Audit of Port Hawkesbury Paper Load Retention Tariff

Prepared for the Nova Scotia Utility and Review Board

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REDACTED VERSION

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1. INTRODUCTION

In April 2012, Nova Scotia Power Inc. (NSPI) applied for approval of a load retention tariff (LRT) mechanism as part of a package of measures associated with a proposal to re-open the former NewPage mill under new ownership as Port Hawkesbury Paper (PHP, or "mill"). The Nova Scotia Utility and Review Board (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. On July 22, 2013, NSPI filed a draft of its report for the first six months of operation of the LRT (September 29, 2013 through March 31, 2013). On November 23, 2013, it filed the final version of that report (NSPI First PHP Report). During that period, NSPI supplied 493,320,177 kWh to PHP. Figure 3 of the NSPI First PHP Report indicates that NSPI recovered [redacted] of incremental energy costs from PHP for that supply. In addition, NSPI recovered the additional categories of costs required under the Board's August 2012 Order, i.e., variable operation and maintenance of $722,501, variable capital of $563,551, customer charges of $125,565, and a $986,640 contribution to NSPI fixed costs, all of which total to $ [redacted].

The Board retained a Synapse Energy Economics project team (Synapse), led by sub-contractor Dr. Alex Rudkevich of the Newton Energy Group, to conduct the audit required under paragraph 241. This report describes our audit. Because this was NSPI's first experience with such a complex tariff, our audit focused on whether the incremental energy costs NSPI calculated and billed PHP under the LRT (as-billed costs) comply with the basic principle specified in the Board's August 2012 Decision. Specifically, did NSPI's as-billed costs recover all of NSPI's incremental costs of supply without subsidization from its other ratepayers? During the audit, we coordinated with the Liberty Consulting Group, who are preparing an audit of NSPI's Fuel Adjustment Mechanism (FAM) on behalf of the Board.

We conducted the audit in two major steps. First, we reviewed the LRT design proposed by NSPI in April 2012 and the evaluation of that proposal in Matter MO4862. Second, we collected and analyzed information on NSPI's operation of the LRT during its first six months of operation.

2. LOAD RETENTION TARIFF PROPOSED AND APPROVED IN 2012

This section summarizes our review of the LRT design proposed by NSPI in April 2012 and the evaluation of that proposed design in MO4862.

2.1. LRT proposed by NSPI in April 2012

The key features of the LRT proposed by NSPI in April 2012 were as follows:

a. PHP would have no obligation to purchase any energy from NSPI on any day, other than the quantity of energy that PHP nominated for a given day on a day-ahead basis and as modified by PHP's ability to change its hourly nominations in advance for each hour of that day.

b. NSPI would have no obligation to plan for, or to optimize its fleet to serve, PHP on any day. Instead, NSPI's only obligation would be to supply the quantity of energy that PHP nominated for a given day on a day-ahead basis and as modified by PHP's ability to change its hourly nominations in advance for each hour of that day.

c. The compensation NSPI would receive for the energy it supplied PHP would be equal to the actual load of the mill in kWh multiplied by NSPI's *hourly incremental cost per kWh* plus a variable capital cost of 0.117 cents per KWh plus a contribution to fixed cost. The minimum contribution to fixed cost would be 0.20 cents per kWh.

d. The LRT included a real time pricing (RTP) protocol, which described the process and format through which NSPI and PHP would implement this incremental costing of electricity supply. The RTP protocol provided for the establishment of financially binding cost quantity pairs (CQ pairs) a day ahead of the operational day, and on an hour-ahead basis during the operational day. The CQ pairs would be NSPI's forecasts of the quantities of power it was prepared to supply the mill in each hour and its estimate of its incremental cost of supplying those quantities in each hour.

    I. A day ahead of the operational day, by 7 a.m., NSPI would provide to PHP a "Day-Ahead Cost Forecast" consisting of CQ pairs for five different levels of supply for each hour of the operational day. By 8 a.m., PWCC would provide NSPI its "Day-Ahead Demand Forecast," i.e., its forecast of demand in each hour.

    II. On an hour-ahead basis during the operational day, i.e., 20 minutes prior to the start of each hour, NSPI would provide to PHP an "Hour-Ahead Cost Quote," its committed CQ pairs for each block of power in the upcoming hour. No later than ten minutes prior to the hour PWCC would provide NSPI its "Hour-Ahead Demand Requirement."

The LRT proposed by NSPI in April 2012 was substantially different from NSPI's prior experience with real time pricing in several respects. First, it was more complex, requiring production of CQ pairs for five levels of supply every hour. Second, unlike the real time pricing that NSPI had provided to New Page Port Hawkesbury and Bowater Mersey Paper under ELI 2P-RTP, PHP would not have customer baseline load (CBL), i.e., average hourly demand of customers' annual forecast total energy requirements—nor would NSPI be able to bill PHP a monthly amount equal to the CBL multiplied by a standard energy charge (SEC).

2.2. Evaluation of proposed LRT in MO4862

In their testimony in the MO4862 proceeding, both Mark Drazen and Richard Hornby raised concerns about NSPI's calculation of incremental energy costs under the LRT. Mr. Hornby expressed concern that NSPI had not provided a detailed description of the method it would use to make those calculations and had not provided a numerical illustration of that method. Mr. Drazen expressed concern that NSPI may miss opportunities to reduce the cost for system load if it provides supply to PHP.

NSPI responded to those concerns in its Reply Evidence by providing a two-page Appendix A, which is included with this report as Attachment A. NSPI stated that the appendix contained a detailed description and a numerical example of the methodology it would use to determine the incremental generation cost of serving the mill on an hourly basis. NSPI also stated,

> "…NS Power will assume for all planning purposes, that the load required to be served is that excluding the mill's load. The Company will plan and optimize its fleet on this basis, independent of whether the mill operates." (NSPI Reply Evidence, page 9 line 26 to page 10 line 2)

In response to cross-examination regarding Mr. Hornby's concerns regarding the method of calculating incremental energy costs, Mr. Sidebottom stated,

> "You're relying on a utility-grade piece of software that's used for economic dispatch, and *you actually compare two runs with a myriad of characteristics that are required to actually dispatch the system in two different states*. So I think it's just not practical to actually describe the many moving parts.
>
> What we try to do is to show output might look like for the customer, and *that is using two generation runs using the generation operation software*." (Transcript, page 645 line 16 to page 646 line 3) [emphasis added]

In response to cross-examination regarding the expected accuracy of NSPI's estimates of its incremental energy costs, Mr. Sidebottom stated,

> "I think a good point of reference here is the real-time rate that we've analyzed in the past, and in that there's -- there isn't as much precision. I think the analysis that was done -- I think we did analysis over a period. I think there was a $200,000 mismatch over a period of time, and that doesn't have near the certainty of customer response and load, and so that for me was a good indication of the type of magnitude that we might experience.
>
> Remember, it can be plus and minus through time. So I would accept that there could be and there will be, frankly differences between the exact forecast and ultimately what is, what it

costs. But you know, taking a look at our experience in the last several years with real-time pricing, also with the added benefit that comes with a customer that is committing in advance to a load profile -- which, frankly, we didn't have in the past; they could choose to move their load. We actually will get benefits from that side.

So I took comfort from that and my experience in that world and I believe that's a reasonable view of the type of magnitude we might be dealing with." (Transcript, page 663 line 9 to page 646 line 5)

The Board noted those points on page 36 of its Decision, where it discusses the determination of Incremental Price. In paragraphs 112 and 113, the Board found that NSPI is in the best position to determine its incremental energy costs and that NSPI bore the responsibility for the accuracy of its determination of those costs, as noted below:

[112] The Board is satisfied, based on the evidence of Mr. Sidebottom, NSPI has a relatively sophisticated method of calculating incremental costs. The Board finds that NSPI is in the best position, and is obligated, to determine the incremental costs to serve the mill. The Board orders NSPI to record the prices and actual incremental costs in accordance with a reporting format discussed later in this Decision.

[113] The Board finds that NSPI is also in the best position to determine the accuracy of its own incremental costs for all the components of the LRT. NSPI has agreed to accept responsibility if there is a defect in the rate design or improper administration of the LRT.

3. Load Retention Tariff Operation in Fourth Quarter 2012 and First Quarter 2013

NSPI has found the LRT to be "…the most complex tariff offered by NS Power." Section 4 of the NSPI First PHP Report describes a number of changes in the protocol that NSPI has had to make relative to the proposed protocol because of this complexity. As described above, the implementation of this tariff requires multiple communications between NSPI and PHP spanning over several decision cycles. NSPI must produce the day-ahead forecast of CQ pairs by 7 a.m. each day for the next day; within one hour from that time, PHP must respond with the day-ahead load forecast and NSPI must incorporate this information into the next day generation planning decisions. Within each day-ahead decision cycle, there are 24 hour-ahead cycles in which NSPI must produce and deliver to PHP hour-ahead CQ pairs no later than 20 minutes before the start of the hour to which. PHP must respond within ten minutes with its hour-ahead demand requirements. Once NSPI began to implement the LRT, it quickly found that its hardware and software could not handle that level of complexity, given the short turn-around times within each decision cycle and the necessary communication between the parties.

3.1. Data collection

Synapse collected the information presented in this report through a set of information requests submitted to and answered by NSPI, and through multiple communications with NSPI personnel. In particular,

- On December 12, 2013, Synapse sent to NSPI draft Information Requests (IRs) and points for discussion in preparation for the site visit and interview with NSPI personnel.
- On December 18 and 19, 2013, Mr. Hornby had several meetings in Halifax with NSPI's Manager, Oil, Gas and Energy; Director, Fuels, Energy and Risk Management; Tariff Administrator; and Energy and Dispatch Optimization Specialist. Dr. Rudkevich could not attend these meetings due to flight cancellation and participated in certain meetings by phone.
- Based on discussions held during the site visit and information provided by NSPI at the meetings, Synapse was able to substantially modify initial IRs. The final set of IRs was sent to NSPI on January 2, 2014.
- On January 13, 2014, Dr. Rudkevich, Mr. Hornby, and NSPI personnel had a telephone conversation to clarify questions regarding the IRs Synapse sent on January 2. During this discussion, among other things, Mr. Hornby and Dr. Rudkevich explained to NSPI the objectives of certain quantitative analyses requested in the IRs and discussed with NSPI the methodology which would permit NSPI to carry out these analyses in a way that is efficient for NSPI and sufficiently informative for Synapse.

- On January 17, 2014, Mr. Hornby had a call with NSPI's Day-Ahead Marketer to better understand the business processes underlying the development of NSPI's generation planning decisions in general and with respect to serving PHP load in particular.

- On February 6, 2014, Dr. Rudkevich had a call with the Tariff Administrator to clarify NSPI's proposed responses to DR 22, 23, and 24.

- Upon conducting a significant portion of the analysis, on February 19, 2014 Synapse sent to NSPI several follow-up questions.

- On February 21, 2014, Dr. Rudkevich and Mr. Hornby discussed with NSPI personnel their responses to these questions and Synapse's preliminary findings in this case.

- Another conversation between Dr. Rudkevich and NSPI took place on February 24, 2014, when NSPI provided additional comments to Synapse's preliminary findings and furnished a description of NSPI's implementation of the "differential method" for assessing incremental costs of serving PHP load.

This section describes the information we collected and analyzed on NSPI's operation of the LRT during its first six months of its operation. Our analysis touches on the changes in CQ communication protocol that NSPI has had to make, but it focuses primarily on the accuracy of the method NSPI has chosen to use to calculate the incremental energy costs it billed PHP. We refer to that method, and the resulting estimates, as NSPI's "as-billed costs." It is important to note that Synapse received from NSPI responses to DR 22, 23, and 24 (information critical to this analysis) only on February 12, and had very limited time to conduct this analysis.

3.2. Analysis of PHP Load

It is important to note that PHP load represents a significant portion of the total system load served by NSPI on a regular basis, as shown in Table 1.

Table 1. PHP Load vs. NSPI System Load[1]

	PHP		NSPI System		PHP Fraction of NSPI	
	6 Months 2012-2013	Estimated Annual	2012	2013	2012	2013
Annual Energy (GWh)	493	987	10,475	11,003	9%	9%
Annual Peak (MW)	190	190	1,882	2,085	10%	9%

[1] Annual NSPI System Energy and Peak as reported in NSPI's 10 Year System Outlook (June 2, 2013)

As shown in Table 1, PHP load accounts for 9% to 10% of system load and therefore makes a significant impact on the operation of NSPI's generation fleet. Although PHP energy use has a significant level of base load, the consumption pattern is volatile, as shown in Figure 1.

Figure 1. (Confidential) Average and Standard Deviation of PHP Load

[redacted]

As shown in this figure, during the period of 26 weeks under review, PHP load was [redacted] on average during off-peak hours and [redacted] during on-peak hours, with standard deviations of [redacted] and [redacted] during off-peak and on-peak hours, respectively. Thus, the standard deviation in PHP's hourly energy use accounts for 30% in off-peak hours and for 42% in on-peak hours. Volatility of PHP load may add to the complexity of NSPI's operation of its generation fleet, although NSPI conducts its own statistical analysis of load by block and may be able to predict PHP load with some degree of precision. For the purpose of this analysis, on-peak hours are defined as 16 hours between 7 a.m. and 10 p.m. on weekdays (Monday through Friday); off-peak hours are defined as the remaining 8 hours of weekdays and all hours during weekends.

3.3. Major Variances in CQ Protocol

Initially, NSPI applied a CQ-pair methodology per the original design of the tariff. As noted above, NSPI faced significant challenges with the practicality of certain elements of the LRT and with its actual implementation.

Changes in the Use of the Day-Ahead CQ Pairs

Despite the original intent to make Day-Ahead CQ pairs financially binding, there was a large discrepancy between day-ahead and actual *ex-post* prices associated with CQ pairs, which Synapse estimated using hourly data for a sample period of March 7, 2013 through April 2, 2013.[2] A summary of Synapse's analysis presented in Table 2 demonstrates that depending on the MW block of CQ pairs, the standard deviation between the day-ahead price and actual *ex-post* price ranges from 35% to 82% of the price and therefore may not provide a reliable market signal to PHP to economically schedule energy use for its operations.

Table 2. (Confidential) Forecast Error of Day-Ahead Prices vs. *Ex-Post* Prices by the Block of CQ Pairs

CQ Pair	35MW	65MW	105MW	135MW	185MW
Standard Deviation between Actual and Forecast	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Average Block Price	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
StDev by Block	35.05%	37.37%	42.84%	51.89%	82.17%

NSPI confirmed in DR 1 that NSPI and PHP stopped considering day-ahead CQ pairs financially binding in February 2013. NSPI and PHP continue to use day-ahead CQ pairs for planning purposes.

Difficulties with Hour-Ahead CQ Pairs

Given the limitations to supporting software, hardware, and communication infrastructure, NSPI was not able to provide hour-ahead CQ pairs every hour as intended by the tariff. PHP expressed interest in receiving CQ pairs every two to three hours, as those would better fit its planning processes (conversation with NSPI personnel on February 21, 2014). However, as NSPI acknowledged in its report, "NS Power found that there were often significant differences between the hour-ahead forecast prices and the cost to generate the energy to meet the PHP demand forecast" (p. 12). As NSPI explains, these differences are driven by a number of uncertainties affecting the operation of the power system and associated costs. In response to DR 1, NSPI confirmed that it was not able to bill PHP on the basis of hour-ahead CQ pairs.

Implications for Billings and Use of *Ex-Post* CQ Pairs

These difficulties resulted in NSPI billing PHP using *ex-post* CQ pairs. NSPI has billed PHP for the *actual energy* NSPI supplied PHP in each hour and for the "actual cost of energy after it has been delivered"

[2] Day-ahead CQ pairs for other periods were not available in a convenient electronic format and were not analyzed due to the lack of time available to perform this study.

(NSPI report, p. 12). However, the calculation of this “actual costs” was not based on the hour-ahead CQ pairs. Instead, NSPI billed PHP based on NSPI’s calculation of *ex-post* CQ pairs (responses DR 4, 5, 19).

As described in response to DR 4, the method NSPI used to calculate *ex-post* CQ pairs was based on updating the Generation Operations optimization software (GenOps) with actual data for maximum and minimum generation capabilities of its generators, system load, imported and exported energy, biomass generation, wind generation, hydro generation, and energy supplied to PHP. Once this information was uploaded, GenOps produced CQ pairs for all hours of the billing period. In each hour, the CQ pairs were used to calculate the hourly cost. NSPI refers to these costs as “actual costs of energy after it has been delivered.”

This method of billing was applied during the entire six-month LRM period under this review. (Follow-up to responses DR 4 and DR 5. Q: Did NS Power bill PHP based on the “actual cost of energy after it has been delivered” during the entire six months of the LRM? A: Yes. NS Power has billed PHP based on the actual cost of energy after delivery since the start of the LRM. This was required as NS Power lacked the software resources to calculate CQ pairs based on the initial requirements of the tariff.)

An important conclusion could be drawn from this discussion:

- CQ pairs produced hour-ahead were not sufficiently accurate to reflect incremental costs of serving PHP and for billing purposes *ex-post* CQ pairs were used instead.

This conclusion raises a valid concern on the usefulness of the CQ-pair method, as it provides a less reliable pricing signal and leads to questionable billing. Indeed, by definition, PHP cannot rely on *ex-post* CQ pairs for its planning. Furthermore, it still remains to be verified whether the use of ex-post CQ pairs provides for a sufficiently accurate recovery of incremental costs of serving PHP. This issue is addressed in the next section of this report.

Treatment of Line Losses

According to NSPI’s report, “for the first two quarters of the Tariff’s operation, transmission line losses were not included in the bill provided to PHP. NS Power has since developed a matrix which can be applied and which takes into account the source of the generation serving PHP” (NSPI Report, p. 29). Although NSPI and PHP recognize the importance of calculating the impact of PHP’s load on transmission losses, this effort is still in progress. NSPI intends to use the PSS/E software it licenses from Siemens to perform the after-the-fact calculation of this impact and adjust the billings accordingly. As of March 31, 2013, NSPI estimates it will issue a refund to PHP in the amount of approximately $588,000 (NSPI Report, p.31).

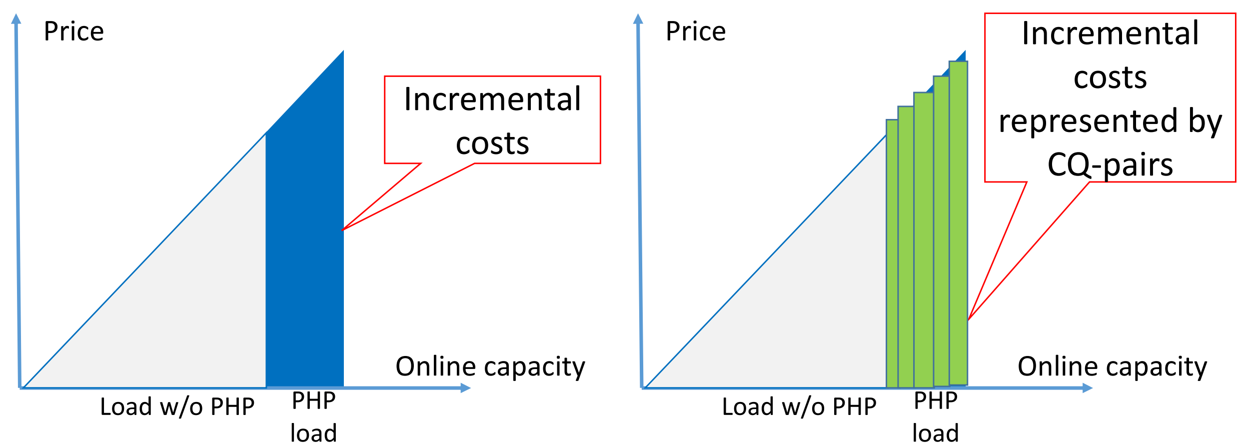
Given the relative magnitude of the PHP load in the power system administered by NSPI, the impact on transmission losses must be significant. Transmission line losses do not scale linearly: according to the laws of physics, transmission line losses increase in proportion to the square of the flow of power in the line. Accurate and consistent accounting of the impact of PHP load on line losses is essential and as soon as NSPI makes its methodology available to the Board, it should be thoroughly examined to make sure it is consistent with the concept of incremental costs and with the methodology used to compute incremental energy costs.

3.4. NSPI Calculation of Incremental Energy Costs

Preamble

The CQ-pairs method is effectively based on simplistic representation of the economics of electricity supply. Consider two stylized representations of the power supply curve as presented in Figure 2

Figure 2. Representation of Incremental Costs with CQ Pairs

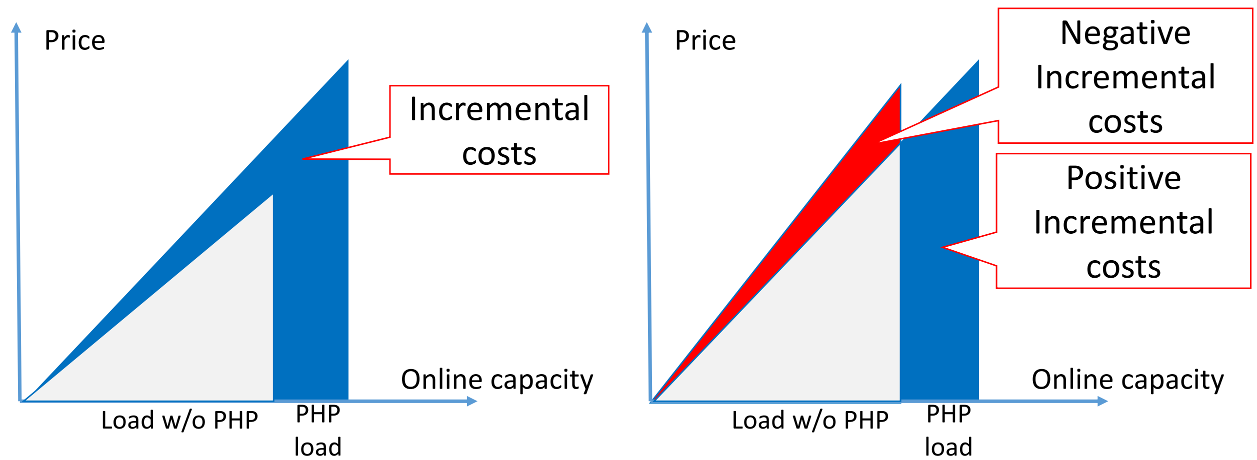


In this figure, the picture on the left represents the system supply curve as a straight line moving upward from the origin, the load level without PHP, and the load level with PHP. The shaded area in this picture represents incremental costs of serving PHP load. The picture on the right graphically depicts the approximation of incremental costs with CQ pairs, where CQ pairs are shown as five vertical bars covering the shaded area representing incremental cost.

This representation creates the impression that the CQ-pairs method can provide an accurate approximation of incremental costs and that the only inaccuracy of that method can be associated with not having enough CQ pairs to achieve a good approximation precision. The real problem with this method is that it fails to reflect fully the operational realities of the power system, rendering this method inadequate.

The CQ-pairs method can only work if the supply curve with PHP is the continuation of the same supply curve without PHP, as is the case in Figure 2. To demonstrate this, consider now an example in which supply curve used to serve load without PHP is different from the supply curve used to service load with PHP, as shown in Figure 3.

Figure 3. Incremental Costs with Changing Supply Curve



In this figure, the picture on the left presents the case in which the supply curve used to serve load without PHP lies below the supply curve used to serve the load with PHP. As shown in this picture, incremental costs are represented by two shaded segments—one to the right of the white triangle and another one above it. Total incremental costs in this case are the sum of these two areas. However, the CQ-pairs method captures only the area to the right of the white triangle and fails to account for incremental costs represented by the shaded area above it. As a result, the CQ-pairs method will understate incremental costs.

In contrast, the picture on the right considers the case in which the supply curve used to serve load without PHP lies above the supply curve used to serve the load with PHP. As shown in this picture, incremental costs also have two shaded segments—one to the right of the white triangle and another one above it. However, in this case total incremental costs are the *difference* between the area to the right and the area above the white triangle. Again, the CQ-pairs method captures only the area to the right of the white triangle and fails to account for *negative* incremental costs represented by the shaded area above it. In this case, the CQ-pairs method will overstate incremental costs. It is possible and, as we demonstrate in the next section, it actually happens that incremental costs can be negative. Serving PHP load can even reduce overall system costs. The CQ-pairs method is simply incapable of capturing this possibility.

In the operations of the power system, supply curve in a given hour is defined by the set of generating units committed to run in that hour. Due to operational constraints, such as minimum up- and down-times, minimum operating limits, and start-up costs, generating units are turned on and off as a result of the unit commitment decision. NSPI makes unit commitment decisions by using GenOps software it licenses from Ventyx. GenOps produces unit commitment decisions by solving advanced algorithms of the mixed integer linear programming problem. The solution to this problem is sensitive to the level of load that the power system is projected to serve. Considering that the PHP load represents 9% to 10% of its system load, it is unlikely that unit commitment with and without PHP load would yield the same set of commitment decisions. What is important here is that different unit commitment decisions result in different hourly supply curves and, as discussed, may lead to inaccuracy in the CQ-pairs method. The magnitude of this inaccuracy cannot be theoretically predicted but can be analyzed empirically using actual data. Synapse undertook such an empirical analysis, which is discussed in the next section of this report.

Empirical Assessment of the Accuracy of the CQ-Pairs Method

To assess the accuracy of the CQ-pairs method as used by NSPI, Synapse compared two calculations of incremental costs. The first calculation was based on the *ex-post* CQ pairs NSPI used to actually bill PHP (as-billed costs). The second calculation is based on the comparison of two GenOps unit commitment solutions produced by NSPI. The first GenOps solution was based on the total load actually served by NSPI, including PHP load. The second solution used exactly the same inputs as the first, except for the load which was reduced in each hour by the level served to PHP. The *difference* in generation costs between these two solutions represents the direct calculation of incremental costs. We will refer to this method as the “differential method” of calculating incremental costs.

This analysis is based on GenOps runs provided by NSPI in DR 24 and in DR 22 on February 12, 2014 for four representative weeks (November 12-18, 2012, December 10-16, 2012, January 7-13, 2013 and February 11-17, 2013).

The results of these two sets of GenOps runs for the four weeks indicate that on many days the commitment of several major units (e.g. Lingan units, Trenton units, Tufts Cove units) to supply only the system load would be quite different from the commitment of those units to supply system load plus PHP load, as shown in Figure 4. This figure compares on a daily basis maximum output of generating units between the two cases and highlights instances in which the unit does not generate under one case but generates in another case on the same day. For steam turbine units such as Tufts Cove, Trenton, or Lingan, zero output during the day implies that units were not committed to run in that day. However, this comparison can miss other instances of unit commitment differences. For example, units that were committed to run on the same day but vary in the start or shut down times during that day would not be identified in that comparison. In other words, there might be other differences in unit commitment than those identified in Figure 4.

Figure 4. (Confidential) Differences in Unit Commitment

UNIT	11/12/2012		11/13/2012		11/14/2012		11/15/2012		11/16/2012		11/17/2012		11/18/2012	
	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP
Lingan 2	[redacted]						0	0	0	0	0	0	123	123
Tufts Cove 1	0	0	0	0	[redacted]				0	0	60	60	62	68

UNIT	12/10/2012		12/11/2012		12/12/2012		12/13/2012		12/14/2012		12/15/2012		12/16/2012	
	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP
Lingan 2	[redacted]						0	0	135	122	122	147	147	148
Burnside 1	0	0	0	0	[redacted]				15	28	0	0	0	0
Burnside 2	0	0	0	0	[redacted]						0	0	0	0

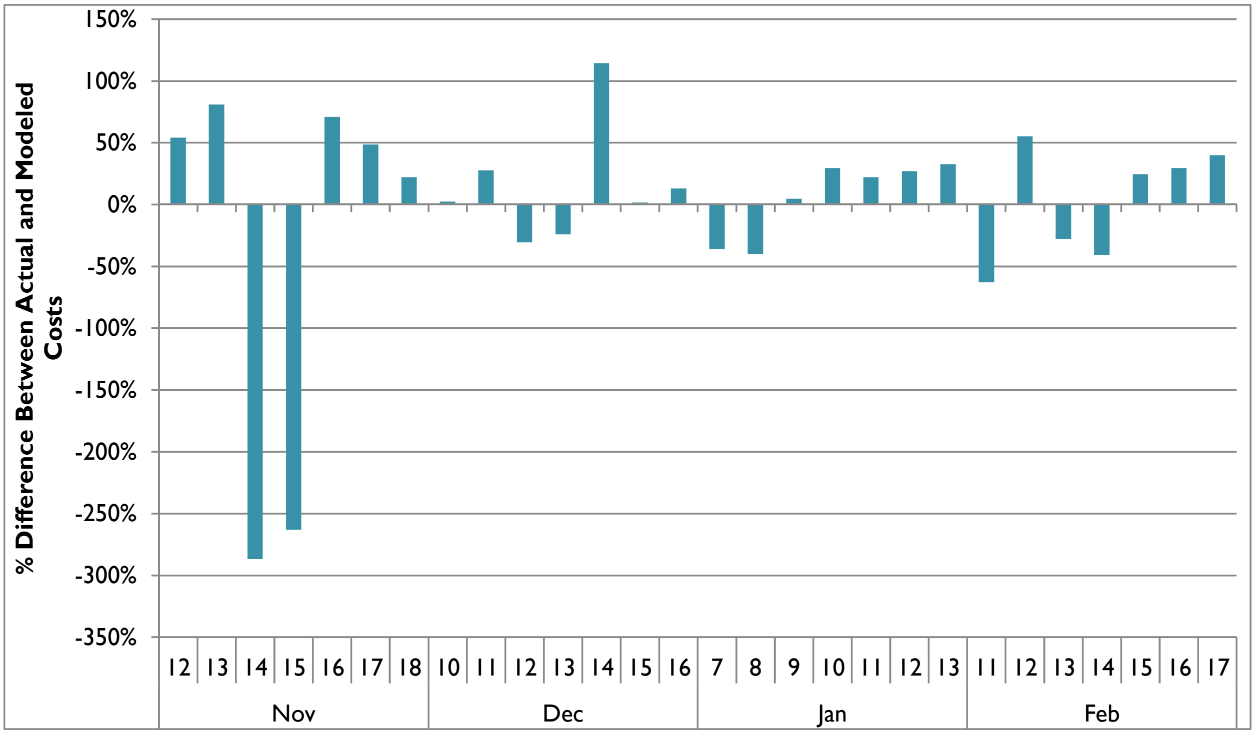
UNIT	1/7/2013		1/8/2013		1/9/2013		1/10/2013		1/11/2013		1/12/2013		1/13/2013	
	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP
Trenton 5	0	0	0	0	[redacted]									

UNIT	2/11/2013		2/12/2013		2/13/2013		2/14/2013		2/15/2013		2/16/2013		2/17/2013	
	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP	No PHP	PHP
Trenton 5	[redacted]													
Tusket CT	0	0	0	0	0	0	0	0	0	0	[redacted]		0	0

Source- Synapse analyses of NSPI responses to DR-22 and DR-24

Given the difference in unit commitments in these four weeks, it appears the as-billed costs based on the CQ-pairs method provide a poor approximation of true incremental costs assessed with the differential method, as shown in Figure 5. This figure depicts daily differences between as-billed costs and the differential method costs expressed as a percentage of as-billed costs. Positive numbers reflect under-recovery of incremental costs, and negative numbers reflect over-recovery. The differences at the daily level are very large. Three days have differences in excess of 100% in each direction, and on most days the as-billed costs deviate from differential method costs by more than 20%. Only on 3 days out of 28 is the difference within 5%. As this figure also demonstrates, as-billed costs under-recover incremental costs in 19 out of 28 days and over-recover them only in 9 days. It is also worth noting that on two days—November 14 and November 15—the differential method yields *negative* incremental costs. This is consistent with the discussion of Figure 3 above on the possibility of incremental cost being negative. This analysis contradicts Mr. Sidebottom's earlier quoted assertion that the CQ-pairs method provides a fairly accurate estimate of incremental costs.

Figure 5. Difference in Estimates of Daily Incremental Energy Costs as % of Differential Method Costs



Source: NSPI First PHP Report, Figure 3, and Synapse analyses of NSPI responses to DR 22 and DR 24

Synapse's empirical analysis further indicates that the "actual costs" NSPI billed PHP in each of those four weeks differ from the after-the-fact estimates of incremental costs under the differential method as follows:

Figure 6. (Confidential) Estimates of Weekly Incremental Energy Costs for Four Sample Weeks

Week	As-billed costs	Differential Method Costs	Under/(Over) Recovery	Under/(Over) Recovery as % Differential Method Costs	Under/(Over) Recovery as % As-billed Costs
	a	b	c = b - a	d = c / b	e = c / a
Nov 12-18, 2012	[redacted]			28.98%	40.81%
Dec 10-16, 2012				5.44%	5.75%
Jan 7-13, 2013				0.57%	0.57%
Feb 11-17, 2013				-27.95%	-21.84%
Total of 4 weeks				**-1.90%**	**-1.87%**

Source- NSPI First PHP Report, Figure 3, and Synapse analyses of NSPI responses to DR 22 and DR 24

If those results were representative of the 26-week period, the 1.87% over-recovery would represent an over-recovery of approximately [redacted]. The 1.87% error is rather coincidental and may not be taken as a comfort that on average the discrepancy does not appear to be very big. For example, over any three weeks out of the four weeks analyzed the discrepancy ranges from approximately 7% in over-recovery to 9% of under-recovery of incremental costs. However, given the magnitude of the differences between two methods, data for four weeks do not provide a representative sample to assess the magnitude of the impact over the 26-week period with a credible degree of precision.

Choice of the Method to Calculate Incremental Costs

As noted above, during the 26-week review period, NSPI billed PHP using *ex-post* CQ pairs to calculate what is called "actual costs of energy after it has been delivered." As the empirical analysis indicates, this method does not accurately represent the actual incremental cost of serving PHP load.

LRT Operating after March 31, 2013

In the follow-up question to NSPI's response to DR 4b, Synapse asked NSPI whether–in determining what method to use to calculate this cost–NSPI considered a method in which it would calculate "actual costs of energy after it has been delivered" using the "differential method." NSPI responded that "this method was not considered as the initial intention of the tariff was to charge PHP based on the Hour-ahead forecast price. Once NS Power realized creating hourly CQ's forecasts were not practical, NS Power implemented a method that was understood by both parties, and consistent with the Forecasted CQ's."

On page 33 of the report, NSPI discusses the reconciliation mechanism that may be required if the bill based on the forecast does not match actual costs. The report further states that since the billings are based on ex-post CQ pairs, no forecast error is introduced and therefore no reconciliation is necessary. Synapse disagrees with NSPI, because ex-post CQ pairs fail to accurately recover incremental costs of serving PHP load and therefore reconciliation may be required.

Synapse also notes that the concept of the differential method is not foreign to NSPI. For example, in its report on pages 26–27, NSPI provides a detailed discussion of effectively using the differential method to attribute incremental generation costs and incremental environmental emissions to serving PHP load.

Finally, during the February 21 telephone discussion of Synapse's follow-up questions and preliminary findings, NSPI advised that, effective October 2013, the company switched from using *ex-post* CQ pairs to the differential method for calculating "actual costs of energy after it has been delivered." On February 24, NSPI provided to Synapse a description of the implementation of the differential method. This description is included as Attachment B to this report. Synapse did not have sufficient time to thoroughly review this implementation to make a definitive conclusion regarding its reasonableness. However, with some reservations due to the lack of analysis of implementation details, Synapse supports the use of the differential method as the most accurate after-the-fact estimate of the incremental costs NSPI incurred to supply PHP.

4. CONCLUSIONS AND RECOMMENDATIONS

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

Conclusions

- NSPI underestimated the complexity of the LRT, and in particular of the software and hardware it would require to implement that tariff as designed.

- NSPI's method based on CQ pairs for calculating incremental energy costs to bill PHP during the 26 weeks does not produce a sufficiently accurate estimate of those costs. Analysis of four sample weeks indicates a weekly range of under-/over-recovery of -41% to +22%, with an average of 1.87% over-recovery. A simple extrapolation of this average to the 26-week period suggests the over-recovery amount could be approximately [redacted]. However, given the magnitude of the differences between two methods, data for four weeks do not provide a representative sample to assess the magnitude of the impact over the 26-week period with a credible degree of precision. For example, over any three weeks out of the four weeks analyzed, the discrepancy ranges from approximately 7% in over-recovery to 9% of under-recovery of incremental costs.

- Variations between CQ pairs and actual costs limit the value of pricing signals. This is a consideration for PHP.

- As of October 2013, NSPI moved to the differential method for calculating incremental energy costs to bill PHP.

- The differential method is the most accurate method for calculating incremental costs of serving PHP load.

Recommendations

- If the Board wants a complete calculation of the difference in estimates of incremental energy costs between NSPI's as-billed costs over the 26 weeks and those under the differential method, it should require NSPI to calculate its incremental costs under the differential method for each of the 26 weeks, and compare the results to the actual amounts it billed.

- Similar analysis is needed for the period between the end of March 2013 and NSPI's change to the differential method (October 2013).

- Synapse recommends the discontinuation of CQ pairs for billing purposes.

- Synapse also recommends further analysis of NSPI's differential calculations as of October 2013 to confirm the accuracy of that incremental cost analysis and billing. In this analysis, special emphasis should be placed on the treatment of the costs of external power purchases on behalf of PHP to make sure that NSPI's other customers are properly isolated from these costs.

- Synapse recommends a thorough review of the methodology to be proposed by NSPI to account for the impact on system line losses of serving PHP load.

PWCC Incremental Cost Calculations

NSPI Marketing is currently using Ventyx Generation Operations Software for both Day Ahead and Real-time Scheduling and Dispatch.

Generation Operations optimizes a portfolio's operation by modeling detailed unit operating constraints and market conditions to provide a generation schedule for energy and ancillary services, fuel nominations, support the evaluation and pricing of potential short-term transactions, and facilitate the analysis and simulation of deterministic scenarios.

Generation Operations utilizes the latest advances in mathematical programming techniques (Mixed Integer Linear Programming) combined with Ventyx's domain expertise to deliver the market leading application for Operations Management.

This software provides dispatch scenario solutions by taking into consideration:

- the maximum and minimum capability of all available units
- their ramp rates
- their AGC (that is, load following) capability
- short term maintenance de-rates
- transmission limitations and corridor constraints
- load and generating locations
- fuel costs and supply availability
- reserve requirements

These solutions provide the basis for the Day Ahead Capacity report submitted to the System Operator, and then the Hourly Dispatch Schedules produced by the Real-time Desk.

Currently, Generation Operations also indicates the Incremental Marginal Cost of the System, or the cost of adding one additional MW of load. The software also possesses the optionality of activating a Cost-Quantity module which, while solving for optimum hourly dispatch based on all input variables, will output Price-Cost pairings based on the Operational Limits provided by PWCC. These pairings take into consideration the additional cost to the system as a whole of adding additional locational load, e.g. 120MW's delivered to PWCC.

An Example of Summer 2012 Price-Cost Pairings:

Assume:

- In-province wind generation is a consistent volume throughout the 24 hours
- NS-NB interface at zero
- Consistent hourly output in small hydro with the exception of tidal
- Gas pricing is approximately 20% above coal pricing
- Lingan 2 and Trenton 5 are not online
- Burnside 1, 2, & 3 are available
- Lingan 1 and Lingan 3 are on a Summer Coal Blend
- Bowater is not online
- Operational capability of PWCC consists of 6 MW levels:
    - 45MW / 70MW / 95MW / 120MW /145MW /170MW

[redacted]

PHP Billing Process – Differential System Cost

The PHP LRT is a relatively new rate for NSP. At the end of August 2013, the GenOps software was updated to allow for the calculation of differential system costs with and without PHP's load.

The calculation of PHP's costs using CQ pairs is a more complex process than the differential system cost process. For example, the calculation involves the build-up of individual costs for each block for each hour. A simpler model generally produces a more consistent result. NS Power implemented the new methodology in October.

The following outlines the current method NS Power employs to calculate the actual cost of energy after it has been delivered to PHP. This method incorporates the following input data/information into GenOps to determine the differential system cost between the system as it was dispatched including PHP's load and a scenario that does not include PHP's for the seven day billing period.

- 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

Step 1: Calculate the system cost including PHP's load

The actual hourly output (in MW) for each generating unit is used in GenOps as the maximum generating capacity for each unit. In addition to this, reserve requirements are shut off in the GenOps models. Using all of the inputs previously listed, the actual hourly output for each unit as each unit's maximum capability and shutting off reserve requirements allows GenOps to simulate a system that is identical to how the system was actually dispatched. This provides the system cost for a seven day period that includes PHP's load.

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

ATTACHMENT B

In order to determine the system cost without PHP's load, a second model run is performed in GenOps without PHP's load. The model run allows GenOps to dispatch the system economically and determine the system cost without PHP's load.

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.