DECISION

IN THE MATTER OF a review of New Brunswick Power Distribution and Customer Service Corporation's Load Forecast Methodology arising from A continuation of an Application by New Brunswick Power Distribution and Customer Service Corporation for approval of a change to its Charges, Rates and Tolls

January 29, 2007

NEW BRUNSWICK

BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

1.0 INTRODUCTION

The New Brunswick Power Distribution and Customer Service Corporation ("Disco") filed an application with the New Brunswick Board of Commissioners of Public Utilities ("the Board"), dated March 21, 2005, for approval of a change in its charges, rates and tolls. Section 101 of the Electricity Act ("the Act") requires that Disco apply to the Board for approval of changes in its charges, rates and tolls where such changes exceed the amount authorized under Section 99 of the Act.

Disco submitted its Load Forecast 2005 – 2015 as evidence (Exhibit A-6) in its rate application. At a Motions Day held on August 25, 2005, the Board ruled that it would divide the review of the load forecast into two components. Arguments on the load forecast for 2006-2007 would be heard during the cost allocation and rate design ("CARD") section of the hearing. A separate hearing to review Disco's methodology and long term load forecast would be held after the conclusion of the rate setting portion of the hearing.

On June 6, 2006, Disco advised the Board that it would rely on its previously filed Load Forecast 2005 – 2015 evidence and related interrogatory responses as its evidence in the load forecast methodology review. Board staff retained Dr. Jerry Jackson to review Disco's evidence and forecast methodology. On July 5, 2006 the Board provided copies of a report prepared by Dr. Jackson to Disco and the intervenors. The report commented on Disco's load forecast methodology and made suggestions for improvements.

A pre-hearing conference was held on July 11, 2006. At the hearing, Mr. William Gould representing the Attorney General of New Brunswick

argued that the Board did not have the jurisdiction to conduct the load forecast methodology review. He cited Bill 81, the Energy and Utilities Board Act, Section 89(5) as the basis for his argument. After considering Mr. Gould's argument, the Board ruled that it did have the jurisdiction to proceed.

Intervenor status was granted to the parties at the pre-hearing conference. Also, the Board recommended that a technical conference be held to give parties an opportunity to discuss suggestions for modifications to Disco's load forecast methodology and identify the data that would be required. The technical conference was held on August 30, 2006.

Interrogatories to Disco were filed on October 25 with responses by Disco by November 1, 2006. Both the Public Intervenor and Dr. Jackson filed evidence on November 8, 2006. Interrogatories on that evidence were filed by November 16, with responses by November 23, 2006.

The hearing was held on November 27 and 28, 2006. Final written arguments were filed on December 15 and Disco filed its rebuttal on December 20, 2006.

1.1 BACKGROUND

The matter at issue is the suitability of Disco's methodology for predicting in-province loads in future years. The Board believes that it is important for all parties to recognize that load forecasts have many uses within a utility and that improvements in forecasting methodology can benefit capital planning, rate design and revenue forecasting.

Load forecast information may be used in the following areas:

- To assist in determining the quantity and timing of additional energy supply,
- To assist in determining capital spending requirements for system growth and system adequacy,
- In cost allocation and rate design,
- In revenue forecasting and rate applications and
- To assist in determining fuel supply requirements.

Load forecasts that are overestimated may impact decisions on capital investment, on procuring energy supply or on fuel purchasing for load growth that fails to materialize or that develops at a later date. Conversely, underestimating may delay capital investments and affect a utilities' ability to serve its customers.

In simple terms, the 'price' or 'rate' set for electricity in a given year is the forecast revenue requirement divided by the load forecast. If load forecasts are higher than the actual demand and revenue forecasts are not increased by a similar amount, a utility would under-recover its revenue requirement. Conversely, where actual demand is greater than forecast, the revenue requirement is over-recovered.

Setting a price for electricity higher or lower than its real cost has a broad impact. The energy market is a competitive market where electricity competes against other energy choices including conservation alternatives. Pricing the cost of electricity at other than its actual cost may unduly influence customers' decisions on energy supply or efficiency alternatives.

2.0 BASIS OF EVALUATION

The Board identified three basic approaches to evaluate the suitability of the load forecast methodology:

1. Comparison of seasonal and year-to-year trends in electricity use that existed when the method was developed to those trends in recent years and those anticipated for the forecast period,
2. Evaluation of past forecasts in relation to actual energy use and
3. Examination of the methods and assumptions used to implement the methodology in the current forecast.

2.1 COMPARISON OF TRENDS IN ELECTRICITY USE

Disco's original load forecast methodology was developed from data of the 1970's and 1980's. This methodology, with some modifications, is being used to forecast loads from 2006 to 2015. Disco has re-estimated certain parameters of the model using data from the 1980's to the early part of this decade. This would be reasonable if the significant predictors of load in the next decade were the same as those identified from the 1970's and 1980's data.

The response to (PUB) LF IR-20 provides historical monthly energy data for New Brunswick in tabular (pp.2-11) and graphical formats (p.12). The period from the early 1970's until the late 1980's is characterized by a large and relatively steady rate of growth of approximately 450 GWh per year. The seasonal variation, as indicated by the difference between maximum and minimum month loads, also grew rapidly. It was 85 GWh

in 1970 and 653 GWh in 1989, an average increase of 28 GWh per year. The period from 1989 to 2005 (the last full year for which data is reported) shows a much lower rate of load growth; less than 28 GWh per year. In the same period the difference between maximum and minimum month loads changed by only 6.1 GWh per year.

The Board considers it significant that Disco developed its load forecast methodology in a period when electricity use was growing substantially faster than it has been in recent years. Such a large difference in overall behavior might reasonably be expected to change the relationship between electricity use and the econometric indictors in a fundamental way. In that case, simply updating the parameters of the old relationships and making other small modifications to the methodology should not be assumed to result in useful load forecasts for the 2005 to 2015 period.

The Board notes that at least one of Disco's changes to the basic load forecast methodology are consistent with these observations. The response to (PUB) IR-102 (p.17) indicates that the regression used in the 1994 load forecast related general service ("GS") load to real personal disposable income ("RPDI"), with both expressed on a *per capita* basis. The response to (PUB) IR-98 indicates that the current forecast for general service load is based on gross domestic provincial product, heating degree-days, the real price of electricity and the prior year's forecast energy consumption. It is thus clear that the methodology used in the GS load forecast has changed between 1994 and the current forecast.

The Board appreciates that Disco may have changed the method of calculating the GS load forecast for the best of reasons – to improve its accuracy. If it did so, the Board must assume that the previous

relationship between GS load and RPDI had deteriorated to the point that it was no longer a reliable predictor of future load. This would be fully consistent with and support a finding that the overall historical record of load growth in the province does not support the use of the 1994 methodology.

Table 11 of Exhibit A-6 presents actual load experience for fiscal years 1994/95 through 2003/04 and forecasts for fiscal years 2004/05 through 2014/15. The column labeled "System Net" provides the total in province electricity supply to meet the needs of all customer classes and system losses. In fiscal year 2003/04, the most recent year for which actual experience is provided, the total energy was 15,640 GWh. The outlook presented for 2004/05 was 15,710 GWh, an increase of 0.4%. From fiscal year 2004/05 to 2009/10, the forecasts predict:

- A 0.4% increase in 2005/06 over 2004/05,
- A 0.7% increase in 2006/07 over 2005/06,
- A 1.2% increase in 2007/08,
- Essentially no change between 2007/08 and 2008/09, and
- A 0.6% increase in 2009/10.

The arithmetic average of these increases is approximately 0.6%; the compound growth rate is the same.

Between fiscal year 2009/10 and 2014/15, the forecasts predict:

- A 1.7% increase in 2010/11 over 2009/10,
- A 1.8% increase in each of the following 3 fiscal years, and
- A 1.9% increase in 2014/15.

The arithmetic average of these increases is 1.8% and the compound growth rate is the same.

The Board considers it significant that Disco anticipates an annual growth rate in the last 5 years of its forecast period that is 3 times larger than the growth rate anticipated in the first 5 years of the forecast. It is also significant that the 1.8% projected growth rate for the last 5 years of the forecast exceeds the 1.6% growth rate Disco reports, at the bottom of Table 11, for the most recent 10 years of actual experience. The Board can find no clear and reasonable explanation as to why this should occur.

Giving consideration to the above, the Board concludes that the load forecasting methodology should be modified to make it reasonably consistent with recent historical experience and with reasonable expectations for future changes in electricity use.

2.2 EVALUATION OF PAST FORECASTS

Examination of the load forecast methodology in terms of its outcomes requires that the Board compare those outcomes to a reasonable expectation for outcomes of load forecasts generally. It is obvious that forecasts will normally be in error, either high or low, and the mere fact that a particular forecast has a particular error in any given year cannot form a reasonable basis of judgement on the methodology. On the other hand, a forecast methodology that produces an unusual number of forecasts that are either too high or too low raises a reasonable apprehension of bias in the forecast methodology. When consideration is given to both the side on which an error occurs and to the size of such

errors, the Board considers it reasonable to expect that the load forecast methodology be unbiased, in that the average error of many forecasts should be close to zero.

Disco's load forecast provides a summary of the outcomes of past forecasts (Exhibit A-6, Table 16, p.42). The rows of the table represent fiscal years from 1992/93 to 2003/04 and the first column of numbers, labelled "Actual Energy", is understood to be the actual electricity supplied during each fiscal year. Subsequent columns, labelled "1992" through "2002" ("1998" is not included in the table) provide the forecast load corresponding to the actual energy, where the column label indicates the year the particular forecast was prepared. Immediately below each forecast load is the percentage difference between the actual outcome and the forecast. It should be noted that this percentage error is expressed as a fraction of the load forecast and not the actual load.

Table 16 of Exhibit A-6 provides 62 separate forecast error estimates, 53 (85%) of which are negative and 9 (15%) of which are positive. The PI's position was that these outcomes suggest that the load forecast is biased in favour of overestimating the load. Disco argued that the variations between forecasts and outcomes that are reported in Table 16 were not an adequate basis for determination of the matter. It indicated that a better basis for such a determination would be found in weather-adjusted data that takes into account the impact of weather variations between the forecast assumptions and the actual fiscal year. Disco also indicated that the forecast of industrial loads (approximately 35% to 40% of total energy load) was likely biased high.

The Board accepts that adjusting for year-to-year weather differences would be helpful in determining the nature and extent of bias in the outcomes of the load forecasts. Given Disco's recognition of the

importance attached to weather effects, a detailed description of the methodology it used to make weather adjustments, along with a complete statement of the outcomes of such adjustments would have been helpful. Disco did file information, by way of an undertaking, that contained a partial description of the forecast error estimates after weather adjustment. Unfortunately, this information omitted the sign of the error, making it of limited value in the determination of forecast bias.

While the Board accepts that the actual weather conditions will vary from the forecast assumption of an average year, it also understands that such variations should average to zero over a succession of load forecasts. It follows that the long-run expectation for both the weather-adjusted and the un-adjusted forecasting error is that 50% will be high and 50% will be low.

Disco also filed a table containing the actual and forecast heating degree days in each fiscal year in (PUB) LF IR-12. This data indicates that the following fiscal years were colder than average: 1992/93, 1993/94, 1995/96, 2000/01, 2002/03. All other things being equal, colder than average weather increases electricity sales over those in an average year. If the forecast is unbiased, one should therefore expect that actual energy use exceeded forecasts for these years. Referring again to Table 16 of Exhibit A-6, the Board notes that 16 of the 21 forecasts prepared for these colder than average years still exceed the actual energy sales experience.

As noted above, 9 of 62 forecasts resulted in positive differences – forecasts lower than actual energy. Of these, only three occurred since the year 2000. This does not provide clear evidence that recent modifications to the load forecast methodology have eliminated a pre-existing bias.

Giving consideration to all of the above the Board concludes that the methodology used by Disco to produce the forecasts reported in Table 16 of exhibit A-6 is biased in the direction of overestimating the loads that will eventually arise.

2.3 METHODS AND ASSUMPTIONS

The third approach deals with the detailed assumptions and decisions that are made to implement the methodology. This review also raised concerns.

2.3.1 Residential Load Forecast

Direct residential sales represented 34.2% of Disco's in-province kilowatt-hour sales in 2004/05 and 40.7% of its dollar sales.

Dr. Jackson's evidence described Disco's residential load forecast model as an end-use model that determines the electricity use for each major appliance and end use. The forecast appliance usage is determined by multiplying the number of appliances by their average unit energy consumption ("UEC"). Dr. Jackson found Disco's model appealing. He stated that *" . . . computing appliance replacements over time based on average appliance lifetimes and incorporating increased appliance efficiency provide dynamic representations of UECs." (Exhibit PUB-1, p.4)*

However, Dr. Jackson identified the following deficient areas in the model and suggested changes to improve the accuracy of the forecast model. The areas identified are:

- Updating Process
- End-Use Model Parameter Estimation
- Estimation of Peak kW and Load Profiles
- Residential Mail Survey
- Historical Forecast Capability and Analysis
- Weather Adjusted kWh Data Series
- Behavioral Impacts (Price Elasticity)
- Forecast Error Evaluation/Model Transparency

Dr. Jackson took issue with Disco's method for updating the UEC parameters stating that the process could not identify structural changes and parameter errors. He noted that the annual growth rate for miscellaneous uses from 2006/07 to 2013/14 is 3.5 percent and was based on an assumption that had not been tested with historical data.

Dr. Jackson supported the use of a statistical procedure called "*conditional demand analysis*" (CDA) and the estimation of new residential UECs based upon data from New Brunswick customer surveys and load research, in place of current UECs that were developed primarily from estimates from other jurisdictions. Both the proposed CDA procedure and development of new UECs would require inputs from a new customer survey.

Disco's end use model is estimated using weather adjusted kWh while Dr. Jackson supports the use of actual kWh consumption. He stated that weather adjustment strips away components of seasonal load, such as space heating, and can potentially bias the model's parameters and forecasts. He also supported the inclusion of short-term price elasticity in Disco's end-use model.

Dr. Jackson commented that there is limited information available on Disco's residential end-use model structure, its development process and its forecasting sensitivities. He recommended that Disco provide detailed documentation on the model structure and development, presentation of sensitivity analysis and detailed error analysis.

Disco took issue with Dr. Jackson's recommendations, particularly the CDA statistical approach and development of new UECs. The company argued that the cost of incorporating the recommended improvements was very large and that the potential benefits to the end-use model were unknown.

Disco provided the monthly history of weather-adjusted revenue for the residential customer classes (Exhibit A-4, Tab 3, sub-tab Exhibit A-61, Respsonse to Undertaking #3, Nov 21/05). The period spanned 147 months, from January 1993 to March 2005, at the end of which the weather-adjusted revenue shortfall, relative to forecast, was $5.9 million. The rolling sum of the forecast errors varied, sometimes positive and sometimes negative, reaching an extreme value of $11.7 million in June 2003.

The Board appreciates that the revenue forecast is based on both the load forecast and the anticipated rate design for the forecast period. It none-the-less considers that a history of both positive and negative errors and a relatively small rolling sum error at all times is a good indication that a forecast is reasonably free from bias. ***While the Board has some concerns with the magnitude and duration of the rolling sum error for residential customers, the weather-adjusted residential revenue forecast appears to be reasonably free of bias in comparison with other classes. The revenue forecast being***

based on the load forecast, this suggests that the residential load forecast is similarly free of bias, relative to that in other classes. The Board found Dr. Jackson's evidence most helpful in illustrating potential improvements to Disco's methodology that may address the Board's concerns with the magnitude and duration of possible residential load forecast errors. While the Board does not consider it appropriate to prescribe any particular methodology or approach to forecasting at this time, it recommends that Disco give full and careful consideration to the matters raised by Dr. Jackson when it revises its load forecast methodology. The Board considers it reasonable that Disco be allowed to make such improvements as it finds appropriate and submit them for examination at a future rate hearing.

2.3.2 General Service Load Forecast

Direct general service sales represented 15.6% of Disco's in-province kilowatt-hour sales in 2004/05 and 19.4% of its dollar sales.

Dr. Jackson also made specific suggestions to improve this portion of the forecast, among them:

- Disaggregating the General Service ("GS") Class single model into separate GS I and GS II class models,
- Segmenting customers by the use of SIC code billing file data into business groupings such as office, retail, restaurant, warehouse, educational, university, grocery, wholesale, nursing home, hospital and all other,

- Applying appropriate econometric techniques to address simultaneity bias and other econometric issues that are associated with time series modeling and
- Analyze business-type load profiles from comparable service areas adjusted for weather, to evaluate the accuracy of coincident peak load contributions currently assumed for the GS I and GS II classes.

The response to (PUB) IR-98 indicated (p.2) that the GS portion of the load forecast is based upon future estimates for gross domestic product (GDP), heating degree-days and price and includes a so-called lag variable in the prior year's sales. It also indicated (p.4) that GDP was not a statistically significant predictor of future loads. ***The Board considers it inappropriate that Disco's forecast is based, in part, on statistically insignificant correlations between past electricity use and regression variables.***

The Board also notes that the load forecast report states (Exhibit A-6, p.15):

> "General service sales in New Brunswick reflect the level of commercial activity and are closely related to the provincial Gross Domestic Product."

The Board is concerned that Disco's characterization of the relationship between GS sales and GDP as "closely related" is not consistent with the fact that the relationship is statistically insignificant.

The Board is also concerned with Disco's use of the nominal GDP rather than real GDP as a regression variable. As noted previously, Disco used

real personal disposable income (RPDI) as the indicator of general service load in the 1994 forecast. It uses the real price in the current methodology, but uses the nominal GDP in the same regression analysis. The record contains no clear evidence that would help the Board appreciate why Disco is selective in its use of inflation-adjusted econometric data in the load forecast.

Disco also provided the monthly history of weather-adjusted revenue for general service customers. It spans the same period as the data for residential customers. The weather-adjusted revenue shortfall, relative to forecast, was approximately $2.2 million at the end of this period. Unlike the case for residential customers, the rolling sum of forecast errors did not change sign after March 1993; it remained negative, reaching an extreme value of $10.5 million in August 1997.
The Board considers it significant that the rolling sum of general service revenue forecast errors remained negative for most of the reporting period. It is also significant that it reached a value nearly as large as that for residential sales ($11.7 million) on the basis of a much smaller stream of revenue. ***The Board concludes that the general service revenue forecast is not reasonably free of bias. The revenue forecast being based on the load forecast, this raises a reasonable apprehension that the general service load forecast is biased.***

2.3.3 Industrial Load Forecast

Industrial sales represented 41.3% of Disco's in-province kilowatt-hour sales in 2004/05 and 30.4% of its dollar sales.

The record indicates that Disco's forecast of industrial loads relies, to some extent, on information provided by those customers' representatives. The extent of the influence of such solicited advice is not clear from the record, but Disco has indicated this practice is possibly responsible for their industrial load forecast being biased high.

The Board appreciates the fact that large industrial customers are significant individual loads and such customers might well have information of value to a load forecaster. Such information should certainly be weighed and considered in Disco's forecasts. In doing so, adequate attention must be given to the consistency of such past advice with the historical record of forecast outcomes and to the acknowledged tendency of such advice to favor high load forecasts.

The public intervenor provided the monthly history of revenue forecasts and outcomes for firm transmission customers during the load forecast portion of the CARD hearing. It spanned the same period as the data for residential and general service customers. The revenue shortfall, relative to forecast, was approximately $26.5 million at the end of this period. Unlike the case for other customers, the rolling sum of forecast errors started with a negative entry and remained negative throughout the entire time period. It reached an extreme value of approximately $35.5 million in March 2002.

The Board notes that the firm transmission customers referred to by the public intervenor did not include the 2 wholesale customers of Disco; it was limited to large industrial customers. The Board considers it significant that the rolling sum of revenue forecast errors for such industrial customers remained negative for all of the reporting period. It is also significant that it reached a value roughly three times that of residential sales on the basis of a smaller stream of revenue. ***The Board***

concludes that the large industrial revenue forecast is not reasonably free of bias. The revenue forecast being based on the load forecast, this raises a reasonable apprehension that the large industrial load forecast is biased.

2.3.4 Wholesale Load Forecast

Wholesale sales represented 8.4% of Disco's in-province kilowatt-hour sales in 2004/05 and 7.7% of its dollar sales.

Disco also provided the monthly history of weather-adjusted revenue for wholesale customers. It spans the same period as the data for residential and general service customers. The weather-adjusted revenue shortfall, relative to forecast, was approximately $3.9 million at the end of this period. The rolling sum of forecast errors did not change sign after April 1994; it remained negative, reaching an extreme value of $10 million in November 1999.

The Board considers it significant that the rolling sum of wholesale revenue forecast errors remained negative for most of the reporting period. It is also significant that it reached a value nearly as large as that for residential sales ($11.7 million) on the basis of a much smaller stream of revenue. ***The Board concludes that the wholesale revenue forecast is not reasonably free of bias. The revenue forecast being based on the load forecast, this raises a reasonable apprehension that the wholesale load forecast is biased.***

3. LOAD FORECAST DOCUMENTATION

The witness called by Board staff, Dr. Jackson, stated:

> ". . . It's very difficult to evaluate the forecast because all we have are the end results. Well actually it's impossible to evaluate the forecast based upon this document alone."
>
> (Transcript, p.358, lines 7-10)

At the time, Dr. Jackson was referring to the load forecast report (Exhibit A-6).

The Board concurs. Many important details do not appear in the 43-page report and no appendices are listed in the Table of Contents. While such details are more-or-less described in the responses to interrogatories that were filed by various parties to the hearing, the fact that Disco did not include a fully-documented load forecast in its original filing led directly to the need for this hearing**.** The Board is of the opinion that the matter of the load forecast could have been fully canvassed in the CARD and revenue requirement portions of the proceeding if the load forecast had been fully and properly documented in the first instance. Disco's failure to do so thus resulted in substantially higher costs for the hearings, costs which must ultimately be borne by either the ratepayer or the taxpayer.

Dr. Jackson also indicated that, in his experience, a load forecast document that fully discloses the methodology has other benefits. He said:

> " . . . [What] that would include is just a description of the equations, the parameters, how they work, where they have come from, and how to run the model. And in my experience . . . it actually reduces the conflict in terms of opposing views, because

what happens is that any improvements or suggestions in terms of structure people can generally agree upon."

(Transcript p.357, lines 17-24)

The Board agrees and is confident such a revised format would also benefit NB Power's senior management and Board of Directors by making them more aware of the various risk factors associated with their revenue projections and capital projects.

4. CONCLUSIONS

When a load forecast is made for the purposes of setting rates in a future test year, it is important that it be unbiased. In the simplest terms, the price of electricity is calculated by dividing the estimated cost of service for a future year by the estimated sales for the same year. Assuming that the cost of service is fairly calculated, an unbiased load forecast makes the result of this calculation a fair price. If the sales forecast is biased high, too low a price results; biased low, and too high a price is set. In either case the outcome is inequitable.

The Board has a responsibility to set rates that are fair and equitable. To do so, it must be assured that the load forecast for every class is unbiased. ***Based on its review of the evidence in this hearing, the Board finds that Disco's load forecasts are biased in their overall outcomes. The Board also finds sufficient evidence to conclude that this overall bias cannot be fully attributed to the bias acknowledged by Disco in respect of its industrial load forecast.***

Giving consideration to all of the above, the Board finds that the existing methodology for forecasting future loads is not adequate. The Board orders Disco to revise and, if necessary, extend its methodology to incorporate data and methods that will result in

unbiased load forecasts for each customer class and forecasting errors that are as low as reasonably achievable.

DATED AT THE CITY OF SAINT JOHN, NB this 29TH day of January, 2007

Original Signed By

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D.S. Nelson, Chairman

Original Signed By

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K.F. Sollows, Commissioner

Original Signed By

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H. Brian Tingley, Commissioner