Supplementary Audit of Port Hawkesbury Paper Load Retention Tariff (September 2012 – March 2014)

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1. INTRODUCTION AND BACKGROUND

This report presents the findings of Synapse's supplementary audit of the operation of the Nova Scotia Power Inc. (NSPI) load retention tariff (LRT) mechanism for Port Hawkesbury Paper (PHP) pursuant to the Nova Scotia Utility and Review Board (Board) Decision Letter of May 23, 2014 in Docket M05803. The confidential sections of the report are sections of Table 1 and Attachment B.

In April 2012, NSPI applied for approval of a LRT mechanism as part of a package of measures associated with a proposal to re-open the former NewPage Mill under new ownership as PHP. The Board approved the PHP LRT in its August 20, 2012 Decision in Matter M04862. The basic principle underlying the Board's approval of the tariff was that NSPI would charge PHP a price that would recover all of NSPI's incremental costs of supply without subsidization from its other ratepayers plus collect a contribution to NSPI's fixed costs of $2 per MWh.

Paragraph 241 of the August 2012 decision specified that a Board-appointed auditor should conduct the first audit of the tariff after the first six months of its operation. The Board retained a Synapse Energy Economics project team (Synapse), led by subcontractor Dr. Alex Rudkevich of the Newton Energy Group, to conduct the audit required under paragraph 241. The Synapse audit concluded that the CQ-pair methodology originally used by NSPI did not produce a sufficiently accurate estimate of the incremental energy costs to bill PHP, and proposed that NSPI use a "differential method" instead (Synapse Differential Method). NSPI used the Synapse Differential Method to prepare retrospective calculations for four representative weeks during the audit period: November 12-18, 2012, December 10-16, 2012, January 7-13, 2013, and February 11-17, 2013. Because the Synapse team could not draw a statistically valid conclusion based on the results for those four weeks, its report (*Audit of Port Hawkesbury Paper Load Retention Tariff*, completed February 28, 2014) recommended that NSPI prepare retrospective calculations using a differential methodology for each week of the audit period.

After reviewing the Synapse February 2014 Audit Report and the comments on that report filed by interested parties, the Board issued a Decision Letter dated May 23, 2014 directing that Synapse be engaged to proceed with a supplementary audit of the incremental costs of supplying PHP under the LRT. The Board specified the following scope of work for the supplementary audit:

1. As of October 2013, NSPI started billing PHP for incremental energy costs that were calculated using a differential method. A thorough review of NSPI's methodology is to be undertaken by Synapse to confirm that it accurately captures all incremental costs. Synapse will work with NSPI to resolve any identified deficiencies.

2. Synapse is to review NSPI's methodology for calculating system losses associated with serving the PHP load to determine its accuracy in capturing those costs for billing purposes. Synapse will work with NSPI to resolve any identified deficiencies.

3. With assistance from The Liberty Consulting Group, Synapse will oversee NSPI's calculation of all incremental costs that should have been billed to PHP from September 2012 to the end of March 2014 using the differential method and algorithms as determined in items 2) and 3) above. The analysis is to include line losses, power purchases, fuel pricing, emission constraints, and unit dispatch issues. The result of this analysis is to be compared with actual NSPI billings to determine any variance amount.

2. Choice of Differential Method for Retrospective Audit Period Calculations

The Board Decision Letter calls for a retrospective calculation of NSPI’s incremental costs of supplying PHP under the LRT in each week from September 2012 through March 2014 (the retrospective audit period). Step one was to choose the differential method to be applied. As explained in the Synapse February 2014 Audit Report, the primary reason behind the inaccuracy of the CQ-pair methodology is its inability to reflect the incremental impact of serving the PHP load on the unit commitment decisions made by NSPI in scheduling operation of its generating units day-ahead of energy delivery. It is essential that the differential method accurately capture both the incremental impact of serving PHP load on NSPI’s day-ahead unit commitment decisions as well as on NSPI’s actual dispatch of its generating units.

2.1. Review of Alternative Differential Methods

Synapse began by working with NSPI to choose the differential method to apply during the retrospective audit period. The two options for a differential method were the Synapse Differential Method and the differential method NSPI began using in October 2013 (NSPI Existing Differential Method).

Effective October 2013, NSPI switched from using ex-post CQ pairs to a differential methodology for calculating the actual cost to serve the PHP load. Synapse did not have sufficient time to review that NSPI Existing Differential Method in its February 2014 Audit Report. On June 5, 2014, NSPI provided to Synapse a PowerPoint overview comparing the Synapse and NSPI Differential Methods, as well as documents describing NSPI’s proposed incremental line loss methodology.

Synapse met with NSPI on June 19 to discuss which of the two differential methods to apply during the retroactive audit period. In the June 5 materials provided to Synapse, NSPI noted that the system-wide production costs for the With PHP case estimated using the Synapse Differential Method did not exactly replicate the total generation costs NSPI actually incurred on each day it supplied PHP plus system load. In addition, NSPI identified a number of methodological reasons why the Synapse Differential Method would not exactly replicate NSPI’s actual costs, specifically:

- The Synapse Differential Method optimizes unit commitment decisions based on perfect hindsight. As such, it does not appropriately factor in the uncertainties that affected the actual unit commitment decisions made by the model operator day-ahead.
- The Synapse Differential Method is set up to run for a seven-day period. As a result, it may suffer from an end-effects problem; if a unit commitment is run for a seven-day period, some units may be incorrectly turned off because that commitment does not consider the need to keep operating them to meet system requirements beyond that period.
- By allowing generators to be dispatched up to the theoretical maximum, the Synapse Differential Method does not appropriately factor in real-time de-ratings of the units.

NSPI proposed various modifications to address these issues in the Synapse Differential Method.

In general, NSPI's feedback of the Synapse differential method has merits. However, the modifications NSPI proposed in its June 5 presentation, while addressing the issues identified above, also have flaws. The major problem with NSPI's proposed modifications is that they effectively would use the same unit commitment for the With PHP run as for the Without PHP run. As a result, that proposed modification to the Synapse Differential Method would have the same deficiency as the CQ-pair method would. Neither of those two approaches would account for the difference in unit commitment solutions between the solution for the With PHP load and the solution for the Without PHP load.

During the June 19 meeting, the NSPI and Synapse teams discussed multiple approaches to addressing the concerns raised by both NSPI and Synapse. Upon consideration of these alternatives, both teams agreed that given the lack of information retained for the historical period, it is not possible to address all concerns in conducting the retrospective analysis of incremental costs of serving PHP load. Ultimately, NSPI and Synapse agreed that, for the purpose of calculating incremental costs in the retrospective audit period, NSPI would use the Synapse Differential Method through at least June 22, 2014. That method is summarized in Section 2.2.

NSPI stated that it planned to move to a new differential method (NSPI Proposed Differential Method, described in section 5 of this report) after June 22, 2014. As of the filing date of this report, NS Power has not moved to the NSPI Proposed Differential Method and is currently using the differential system cost methodology it moved to on October 23, 2013. NS Power plans to move to the NSPI Proposed Differential Method for the billing period starting October 6, 2014.

2.2. Differential Method for Retrospective Audit Period Calculations

The Synapse Differential Method used to make the retrospective calculation relies on two sets of runs of the GenOps software: one set of runs With PHP load and one set of runs Without PHP load. NSPI computes its incremental costs of supplying PHP on an hourly basis by comparing the generation dispatch costs produced by these two runs of GenOps.

In conducting these runs, unit commitment decisions are simulated based on the actual load data, actual hydro schedules, wind generation injections, and interchange flows. Because the unit commitment decisions and system dispatch are based on perfect hindsight—i.e., actual conditions rather than projected conditions— the GenOps runs may slightly underestimate the actual total system costs for the With PHP load and the Without PHP load. With the perfect hindsight unit commitment decisions are perfectly optimized as if day ahead electricity consumption and other conditions were perfectly known at the time these decisions were made. In reality, unit commitment decisions are made under uncertainty and may be imperfect given the demand that have been realized and result in higher dispatch costs. On the other hand, in each set of runs, GenOps is set to maintain reserve requirements and commit generating units subject to their minimum and maximum generating capabilities. This tends to reduce the optimization benefit of perfect hindsight associated with using actual data rather than projected conditions.

Both NSPI and Synapse believe that the Synapse Differential Method provides the best estimate of NSPI's incremental costs of serving PHP when applied on a retroactive basis to the retrospective audit period. They believe it provides a substantially more accurate estimate than the estimate based on the use of CQ pairs.

NSPI's summary of the Synapse Differential Method it applied to make these retroactive calculations of incremental cost is provided in Attachment A.

2.3. Specific Issues Associated with Retrospective Audit Period Calculations

The Board Decision Letter required Synapse to examine several specific inputs and issues associated with the calculation of incremental costs in the retrospective audit period. This section addresses each of those inputs and issues.

Treatment of power purchases

Based on the information NSPI provided during the June 19 meeting, NSPI's treatment of imports for PHP appears reasonable. According to NSPI, the only imports attributable to PHP are those directly requested by PHP or identified by NSPI and explicitly approved by PHP prior to acquisition. These import volumes are explicitly factored into NSPI's calculation of incremental costs. Synapse verified NSPI's treatment of import costs in its review of the NSPI workbooks.

Fuel prices

In its 2010-11 audit, Liberty concluded that NSPI should move to a new approach to pricing coal in its dispatch analyses. Liberty recommended it implement a method based on the current market price of coal. It is our understanding that NSPI agreed to implement this new approach sometime after Q1 2014. Thus, NSPI was not obligated to implement this approach until on or after April 1, 2014. Based on the discussion of this issue with NSPI, we learned that NSPI had not implemented this approach during the retrospective period ending in the first quarter of 2014. Therefore, we did not require NSPI to use that approach in its calculations for the retrospective audit period. With respect to prices of other fuels, Synapse in consultation with Liberty did not identify any problems that materially impact calculation of incremental costs of serving PHP.

Emission constraint costs

NSPI's treatment of environmental costs is reasonable. NSPI uses the PLEXOS model to calculate an optimal fuel blend and appropriate amount of powdered activated carbon at each plant to meet annual emissions requirements for sulfur dioxide and mercury. Among other outputs, PLEXOS computes shadow prices associated with emission allowance constraints – economic values of emission allowances. These calculations of allowance shadow prices are performed annually in advance of the calendar year. NSPI adds these emission allowance prices to fuel costs on a unit-by-unit basis as if with every MMBtu of burnt fuel the generator "burns" a corresponding number of allowances. Emission allowance prices are factored into unit commitment and dispatch calculations for each plant in GenOps and influence dispatch order of generators as well as total generations costs and incremental costs of serving PHP load.

Unit dispatch

Use of the Synapse Differential Method to prepare the retroactive calculations ensures the correct dispatch of units under the With PHP run and the Without PHP run. The correct unit dispatch results from the distinct unit commitment decisions and distinct unit dispatch decisions that result from the separate GenOps runs for the With PHP case and the Without PHP case.

3. Review of NSPI Line Loss Calculation Method

NSPI has to adjust the incremental supply costs generated by any differential method to account for the line losses associated with the delivery of power from each generating unit to PHP. This section of the report describes our review of the NSPI's line loss methodology.

For the first two quarters of the tariff operation (Q4 2012 and Q1 2013), NSPI did not include an adjustment for line losses in the calculation of its incremental costs of serving PHP. Thus, the NSPI bills to PHP through that period did not reflect costs associated with line losses. However, according to NSPI's first report on the LRT, NSPI retroactively estimated incremental costs of line losses associated with serving PHP load through March 2013, which resulted in a credit to PHP of $588,000.[1]

NSPI's first report on the LRT also stated that it was developing a line loss methodology based on power flow analysis for tracking and accounting for the cost of transmission losses associated with serving PHP load[2] However, in at that time NSPI was still developing that methodology.

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[1] *Port Hawkesbury Paper Load Retention Mechanism, First Report Covering 2012 Fourth Quarter and 2013 First Quarter*. November 26, 2013. NSPI. Page 29.

[2] Ibid, page 30.

At the June 19, 2014 meeting, NSPI provided Synapse a description of the method it had implemented as of March 2013 for calculating the line loss charges associated with serving PHP. NSPI does include line losses when using its Existing Differential Method to compute unit commitment and unit dispatch to supply its forecast system load. However, NSPI does not calculate the total generation required in the Without PHP case by subtracting the line losses associated with both the PHP metered load and the PHP metered load itself. NSPI only reduces its system load by the PHP metered load not accounting for incremental losses incurred for serving that load.

NSPI makes an offline calculation of the energy needed to compensate for the line losses it incurs when it serves PHP load, and the cost of that energy. The offline calculation of the cost of that energy equals the ***MWh of transmission losses associated with supplying the PHP load*** multiplied by ***NSPI's average unit incremental cost of supplying PHP***, in dollars per megawatt-hour.

The MWh quantity of transmission losses by hour are computed as a product of the loss factors and PHP metered load. Losses are based on point-to-point loss factors associated with the delivery of energy from each NSPI generating unit to PHP. NSPI uses Siemens PSS/E power flow software applied to hourly ex-post conditions to compute hourly point-to-point loss factors. These are theoretical loss factors assuming that the entire supply to PHP originates from a particular generating unit. Using the Existing Differential Method, NSPI determines the quantity of supply from each generating plant and from imports that it used to supply PHP. It uses those quantities to calculate a weighted average of point-to-point loss factors. In this calculation, NSPI uses the difference in generation dispatch between the With PHP case and the Without PHP case to determine the weights attributable to each source.

NSPI's hourly average per unit incremental cost of supplying PHP, in dollars per megawatt-hour, is computed using its Existing Differential Method.

4. NSPI Retrospective Calculation of Incremental Costs to Supply PHP, September 29, 2012 – June 22, 2014

4.1. Summary Results

The Board directed Synapse to oversee NSPI's calculation of all incremental costs that should have been billed to PHP from September 2012 to the end of March 2014. However, NSPI provided Synapse with the results of these calculations through June 22, 2014 which are discussed in this section of the report. The application of the Synapse Differential Method to all billing periods in the retrospective audit period indicates that NSPI's bills to PHP have under-recovered its incremental costs in some billing periods and have over-recovered its incremental costs in other billing periods. As Table 1 indicates, the use of the CQ-pairs method between September of 2012 and October of 2013 resulted in an under-recovery from PHP of $4.6 million in incremental energy costs. On the other hand, use of the NSPI Existing Differential method adopted at the end of October of 2013 resulted in over-recovery from PHP of $3.5 million in incremental energy costs during the period between October 27, 2013 and June 22, 2014. The net result for September 29, 2012 through June 22, 2014 is an under-collection of $817,715, or 0.7% of the total amount NSPI billed to PHP over that period. As shown in Table 1, that net amount consists of an under-recovery of energy, line loss, and environmental charges of $3.1 million and an over-recovery of variable operations and maintenance (VOM) costs of $2.3 million.

Table 1: Summary of billed and retroactive costs to supply PHP between September 29, 2012 and June 22, 2014

		Billed	Retroactive Calculation	Over/(Under) Recovery
CQ Pairs Period (9/29/2012-10/27/2013)	Energy			$ (4,583,091)
	Line Losses	$ (317,918)	$ 908,693	$ (1,226,611)
	Environmental Adder	$ 7,782,337	$ 7,090,766	$ 691,571
	VOM Correction	$ 3,111,303	$ 1,673,226	$ 1,438,077
	Subtotal Over/(Under) Recovery			*$ (3,680,054)*
Pre-audit NSPI differential method (10/28/2013-6/22/2014)	Energy			$ 3,451,344
	Line Losses	$ (551,691)	$ 154,731	$ (706,421)
	Environmental Adder	$ 3,754,451	$ 4,518,975	$ (764,524)
	VOM Correction	$ 1,900,245	$ 1,018,305	$ 881,940
	Subtotal Over/(Under) Recovery			*$ 2,862,339*
Total (9/29/2012-6/22/2014)	Energy			$ (1,131,747)
	Line Losses	$ (869,609)	$ 1,063,424	$ (1,933,033)
	Environmental Adder	$ 11,536,788	$ 11,609,741	$ (72,953)
	VOM Correction	$ 5,011,549	$ 2,691,531	$ 2,320,017
Total				**$ (817,715)**

The detailed over/under recovery values by billing period developed by NSPI are provided in Attachment B.

NSPI informed Synapse that NSPI had inadvertently double-billed PHP for VOM. The double-billing occurred because GenOps incorporates VOM costs at the plant level in its hourly dispatch, and any incremental changes in VOM are embedded in the resulting estimates of incremental supply costs. However, the LRT specifies a VOM charge of $1.5 per MWh, which NSPI also charged PHP through additional billings.. During the entire reported period, NSPI billed PHP $5 million in total VOM costs: $2.7 million through the $1.50/MWh LRT VOM charge and $2.3 million through the recovery of incremental energy costs. In sum, there has been an over- recovery of VOM from PHP of $2.3 million for the VOM costs. These numbers indicate a material difference between two estimates of VOM costs, one based on the LRT approved rate, another -- embedded in calculated incremental costs. The difference amounts to $0.4 million, $2.7 million minus $2.3 million, or 15% of VOM the cost billed to PHP.

Please note that the allocation of environmental charges between two periods in Table 1 is approximate. NSPI provided a single retroactive calculation of environmental costs for the entire calendar year of 2013. Synapse allocated these costs to the CQ pair period.

5. Differences from Results for Corresponding Weeks in Synapse February Audit Report

The results of the revised retroactive calculations by NSPI differ in some respects to the four sample weeks covered in the Synapse February audit, provided by NSPI on February 12th 2014 in response to CA-IR-22. According to NSPI, there are three primary differences that results in changes in unit commitment and dispatch:

1. ***Generating unit maximum and minimum operating levels***. Calculations for the four-week sample set utilized maximum and minimum capabilities that more closely represented the actual levels at which the units were actually dispatched by the Energy Control Center (ECC). The retroactive calculations use maximum and minimum capabilities reported by the generating units.

2. ***Wreck Cove hydro***. The calculations for the four-week sample assumed that the dispatch of Wreck Cove would not be affected by the presence or absence of PHP load, i.e., the models were run using the same actual output from Wreck Cove for both the With PHP and the Without PHP cases. In the retroactive calculations, Wreck Cove was modeled on an economic unit commitment and dispatch basis for the With PHP and the Without PHP cases. This was done by inputting the daily volumetric target run for Wreck Cove in both cases yielding an optimized dispatch of the resource.

3. ***Solution tolerance ("duality gap")***. NSPI uses a model solution tolerance to facilitate a reasonable computation time for optimization problems solved by GenOps. This tolerance specifies the point at which GenOps considers the solution sufficiently optimized. Two different solutions within the same tolerance will have very similar production costs and will be deemed optimal but could result in different commitment and dispatch decisions resulting in an additional discrepancy between two sets of calculations performed for the four sample weeks.

6. Differential Method post October 6, 2014

Like the Synapse Differential Method used for retrospective calculations, the NSPI Proposed Differential Method will be a two-step process. In the first step, NSPI will calculate generation costs of serving system load with PHP load. In the second step, it will calculate those costs without PHP load. However, unlike the Synapse Differential Method used for the retrospective calculations, each step will rely on two series of runs of the GenOps model.

The first or “*Ex Ante”* series of runs will be performed on a daily basis in advance of its actual operations. Each day, NSPI will perform two unit commitment runs of GenOps—With PHP and Without PHP. For the With PHP case, NSPI will make unit commitment decisions subject to the business process the company currently has in place. It is important to note that the day-ahead run of GenOps has a one-day lead time and a four-day look-ahead period. In other words, the optimization horizon begins one day in advance of the day for which the commitment decision is made and covers four days after the end of the day for which the commitment decision is made. Under this approach, NSPI will not rely solely on the GenOps run results to make commitment decisions. Instead, it will allow its model operator some discretion to modify commitment decisions accounting for uncertainties that may not be adequately represented in the GenOps model. The model operator will document these modifications.

For the Without PHP case, NSPI will re-run GenOps using the same input assumptions as in the With PHP case, with the exception of the NSPI load forecast. The NSPI load forecast in this run will exclude projected PHP load in the entire optimization period. In addition, PHP load will be excluded for three days prior to the day for which the commitment decision is made and for four days after that day. In this case, reserve requirements will be turned on in GenOps and plants allowed to dispatch to their maximum levels, as long as reserves are met. This approach will adequately represent the “No PHP” alternative. Similarly to the With PHP case, NSPI will use model operator discretion to modify commitment decisions if necessary and document these modifications.

The second or “*Ex Post”* series of runs will be performed at the end of each weekly billing cycle (i.e., after its actual operations). NSPI will compute differential costs for each day of the billing period using actual system load and actual PHP load served in each hour of that day, actual fuel costs, generating units derating and outages, actual injections of wind and hydro generators and actual interchange flows. NSPI will make these computations using the *Ex Ante* unit commitment decisions for the With PHP and the Without PHP cases as determined by five *Ex Ante* run of GenOps performed for each weekday (Monday through Friday with Friday run covering three days, Saturday, Sunday and Monday) of the seven-day billing period. In the “Ex Post” run With PHP, GenOps will not be required to maintain reserve requirements but all generating units will be dispatched up to their actual levels. This will allow GenOps to effectively match the simulated costs to actual costs incurred. For the Without PHP case, actual dispatch levels of generators are not known, because this case did not occur in reality. In this case dispatch limits of generating units will be set at technical maximum and reserve requirements will be imposed.

This method is different from the application of the Synapse Differential Method for the retroactive calculations in that it incorporates model operator discretion in unit commitments. The retroactive calculations did not have any system operator adjustments to the GenOps run results. Model operators did make such adjustments in the retrospective audit period, but they did not record them. NSPI states that model operators will document those adjustments on a -going-forward basis to accurately record the modeling of the system. This approach will reflect the impact of uncertain information on unit commitment decisions and thus lead to reasonable estimates of actual and incremental costs.

Synapse believes that the differential method NSPI proposes to use on a going-forward basis is reasonable and will accurately capture the incremental costs incurred by NSPI in serving PHP load.

NSPI's summary of the going-forward differential cost methodology is provided in Attachment C.

7. Conclusions and Recommendations

Based on the review and analysis summarized in this report, Synapse makes the following conclusions and recommendations:

Conclusions

- The Synapse Differential Method used to calculate incremental costs of supplying PHP in the retrospective period is more accurate than the CQ-pair method. By allowing GenOps to adjust the unit commitment under the With PHP load and the Without PHP load runs, the model better reflects how the system would operate. However, the resulting unit commitment decisions do not reflect adjustments that model operators would make to these decisions. Those operator adjustments play an important role based on the current readiness of NSPI's power plants.

- NSPI's Proposed Differential Method does allow for model operator adjustments to unit commitment. It is essential that model operators document their adjustments to unit commitment decisions from GenOps.

- The differential cost method does not explicitly account for the costs of incremental line losses incurred by serving PHP load. These costs are estimated separately. NSPI's calculation of the cost of incremental line losses based on weighted-average loss factors provides a reasonable estimate of those costs.

- The double-billing of VOM costs resulted in a significant over-recovery of VOM costs from PHP. However, over the retrospective period, NSPI had a net under-recovery of its incremental costs.

- There appears to be a 15% difference between two estimates of non-fuel Variable O&M costs, applicable to the PHP load. One estimate is based on the LRT approved value of $1.50/MWh, another is based on unit-by-unit calculation of incremental costs using GenOps software.

- The revised retroactive calculations give an under-recovery of energy costs of $1,131,747, an under-recovery of line losses of $1,933,033, an under-recovery of $72,953 for environmental adders, and an over-recovery of $2,320,017 for VOM costs. In total this results in an under-recovery of $817,715.

Recommendations

- The Board should approve NSPI's plan to bill PHP based on its Proposed Differential Method starting October 6, 2014.
- The Board should require an audit of NSPI's billing of PHP under its Proposed Differential Methodology after it has been in operation for several months. The implementation of the Proposed Differential Method should be independently reviewed and validated.
- NSPI should assess the accuracy of the $1.50/MWh LRT VOM charge as applied to the total energy delivered to PHP as opposed to the direct estimate of VOM costs on a unit-by-unit basis embedded in the Differential Method.

Retroactive Calculation of PHP's Cost of Energy After it has been Delivered

Background:

Further to the document titled "Differential System Cost Calculation Methodology for the Port Hawkesbury Paper (PHP) Load Retention Tariff (LRT)", the following describes the methodology that NS Power and Synapse have agreed to use in calculating PHP's cost of energy on a retroactive basis.

The methodology to be used in calculating PHP's cost of energy on a retrospective basis involves determining the system cost in the with PHP scenario and without PHP scenario and taking the difference between these two scenarios to determine PHP's cost of energy. In both scenarios, NS Power's economic dispatch software (GenOps) is used to determine the system cost. Both scenarios allow GenOps to economically optimize the system while considering a number of system inputs and constraints (e.g. generating unit capabilities, transmission restrictions, actual system load etc.).

For several reasons, it is not reasonable or possible to apply the methodology agreed to for calculating PHP's cost of energy on a go-forward basis to calculate PHP's cost of energy on a retrospective basis. The primary reason why applying the methodology used to calculate PHP's cost of energy after it has been delivered on a go-forward basis cannot be used to determine PHP's costs on a retrospective basis is that the risk management elements considered in the economic scheduling and dispatch of the system on a Day-Ahead basis cannot be replicated retrospectively. Completing retrospective calculations that do not include the risk management elements considered on a Day-Ahead basis (e.g. possibility of generating unit de-rates and unplanned maintenance outages) would not accurately reflect the cost to serve PHP's load over the retroactive period.

Another reason why applying the methodology used to calculate PHP's cost of energy after it has been delivered on a go-forward basis cannot be used to determine PHP's cost on a retrospective basis is that GenOps did not have the ability to run a scenario that was identical to the system as it was dispatched until October 2013. NS Power had to work with its service provider and supplier of GenOps (Ventyx) over the course of the period in question to reconfigure the software such that it had the ability to model the system as it was dispatched. As this capability was not available until October 2013, it would not be reasonable to apply the methodology to be used on a go-forward basis to the retrospective calculations.

For these reasons, NS Power and Synapse have worked cooperatively in developing the following retroactive differential system cost methodology that most accurately estimates the cost of serving PHP's load since inception of the Load Retention Tariff (LRT). This methodology would have been possible to implement at the time of calculating PHP's cost of energy after it has been delivered since inception of the LRT to present.

PHP Bill Details:

- **Retroactive Period:** September 29, 2012 – June 22, 2014

- **Weekly Billing Period**: Monday (HE1) through Sunday (HE24)

- **Concept**: GenOps is used to calculate NS Power's best estimate of the system costs in the with and without PHP scenarios for each hour of the billing period. Based on these model runs, an hourly differential system cost can be calculated by subtracting the total system cost in the without PHP scenario, from the total system cost in the with PHP scenario. This differential represents the incremental cost of supplying power to PHP. PHP's bill will be calculated as the sum of all the hourly system cost differentials.

  Example of Differential Calculation:

  - System cost in the with PHP scenario for HE11: $115,500

  - System cost in the without PHP scenario for HE11: $105,000

  - Incremental System Cost to serve PHP in HE 11: $10,500

- **GenOps Inputs**:
  - System load (without PHP)
  - PHP's load (in applicable study)
  - Actual wind generation
  - Actual hydro generation
  - Actual energy sales or purchases
  - Transmission constraints
  - Fuel prices
  - Heat rate curves
  - Minimum up and down time for generating units
  - Start costs
  - Ramp rates

Bill Calculation

Step 1: Calculation of system cost including PHP's load

Unlike the billing process to be used on a go forward basis, the retroactive calculation "with PHP" will use the following:

- All previously listed GenOps inputs,
- Reported maximum and minimum generating unit capabilities,
- Reserve requirements,

- Implementation of operating constraints for VAR requirement purposes only.

This approach to the retroactive calculation will produce an optimal system dispatch to serve total load (including PHP's load).

Step 2: Calculate the system cost without PHP's load

Similar to Step 1, the "without PHP" scenario will also use all previously listed GenOps inputs, reported maximum and minimum generating unit capabilities, reserve requirements, and implementation of operating constraints for VAR requirement purposes only.

Using this approach in the without PHP scenario will also produce an optimal system dispatch to serve total load (excluding PHP's load). As operating constraints are not placed on all thermal units, it is possible that the unit commitments in step 2 may differ from those in step 1.

Step 3: Calculate the differential system cost

The differential system cost (the cost attributed to PHP's load) is calculated by subtracting the system cost derived in the "without" PHP model run described in step 2, from the system cost including PHP's load calculated in step 1. Using outputs from the previously stated scenario runs, line losses and environmental costs are also calculated.

Although both of the previously described scenarios produces an optimal system dispatch and may slightly underestimate the total system cost for the with and without PHP scenarios, both NS Power and Synapse, believe that the differential between these two optimal systems is the best approach to use on a retrospective basis and will result in a very close approximation to the cost of serving PHP's load.

Attachment B: Detailed Over/ (Under) Recovery

Attachment B is confidential.

Differential System Cost Calculation Methodology for the Port Hawkesbury Paper (PHP) Load Retention Tariff (LRT):

The following describes the differential system cost methodology that NS Power and Synapse have agreed to use for calculating PHP's cost of energy after it has been delivered.

The methodology used to determine PHP's cost of energy after it has been delivered involves calculating the following:

1) The cost to serve the system including PHP's load (referred to as the "with PHP" scenario).

2) The system cost without PHP's load (referred to as the "without PHP" scenario).

3) Once the system cost for both scenarios has been calculated, the differential cost between them represents the incremental cost to serve PHP's load.

PHP Bill Details:

- **Billing Period**: Monday (HE1) through Sunday (HE24)

- **Bill generation time frame**: Weekly

- **Concept**: NS Power's economic dispatch software, Generation Operations (GenOps) is used to generate the most accurate estimate of the system costs in the with and without PHP scenarios for each hour of the billing period. Based on the results of these model runs, an hourly differential system cost is calculated by subtracting the total system cost without PHP from the total system cost with PHP. This differential represents the incremental cost of supplying power to PHP. PHP's weekly cost of energy after it has been delivered is calculated as the sum of the hourly system cost differentials.

- **Example of hourly differential cost calculation**:

    - With PHP System Cost for hour-ending (HE) 11: $115,500

    - Without PHP System Cost for HE 11: $105,000

    - PHP's Incremental System Cost for HE 11: $10,500

- **GenOps Inputs**:
    - System load (without PHP)
    - PHP's load (in applicable study)
    - Actual wind generation

- Actual hydro generation
- Actual energy sales or purchases
- Transmission constraints
- Must-runs on all gas/coal units when they were actually run
- Fuel prices
- Heat rate curves
- Minimum up and down time for generating units
- Start costs
- Ramp rates
- Maximum and minimum generation levels for generating units

Differential System Cost Calculation:

Step 1: Calculation of system cost including PHP's load

The purpose of step 1 is to re-create the system as is was dispatched over the past week and to calculate the system cost including PHP's load using GenOps. The following actions are required in calculating the system cost in the with PHP scenario:

- Use the actual hourly output (in MW) for each generating unit in GenOps as the maximum generating capacity for each unit. This ensures that GenOps only has enough generation to meet load (without considering reserve requirements).
- As GenOps only recognizes enough generation capacity to meet load, it would be incapable of meeting reserve requirements. For this reason, and because reserve requirements were actually met throughout the day, reserve requirements in GenOps are shut off.

Using these elements and all of the inputs previously listed, GenOps is able to simulate a system that is almost identical to how the system was dispatched and derive a system cost that is as close to the actual cost to serve the system as possible.

Step 2: Calculate the system cost without PHP's load

To calculate the system cost in the "without PHP" scenario, the following steps are performed:

On a daily basis, NS Power's Day-Ahead Energy Marketer runs a Day-Ahead "without PHP" scenario in GenOps. The sole purpose of this is to identify the units that GenOps would have committed for the next day absent of PHP's load. With the exception of PHP's load forecast being set to zero for the entirety of the scenario run, all other inputs remain identical to the "with PHP" day-ahead dispatch run, which is performed daily to generate actual unit commitments.

Similar to the “with PHP” day-ahead dispatch run, the Day-Ahead Energy Marketer also considers any risks with generating units that could not be modeled in GenOps, and makes adjustments to the day-ahead dispatch plan produced by GenOps to address those risks. At times, this may result in committing an additional generating unit in the economic dispatch plan. The Day-Ahead Energy Marketer will document any modifications made to the day-ahead “without PHP” dispatch run and rationale for the modifications.

These daily unit commitments produced ex-ante are then compiled for the billing period and uploaded into GenOps to act as operating constraints for the without PHP billing run (performed once a week, ex-post). Unlike the “with PHP” scenario, reported maximum/minimum unit capabilities are used, rather than the actual output levels from NS Power’s generators. Additionally, as this is a theoretical scenario, GenOps must ensure reserve requirements are met. For this reason, reserve requirement functionality is turned on for the GenOps run in this scenario.

Step 3: Calculate the differential system cost

The differential system cost (the cost attributed to PHP’s load) is calculated by subtracting the system cost derived in the “without” PHP model run described in step 2, from the system cost including PHP’s load calculated in step 1. Using outputs from the previously stated scenario runs, line losses and environmental costs that are attributable to PHP’s load are calculated.