Transformer Capacity

Year	Hardwoods Terminal Station			Oxen Pond Terminal Station		
	MW	MVA	Stn Load	MW	MVA	Stn Load
2010	269.3	276.2	85.0%	290.1	297.5	94.0%
2011	274.0	281.0	86.5%	295.1	302.7	95.6%
2012	280.7	287.9	88.6%	302.3	310.1	97.9%
2013	286.5	293.8	90.4%	308.6	316.5	99.9%
2014	292.0	299.5	92.2%	314.5	322.6	101.8%

Notes:

1. Hardwoods installed transformer capacity equals 324.8 MVA
2. Oxen Pond installed transformer capacity equals 316.6 MVA
3. Station load in MVA calculated based upon a load power factor of 0.975 during peak

Table 2 summarizes the Hardwoods – Oxen Pond Looped load versus the firm transformer capacity as it relates to the transformer back up criterion. The table indicates that based upon 2010 actuals and the 2011 to 2014 forecast the Hardwoods – Oxen Pond Loop transformer back up criteria has been violated. Additional transformer capacity is required immediately to maintain sufficient transformer capacity in the Hardwoods – Oxen Pond Loop to supply the forecast load during a single transformer outage.

Table 2: Hardwoods – Oxen Pond Loop Load versus Firm[1] Transformer Capacity

	2010	**2011**	**2012**	**2013**	**2014**
Transformer Load - MVA	514.4	524.1	538.0	550.1	561.5
Transformer Capacity - MVA	484.6	484.6	484.6	484.6	484.6
Transformer Loading - %	106.1	108.2	111.0	113.5	115.8

Notes:

1. Firm Transformer Capacity means transformer capacity with largest transformer (i.e. 125 MVA) in loop out of service.

Combined, Table 1 and 2 indicate that additional 230/66 kV transformer capacity is required

in the St. John's Region and that the appropriate location for that additional transformer capacity is Oxen Pond Terminal Station.

By comparison, the 2009 Hardwoods-Oxen Pond Loop analysis indicated no transformer overload or backup criteria violation in the near term. Table 3 provides a summary of the analysis performed in March of 2009.

Table 3: Hardwoods – Oxen Pond Loop Load versus Firm[1] Transformer Capacity (March 2009)

	2008	**2009**	**2010**	**2011**	**2012**
Transformer Load - MVA	435.0	444.3	453.4	461.7	469.3
Transformer Capacity - MVA	484.6	484.6	484.6	484.6	484.6
Transformer Loading - %	89.7	91.7	93.6	95.2	96.8

Notes:

1. Firm Transformer Capacity means transformer capacity with largest transformer (i.e. 125 MVA) in loop out of service.

It should be noted that following this analysis, the next available load forecast from Newfoundland Power for use in the planning and capital budget cycle revealed actual system peaks from 2010. As indicated in Tables 1 and 2, these figures were significantly higher than previously forecasted. As a result, the addition of the Oxen Pond transformer was advanced from 2015 to 2013, the earliest possible in-service date.

2 PROJECT DESCRIPTION

The load forecast for the St. John's Region indicates that the load at Oxen Pond Terminal Station will exceed the installed transformer capacity in 2014. In addition, the existing load in the Hardwoods – Oxen Pond loop exceeds the firm transformer capacity under a loss of the largest unit scenario. Consequently, additional transformer capacity is required at Oxen Pond Terminal Station.

This project includes the costs to purchase and install a fourth 230/66 kV power transformer at Oxen Pond Terminal Station with a rating of 75/100/125 MVA. As part of the project, a 230 kV ring bus arrangement will be added to increase the level of reliability and maintainability of the station given its significant load. At present, any required maintenance to the 230 kV bus requires a complete station outage. Given that Oxen Pond Terminal Station is located within the boundaries of Pippy Park, Hydro proposes to limit the impact of the required increase in the terminal station area by expanding the terminal station into the existing 230 kV transmission line corridor to the north of the station to accommodate the 230 kV ring bus addition, to install a firewall[1] between existing T3 and the proposed T4 to limit space requirements on the east side of the station and double circuiting of existing 66 kV transmission lines on the east side such that expansion to accommodate T4 does not exceed the area of the existing parking lot.

In addition, the remaining 230 kV air blast circuit breaker, B1L36, will be replaced with a new 230 kV sulphur hexafluoride (SF_6) gas filled circuit breaker and the associated air handling and compression system removed to facilitate the installation of the required protection and control panels without the need to extend the existing control building.

[1] In a typical terminal station layout, Hydro will place power transformers at sufficient spacing such that a problem with one transformer which leads to an equipment fire will not damage an adjacent unit. An alternative is to place a concrete firewall between two closely spaced transformers to prevent a fire from spreading to multiple units.

3 EXISTING SYSTEM

Hydro delivers bulk electric power and energy via 230 kV transmission lines TL-201, TL-218, TL-236 and TL-242 to the St. John's Region at two 230/66 kV terminal stations – Hardwoods and Oxen Pond. The Newfoundland Power owned 66 kV transmission system is used to transmit power and energy from the bulk delivery points to a number of distribution class substations throughout the region. This system is illustrated in Figure 1.

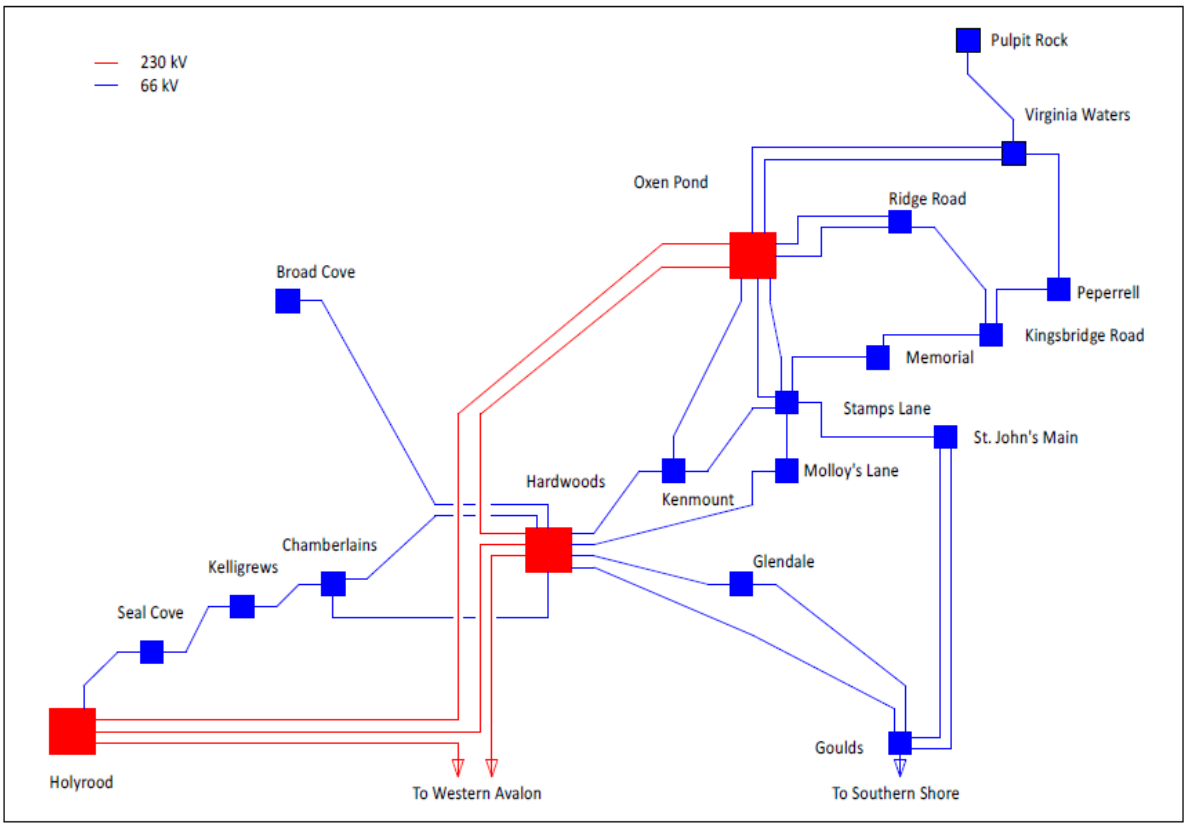

Figure 1 – Power System for the St. John's Region

The installed 230/66 kV transformer capacity at Hardwoods Terminal Station consists of three 40/53.3/66.6 MVA units and one 75/100/125 MVA unit for a total of 324.8 MVA. The installed 230/66 kV transformer capacity at Oxen Pond Terminal Station consists of two 75/100/125 MVA units and one 40/53.3/66.6 MVA unit for a total of 316.6 MVA. The resultant total installed capacity for the system is 641.4 MVA.

3.1 Age of Equipment or System

The original Oxen Pond Terminal Station was built in 1967. The original Hardwoods Terminal Station was built in 1972. Table 4 lists the in service dates of the transformers and capacitor banks at each terminal station.

Table 4: Hardwoods and Oxen Pond Terminal Station Asset In Service Dates

Asset	In Service Date	Comments
Hardwoods T1 40/53.3/66.6 MVA	1972	
Hardwoods T2 40/53.3/66.6 MVA	1976	
Hardwoods T3 40/53.3/66.6 MVA	1968	Relocated from Oxen Pond in 1986
Hardwoods T4 75/100/125 MVA	1992	
Hardwoods T5 and CT	1976	CT – Combustion Turbine
Hardwoods C1 26.4 MVAR	1999	Original 14.4 MVAR bank retired
Hardwoods C2 26.4 MVAR	1999	
Oxen Pond T1 40/53.3/66.6 MVA	1967	
Oxen Pond T2 75/100/125 MVA	1986	Original T2 moved to Hardwoods
Oxen Pond T3 75/100/125 MVA	1977	
Oxen Pond C1 25.2 MVAR	1978	Upgraded in 1999
Oxen Pond C2 26.4 MVAR	1999	

3.2 Major Work and/or Upgrades

The last transformer addition to the Hardwoods – Oxen Pond Loop for load growth in the St. John's Region was Hardwoods T4 in 1992. In 1999 existing shunt capacitor banks were upgraded and a new shunt capacitor bank was added at each of Hardwoods and Oxen Pond Terminal Stations.

3.3 Anticipated Useful life

The proposed transformer, circuit breaker and disconnect switch additions have an estimated service life of 40 years.

3.4 Maintenance History

As the proposed project covers the installation of a new 230/66 kV power transformer, associated circuit breakers and disconnect switches, there is no existing maintenance history for the assets.

3.5 Outage Statistics

No component at Oxen Pond Terminal Station is being replaced due to issues associated with unacceptable forced outage rates. As indicated in the table below, over the period 1990 to 2010 there has been one outage to 230 kV air blast circuit breaker B1L36 at Oxen Pond and no outage to 230 kV air blast circuit breaker B1L18. By comparison, for the period 2006 – 2010 there has been 13 outages to Hydro owned 230 kV air blast circuit breakers. The CEA statistics for Canada indicate 249 outages to 230 kV air blast circuit breakers during the period 2005 – 2009. No component at Oxen Pond Terminal Station is being replaced due to issues associated with unacceptable forced outage rates.

Table 5: Oxen Pond Air Blast Breaker Outage Statistics

	Number of Outages	Frequency (PER a)	Unavailability (%)
OPD B1L36 (1990-2010)	1	0.025	0.000
OPD B1L18 (1990-2010)	0	0.000	0.000
230 kV Air Blast Breakers (2006-2010)	13	0.048	0.004
CEA 230 kV Air Blast Breakers (2005-2009)	249	0.086	0.169

Frequency (per a) is the number of failures per year.

Unavailability is the percent of time per year the unit is unavailable.

3.6 Industry Experience

This project is required to meet additional load growth. Industry experience dictates that to meet increased demand for electric power, utilities must increase the installed transformer capacity to avoid overload and damage to existing transformation equipment. The proposed transformer addition to meet load growth and transformer back-up criterion is within Hydro's established transmission planning criteria.

3.7 Maintenance or Support Arrangements

Normal routine maintenance work is performed by Hydro personnel.

3.8 Vendor Recommendations

There are no relevant vendor recommendations.

3.9 Availability of Replacement Parts

There are no issues with the availability of replacement parts.

3.10 Safety Performance

There are no safety performance issues.

3.11 Environmental Performance

There are no relevant environmental performance issues.

3.12 Operating Regime

The Oxen Pond terminal station operates on a continuous basis with periodic removals from service to perform preventive maintenance in accordance with Hydro's maintenance practices for terminal station equipment.

4 JUSTIFICATION

The total installed 230/66 kV transformer capacity in the Hardwoods – Oxen Pond Loop is 641.6 MVA. Hydro's transformer back-up criterion requires that Hydro be able to supply the peak customer load with the largest transformer out of service. With the largest transformer having a rating of 125 MVA, the total transformer capacity in the loop is reduced to 516.4 MVA. Because the transformers were manufactured at different times, have different manufacturers and therefore different designs, the transformers have slightly different impedances. This impedance mismatch results in a loss of transformer capacity as all remaining 230/66 kV power transformers in the loop will not load equally such that they all reach 100 percent of nameplate rating at the same system loading condition. As a result of the impedance mismatch, the total installed transformer capacity with the largest unit out of service is reduced by 31.8 MVA to 484.6 MVA.

During a forced or unplanned outage to a 230/66 kV power transformer (i.e. a transformer contingency), Hydro will operate its combustion turbine at Hardwoods Terminal Station to meet load that cannot be supplied by the remaining power transformers. For analysis purposes the Hardwoods combustion turbine is set to provide 45 MW and 28 MVAR to the system[2]. In addition to the Hardwoods combustion turbine there are three 26.4 MVAR capacitor banks and one 25.2 MVAR capacitor bank located at the terminal stations to provide voltage support.

Table 6 provides the calculations of the transformer loading for the Hardwoods – Oxen Pond Loop under loss of the largest transformer (i.e. 125 MVA) in the loop. The analysis indicates that the transformer back up capacity criterion was violated based upon 2010 actuals and the violation will continue to increase based upon the load forecast. Consequently, additional transformer capacity is required in the Hardwoods – Oxen Pond

[2] Newfoundland Power generation behind the load (i.e. Southern Shore generation) is assumed to be in service at the time of peak and therefore netted out of the peak load forecast to be served by Hydro.

Loop as soon as it can be reasonably installed.

Table 6: Calculation of Transformer Loading Under Transformer Contingency, Hardwoods – Oxen Pond Loop

	2010		**2011**		**2012**		**2013**		**2014**	
	MW	**MVAR**	**MW**	**MVAR**	**MW**	**MVAR**	**MW**	**MVAR**	**MW**	**MVAR**
Oxen Pond Load	290.1	66.1	295.1	67.3	302.3	68.9	308.6	70.3	314.5	71.7
Hardwoods Load	269.3	61.4	274.0	62.4	280.7	64.0	286.5	65.3	292.0	66.5
Total Loop Load	559.4	127.5	569.1	129.7	583.0	132.9	595.1	135.6	606.5	138.2
Less CT	45.0	28.0	45.0	28.0	45.0	28.0	45.0	28.0	45.0	28.0
Less Capacitor Bank MVAR		104.4		104.4		104.4		104.4		104.4
Net Transformer Load	514.4	-4.9	524.1	-2.7	538.0	0.5	550.1	3.2	561.5	5.8
Net Transformer Load MVA	514.4		524.1		538.0		550.1		561.5	
Firm Transformer Capacity MVA	484.6		484.6		484.6		484.6		484.6	
Transformer Loading	106.1%		108.2%		111.0%		113.5%		115.8%	

A review of the individual station loads, as shown in Table 1, indicates that under normal operation the load at Oxen Pond Terminal Station is expected to equal and exceed the installed transformer capacity in that station in the 2013 – 2014 time frame. The loading at Hardwoods Terminal Station is expected to be well within its installed transformer capacity for the duration of the five year load forecast. Therefore, additional transformer capacity

should be installed at the Oxen Pond Terminal Station to meet both the increased station load requirements and the transformer back up criterion for the load forecast period.

There are two alternatives to increase the transformer capacity at Oxen Pond Terminal Station. First, the existing T1 transformer (40/53.3/66.6 MVA) may be changed out for a larger 75/100/125 MVA unit bringing the total installed transformer capacity at Oxen Pond to 375 MVA. Alternatively, the terminal station may be expanded to add a new transformer, T4, rated 75/100/125 MVA, bringing the total installed capacity at Oxen Pond to 441.6 MVA.

Figure 2 provides a simplified single line diagram of the existing Oxen Pond Terminal Station.

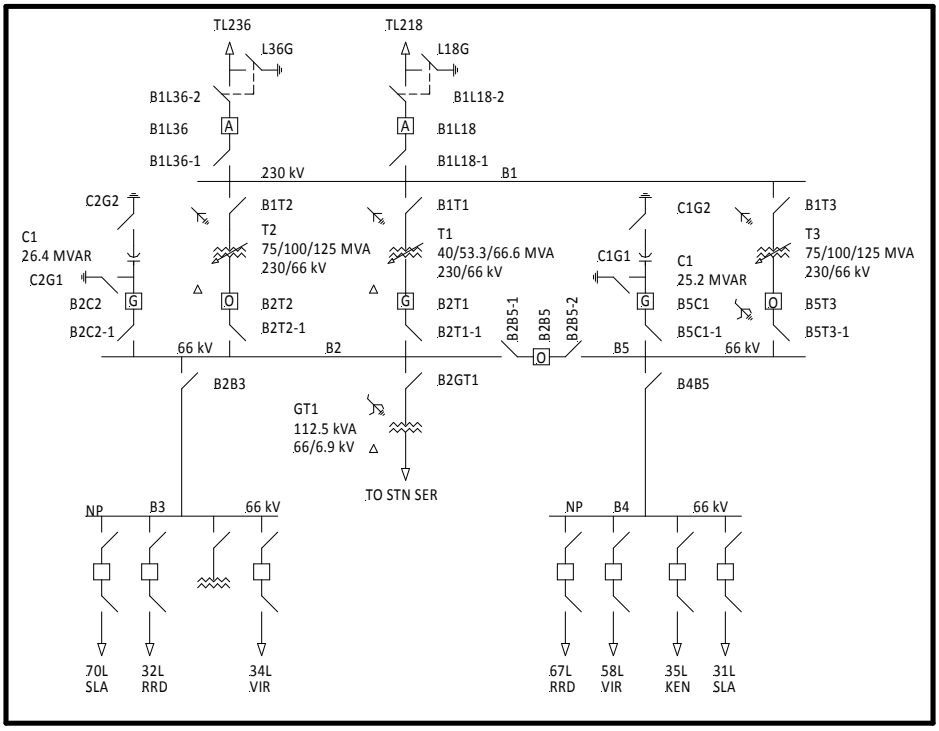

Figure 2 – Existing Oxen Pond Terminal Station

A review of the single line diagram indicates that Newfoundland Power has two 66 kV transmission lines to each of Stamps Lane (SLA – 31L and 70L), Ridge Road (RRD – 32L and 67L) and Virginia Waters (VIR - 34L and 58L) substations which are supplied from separate 66 kV buses, B3 and B4. A 66 kV bus tie circuit breaker B2B5 ensures that a 66 kV bus fault

isolates one half of the 66 kV station bus while maintaining supply to each of the three remote substations. It should be noted that while Kenmount Substation is supplied from only 35L and bus B4 at Oxen Pond, a second supply to Kenmount Substation originates at Hardwoods Terminal Station. Unfortunately, there is no bus tie circuit breaker on the 230 kV side of the Oxen Pond Terminal Station at this time. A 230 kV bus fault, transformer failure or 230 kV transmission line fault with failure of the appropriate 230 kV line circuit breaker to open will result in loss of the entire station. During the addition of T4 at Hardwoods Terminal Station in 1992 a 230 kV bus tie circuit breaker was added at Hardwoods to reduce the risk of outage to the entire station. A 230 kV bus tie circuit breaker is warranted at Oxen Pond given the magnitude of the installed transformer capacity and the load being supplied. A fourth 230 kV circuit breaker is warranted to complete a 230 kV ring bus arrangement at Oxen Pond Terminal Station so that breaker maintenance can be performed without having to remove a transmission line from service. Figure 3 provides a simplified single line diagram of the proposed additions at Oxen Pond Terminal Station.

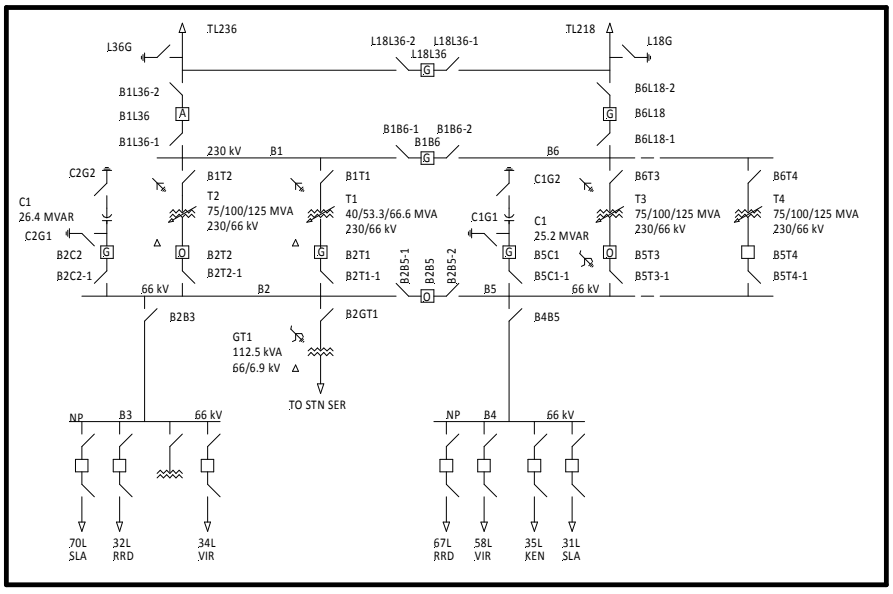

Figure 3 – Proposed Oxen Pond Terminal Station Circuit Breaker and T4 Additions

The existing control building at Oxen Pond Terminal Station has insufficient space to

accommodate the additional protection and control panels associated with proposed additions at Oxen Pond. Two solutions to this problem exist. First, additional panel space can be established through an extension to the existing control building. Alternatively, replacement of the remaining air blast circuit breaker (B1L36) with a gas filled circuit breaker and subsequent removal of the air compression system would free up the required space for additional panels within the existing control building. It should be noted that a new 230 kV gas filled circuit breaker will be installed for the re-termination of TL-218 opposite T3 in order to minimize TL-218 outage time and the existing TL-218 air blast circuit breaker retired. There is insufficient space to install a conventional 230 kV circuit breaker in bus B1 between the existing TL-236 and TL-218 circuit breakers.

A net present value analysis of a building extension versus replacement of air blast circuit breaker B1L36 indicates a cumulative present worth preference of $109,040 for the replacement option. Further details are provided in section 4.1.

The timing of transformer additions at Oxen Pond Terminal Station for each alternative is provided in Table 7.

Table 7: Oxen Pond Transformer Timings for Transformer Back-up Criterion

Year	Alternative 1	Alternative 2
2013	T1 Changeout	T4 Addition
2015	T4 Addition	
2020		T1 Changeout

Analysis of the Hardwoods – Oxen Pond Looped system indicates that if the Oxen Pond T1 unit was changed out to a 75/100/125 MVA in 2013, the transformer back-up criterion would be violated in 2015 requiring the addition of a fourth 230/66 kV, 75/100/125 MVA transformer, T4, at Oxen Pond in that year. However, if a 230/66 kV, 75/100/125 MVA transformer, T4, is added at Oxen Pond in 2013, the transformer back-up criterion for the

looped system would not be violated until 2020. In 2020, Oxen Pond T1 would then be changed out to a 75/100/125 MVA unit to meet the transformer back-up criterion. A net present value analysis of the alternatives indicates a cumulative present worth preference of $541,066 for the installation of T4 at Oxen Pond in 2013 rather than changeout Oxen Pond T1 to a larger unit. Further details are provided in Section 4.1.

The Generation Planning Issues 2010 July Update document filed with the Board of Commissioners of Public Utilities (Board) indicates that for a generation expansion scenario involving the HVdc Island Link, a 50 MW combustion turbine (CT) would be required in 2014. Addition of this 50 MW CT at Hardwoods Terminal Station would increase the available generation that could be started to off load the remaining transformers in the Hardwoods – Oxen Pond loop during loss of the largest transformer. The impact would be to delay the need for additional transformer capacity following the proposed addition in 2013. While the HVdc Island Link has yet to receive final sanction, a sensitivity analysis is completed to assess the impact on the Oxen Pond transformer capacity decision. Table 8 provides the Oxen Pond transformer timings assuming that a 50 MW CT is added to Hardwoods Terminal Station in 2014. Hydro notes that irrespective of the Lower Churchill Project sanction decision, the addition of T4 at Oxen Pond is the preferred alternative to meet load requirements of the Hardwoods-Oxen Pond Loop.

The sensitivity analysis indicates that if a second 50 MW CT were added to Hardwoods in 2014 and Oxen Pond T1 were changed out to a larger size (75/100/125 MVA) the addition of a fourth transformer, T4, would be required in 2019. If the second CT were added in 2014 following the addition of Oxen Pond T4 in 2013, the changeout of Oxen Pond T1 to a larger unit would be required in 2024 to meet the transformer back-up criterion. A net present value analysis of the sensitivity alternatives indicates a cumulative present worth preference of $224,554 for the installation of T4 at Oxen Pond in 2013 rather than changeout Oxen Pond T1 to a larger unit. Further details are provided in Section 4.1.

Table 8: Oxen Pond Transformer Timing for Transformer Back-up Criterion Assuming a Second 50 MW Combustion Turbine at Hardwoods in 2014

Year	Alternative 1	Alternative 2
2013	T1 Changeout	T4 Addition
2019	T4 Addition	
2020		
2024		T1 Changeout

4.1 Net Present Value

The net present value analysis for the project is split into two components. The first component considers the decision whether to expand the control building to accommodate the additional protection and control panels associated with the project or to replace the air blast circuit breaker B1L36 and its ancillaries with a new gas filled circuit breaker and utilize the space now occupied by the air handling equipment to accommodate the additional protection and control panels. The maintenance costs for the physical circuit breaker are considered the same for the both the air blast and gas filled technologies. However, the ancillaries of the air blast circuit breaker (including air receivers, air dryers, compressors, piping, etc.) require an additional $10,000 per year in maintenance when compared to the stand alone gas filled circuit breaker. The air blast breakers and ancillaries at Oxen Pond are of the same vintage as those at Bay d'Espoir and Holyrood Terminal Stations. Replacement/upgrading of the air blast circuit breaker ancillaries at Holyrood is being completed in 2010 – 2011 at a cost of $496,000. It is proposed to replace/upgrade air blast circuit breaker ancillaries at Bay d'Espoir beginning in 2012. Based upon existing conditions, it is anticipated that the air blast circuit breaker ancillaries at Oxen Pond would have to be replaced in 2018 at an estimated cost of $175,000. In addition, air blast circuit breaker B1L36 will require an insulator replacement in 2016 at an estimated cost of $60,000. By comparison an extension to the existing control building to accommodate additional protection and control panels is estimated at $250,000. A cost benefit analysis of the B1L36 circuit breaker replacement versus the building extension indicates a $109,040 cumulative present worth preference for the breaker replacement option. See Table 9.

Table 9: B1L36 Breaker Replacement vs Building Extension

Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2031**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
B1L36 Breaker Replacement Building Extension	361,778 470,819	0 109,040

The second component of the net present value analysis considers the decision whether to changeout the existing 230/66 kV, 40/53.3/66.6 MVA T1 at Oxen Pond for a larger 230/66 kV power transformer rated 75/100/125 MVA or add a fourth 230/66 kV power transformer, T4, with a rating of 75/100/125 MVA to meet the load growth at Oxen Pond Terminal Station and provide the necessary transformer capacity in the Hardwoods – Oxen Pond loop to maintain supply during loss of the largest transformer in the loop. The alternatives considered include:

- T1 changeout first followed by T4 addition when required for load and/or the transformer back-up criterion; and
- T4 addition first followed by T1 changeout when required for load and/or the transformer back-up criterion.

Given the differences in installed transformer capacity at any point in time afforded by the two alternatives, the timing of the second capacity addition varies for the given load forecast. Consequently, the net present value analysis considered the transformer capacity additions required for the period 2011 to 2031. The analysis indicates a cumulative present worth preference of $541,066 for the installation of T4 in 2013 instead of changing T1 for a larger unit. See Table 10.

Table 10: T1 Change Out vs T4 Addition

Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2031**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
T1 Replacement	5,104,850	541,066
T4 Addition	4,563,784	0

The Generation Planning Issues 2010 July Update prepared by Hydro indicates that for an HVdc Island Link Scenario a 50 MW combustion turbine (CT) will be required in 2014 to meet the Hydro's generation planning criteria. The HVdc Island Link Project has yet to receive final sanction and the status of the new 50 MW CT has not been finalized. To assess the potential impact on the Oxen Pond transformer capacity decision a sensitivity analysis was completed assuming that the 50 MW CT is added at Hardwoods Terminal Station for the 2015 peak and is available to provide generation to the Hardwoods – Oxen Pond Loop in the event of loss of the largest transformer. The net present value analysis of the sensitivity case indicates a cumulative present worth difference of $224,554 for the addition of T4 over the changeout of T3 even though the addition of the CT will delay the requirement for additional transformer capacity to meet the transformer back-up criterion. See Table 11.

Table 11: T1 Change Out vs T4 Addition (HWD CT2 In Service 2015)

Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2031**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
T1 Replacement	4,430,399	224,554
T4 Transformer	4,205,845	0

4.2 Levelized Cost of Energy

The levelized cost of energy is a high level means to compare costs of developing two or more alternative generating sources. Therefore, the levelized cost of energy is not applicable in this case.

4.3 Cost Benefit Analysis

A net present value analysis was performed to determine the economic viability of this project.

4.4 Legislative or Regulatory Requirements

There is no legislative or regulatory requirements for this project.

4.5 Historical Information

The addition of a large 230/66 kV power transformer in the St. John's Region is a project that occurs based upon load growth in the area and as such is not a project that occurs on a

regular basis. The last 230/66 kV transformer addition in the region occurred at Hardwoods Terminal Station in 1992.

4.6 Forecast Customer Growth

The load forecast for the Hardwoods – Oxen Pond Loop is summarized in Table 12.

Table 12: Hardwoods – Oxen Pond Loop Peak Load Forecast - MW

Station	2010	2011	2012	2013	2014
Hardwoods	269.3	274.0	280.7	286.5	292.0
Oxen Pond	290.1	295.1	302.3	308.6	314.5

4.7 Energy Efficiency Benefits

This project is not specifically justified based on improvements in energy efficiency. The addition of a fourth 230/66 kV power transformer will cause a very marginal increase in system no load losses (estimated at 70 kW based upon transformers of similar size). During certain system loading conditions the addition of a fourth transformer will reduce overall system impedance leading to a slight reduction in total system losses. The magnitude of the reduction is unquantifiable given the variability in load over the life of the asset.

4.8 Losses during Construction

There are no anticipated losses during construction.

4.9 Status Quo

Failure to increase the transformer capacity at the Oxen Pond Terminal Station will result in the overloading of the existing power transformers. In addition, at present the installed

transformer capacity and combustion turbine capacity is insufficient to supply the load in the Hardwoods – Oxen Pond loop. Combined the conditions are in violation of Hydro's transmission planning criteria for the region and corrective action is warranted.

4.10 Alternatives

There are two alternatives for increasing the transformer capacity at Oxen Pond Terminal Station.

Alternative 1 – replace the existing 230/66 kV, 40/553.3/66.6 MVA transformer T1 with a larger 230/66 kV unit rated 75/100/125 MVA.

Alternative 2 – install a fourth 230/66 kV transformer, T4, rated 75/100/125 MVA.

5 CONCLUSION

The forecast load growth for the St. John's Region indicates that the installed transformer capacity at Oxen Pond will be insufficient to meet the station load in 2014. Further, the load in the region has increased to the level where there is insufficient transformer capacity to supply the load during loss of the largest 230/66 kV power transformer in the Hardwoods – Oxen Pond Loop. Consequently, additional transformer capacity is required at Oxen Pond Terminal Station as soon as possible.

Net present value analysis has indicated that the addition of a fourth 230/66 kV power transformer, rated 75/100/125 MVA, in 2013 is the least cost option with a cumulative present worth preference of $541,000 over changeout of an existing transformer, T1, for a larger unit.

5.1 Budget Estimate

Table 13: Budget Estimate

Project Cost: *($ x1,000)*	**2012**	**2013**	**2014**	**Beyond**	**Total**
Material Supply	814.5	1,575.0	1,694.5	0.0	4,084.0
Labour	366.9	500.6	288.0	0.0	1,155.5
Consultant	48.6	0.0	0.0	0.0	48.6
Contract Work	2,073.3	750.0	0.0	0.0	2,823.3
Other Direct Costs	50.4	38.6	34.7	0.0	123.7
Interest and Escalation	181.6	489.9	857.1	0.0	1,528.6
Contingency	0.0	0.0	775.9	0.0	775.9
TOTAL	**3,535.2**	**3,354.1**	**3,650.2**	**0.0**	**10,539.5**

5.2 Project Schedule

Table 14 Project Schedule: Year 1 -2012

Activity		Start Date	End Date
Planning	• Coordination of outrages and interfacing with Newfoundland Power	Jan. 2012	Mar. 2012
	• Property/Environmental Coordination	Jan. 2012	Dec. 2012
Design	• Develop Discipline Designs	Apr. 2012	Jul. 2012
	• Newfoundland Power TL Upgrades	Mar. 2012	May 2012
Procurement	• Complete Civil/Transmission Tender and Award	May 2012	Oct. 2012
	• Complete Electrical Tender and Award	May 2012	Oct. 2012
Construction	• Civil /Transmission Works	Jun. 2012	Nov. 2012
Commissioning	• Review Civil/Transmission Works	Nov. 2012	Nov. 2012
	• Review Newfoundland Power TL Upgrades	Sep. 2012	Nov. 2012
	• Finalize Properties Issues	Oct. 2012	Nov. 2012
Closeout	• Update Documents and Drawings	Dec. 2012	Dec. 2012

Table 15 Project Schedule: Year 2 -2013

Activity		Start Date	End Date
Planning	• Coordination of outrages and interfacing with Newfoundland Power	Jan. 2013	Mar. 2013
Design	• Finalize Electrical Design	Jan. 2013	Apr. 2013
	• Newfoundland Power TL Upgrades Design	Jan. 2013	Jun. 2013
	• Draft P&C/Telecontrol Design	Jan. 2013	Jun. 2013
Procurement	• Electrical Equipment Delivery including T4 Transformer	Mar. 2013	Jun. 2013
	• P&C/Telecontrol Equipment Tender and Award	Jul. 2013	Oct. 2013
Construction	• Transmission Line TL218 Relocation	Apr. 2013	May 2013
	• Electrical Construction	Jun. 2013	Nov. 2013
	• Newfoundland Power TL Upgrades	Jun. 2013	Aug. 2013
	• Control Building Upgrades	Jul. 2013	Sep. 2013
Commissioning	• Electrical Equipment Commissioning	Jun 2013	Nov. 2013
Closeout	• Update Documents and Drawings	Dec. 2013	Dec. 2013

Table 16 Project Schedule: Year 3 -2014

Activity		Start Date	End Date
Planning	• Coordination of outrages and interfacing with Newfoundland Power	Jan. 2014	Dec. 2014
Design	• Finalization of Discipline Designs	Jan. 2014	Apr. 2014
Procurement	• Final Equipment Delivery	Jan. 2014	Jun. 2014
Construction	• Construction Completion	Jul. 2014	Oct. 2014
Commissioning	• Terminal Station Commissioning	Nov. 2014	Nov. 2014
Closeout	• Update Documents and Drawings	Dec. 2014	Dec. 2014