

**A Review of Manitoba Hydro's Electric Load Forecasting  
a 5 January 2018 presentation to the Manitoba Public Utilities Board  
delivered by Dr. Garland Laliberte on behalf of the Bipole III Coalition  
in the matter of Manitoba Hydro's 2017-18 and 2018-19 General Rate Application**

**Preamble:**

For several years, Manitoba Hydro filed forecasts for electric load in support of its General Rate Applications that were well above forecasts published by other utilities in North America and that turned out to be well above actual experience as time advanced.<sup>1</sup> Its filed forecasts for Demand Side Management (DSM), on the other hand, have been inconsistent, frequently changing during hearings conducted in connection with these applications.

This presentation will show that the pattern of over-forecasting, in evidence for several years beginning about a decade ago, began to change shortly after Manitoba Hydro obtained approval for system expansion and licenses were granted for key elements of that expansion even though there was evidence for several prior years that electric load forecasts were not being met. It documents Manitoba Hydro's current and recent forecasts for electric load comparing them with historic records. Both Gross Firm Energy and Gross Total Peak are considered.

It also documents the impact of DSM as planned by Manitoba Hydro and as mandated by the Efficiency Manitoba Act. In all cases, at-generation values of electric load are used. Except for DSM mandated by Efficiency Manitoba, all data used are taken directly or calculated from Manitoba Hydro's submissions to the Manitoba Public Utilities Board (PUB).

The Efficiency Manitoba Act sets targets for energy but fails to set targets for peak load. DSM mandated by Efficiency Manitoba for energy is projected forward at 1.5% per year beginning with a 2017/18 value of Gross Firm Energy calculated from regressed weather-adjusted values reported by Manitoba Hydro for the most recent 10 historic years. No DSM savings for peak load are calculated for Efficiency Manitoba.

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<sup>1</sup> Presentation by the Bipole III Coalition to the Needs For and Alternatives To (NFAT) review of Manitoba Hydro's Preferred Expansion Plan by the Public Utilities Board submitted on February 3, 2014 and accessible at [http://www.pubmanitoba.ca/v1/nfat/pdf/bipole\\_3\\_nfat\\_presentation.pdf](http://www.pubmanitoba.ca/v1/nfat/pdf/bipole_3_nfat_presentation.pdf).

## **Recent Electric Load Forecasts Compared to 20-year Historic Data:**

Figures 1 and 2 present graphs of 20 years of historic weather-adjusted data for Gross Firm Energy<sup>2</sup> and Gross Total Peak<sup>3</sup>, respectively. Figures 1 and 2 also present graphs of (at-generation) values of Gross Firm Energy and Gross Total Peak forecast by Manitoba Hydro in 2015<sup>4</sup>, 2016<sup>5</sup> and 2017.<sup>6</sup> The forecast values for 2015 and 2016 are identified in these figures as MH15 Forecast (orange line) and MH16 Forecast (grey line), respectively. For clarity, the current forecast, referenced as either MH16 or MH16 Update in Manitoba Hydro's submissions for the current Application, is identified, in this presentation, as MH17 Forecast (yellow line). The data for these graphs are presented in Tables 1 and 2 at the end of this presentation.

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<sup>2</sup> Weather-adjusted values for Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7: Appendix 7.1 (2016 Electric Load Forecast), Table 29, page 47/82, and also Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382.

<sup>3</sup> Weather-adjusted values for Gross Total Peak from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7: Appendix 7.1 (2016 Electric Load Forecast), Table 32, page 49/82, and also Tab 11: Public Utilities Board (PUB) MFRs, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382.

<sup>4</sup> MH15 Forecast values of Gross Firm Energy and Gross Total Peak from Manitoba Hydro 2015/16 and 2016/17 General Rate Application Attachment 25 (2015 Electric Load Forecast and Power Smart Plans MFR 1), Table 2, page 6/81, and also from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7, Appendix 7.1 (2016 Electric Load Forecast), Table 2, page 6/82, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>5</sup> MH16 Forecast values for Gross Firm Energy and Gross Total Peak from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7, Appendix 7.1 (2016 Electric Load Forecast), Table 1, page 5/82, and Table 2, page 6/82, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>6</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

### Weather-Adjusted Historic and Forecast Gross Firm Energy before DSM, projected from 20-year historic data, GWh



Figure 1: Weather-adjusted historic and forecast Gross Firm Energy before DSM, projected from 20-year historic data.

### Weather-Adjusted Historic and Forecast Gross Total Peak before DSM, projected from 20-year historic data, MW

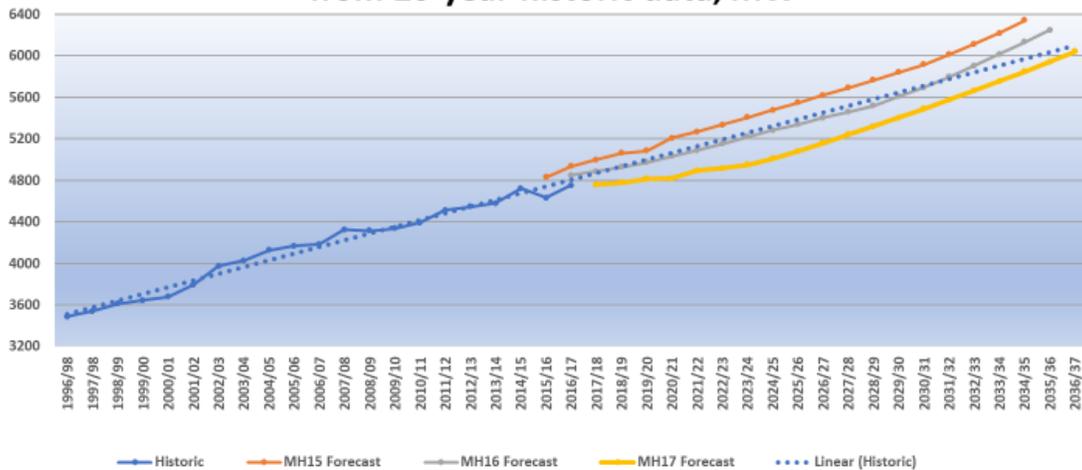


Figure 2: Weather-adjusted historic and forecast Gross Total Peak before DSM, projected from 20-year historic data.

The dotted line identified in both Figure 1 and Figure 2 as “Linear (Historic)” is the result of linear regression analyses of 20 years of data for Gross Firm Energy and Gross Total Peak, respectively.

The linear regression lines are extended forward to allow comparison of forecasts in 2015, 2016 and 2017 with past historic trends.

Some observations are possible from these graphs.

- Manitoba Hydro's recent forecasts for Gross Firm Energy and Gross Total Peak (2015 to 2017) are a reasonable reflection of the past, as long as 20 years of history is considered.
- Manitoba Hydro's forecasts of both Gross Firm Energy and Gross Total Peak have been decreasing in recent years.
- Generally, values forecast for both Gross Firm Energy and Gross Total Peak for several future years of its 2015 forecast are now not expected to be reached until two to seven years later.
- If the historic trends are examined more closely, growth for both Gross Firm Energy and Gross Total Peak does not appear to have been uniform over the 20-year historic period. For both energy and peak power but particularly for Gross Firm Energy, growth appears to have slowed down in the second half of this 20-year period compared to the first half.

Because recent trends are more likely to be a reasonable basis for forecasting than trends that are up to 20 years old, comparison of recent forecasts of electric load with more recent historic trends is strongly suggested.

### **Recent Electric Load Forecasts Compared to 10-year Historic Data:**

Figures 3 and 4 present 10 years of recent historic weather-adjusted data for Gross Firm Energy and Gross Total Peak. Respectively, they also present (at-generation) values of Gross Firm Energy and Gross Total Peak forecast by Manitoba Hydro for 2015, 2016 and 2017. These are the same forecasts as those already presented in Figures 1 and 2 and all data supporting them are from Manitoba Hydro data appearing in Tables 1 and 2 at the end of this presentation.

The dotted line in Figures 3 and 4 is different from the dotted line in Figures 1 and 2 although both lines are identified as "Linear Historic". In Figures 1 and 2, the dotted line derives from a linear regression analysis of 20 years of historic data for Gross Firm Energy and Gross Total Peak, respectively. The linear regression line is extended forward to allow for comparison of forecasts in 2015, 2016 and 2017 with past historic trends. In Figures 3 and 4, the dotted line derives from a linear regression analysis of only the 10 most recent historic years for Gross Firm Energy and Gross Total Peak. It is notable that 10 years matches closely with the timeline since the 2008 recession. That match may not be the entire reason for the deflection in the electric load curve 10 years ago. But the recession could be a factor.

### Weather-Adjusted Historic and Forecast Gross Firm Energy before DSM, projected from 10-year historic data, GWh

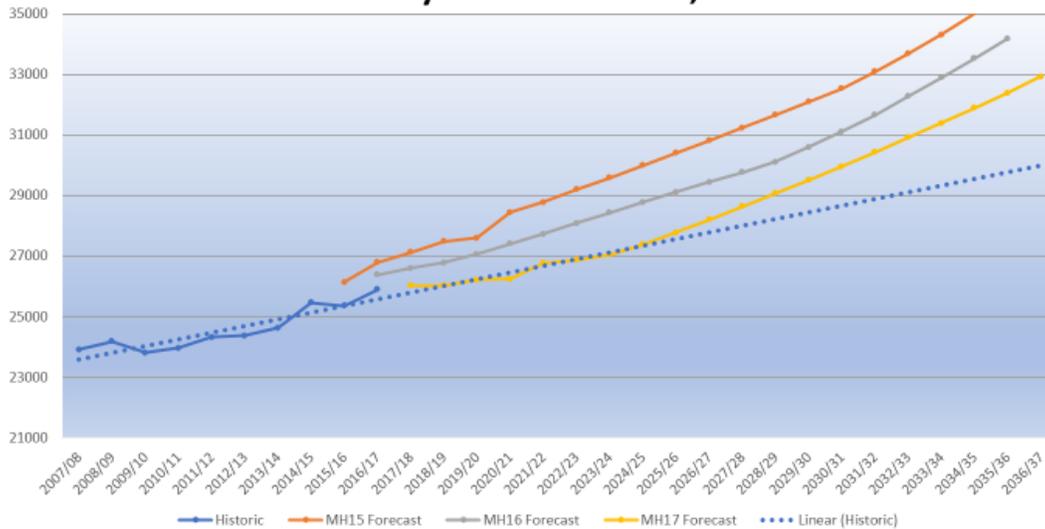


Figure 3: Weather-adjusted historic and forecast Gross Firm Energy before DSM, projected from 10-year historic data.

The slope of the dotted line in Figure 3 is 220.7 GWh per year (0.86% of the 25,583 GWh regressed value of Gross Firm Energy in 2016/17). The slope of the dotted line in Figure 4 is 52.1 MW per year (1.10% of the 4,746 MW regressed value of Gross Total Peak in 2016/17).

It is readily apparent from Figure 3 that, although recent forecasts of Gross Firm Energy before DSM have been adjusted downward in recent years, the current forecast (yellow line) reflects recent trends for only the next seven or eight years. Beyond then, Manitoba Hydro’s forecasts for energy begin to depart significantly from a projection of recent trends. For example, Manitoba Hydro is currently forecasting energy levels for 2030 that recent trends would suggest are not likely to be reached until five years later. Manitoba Hydro forecasts a 20-year average annual growth rate of 1.2%, a figure that is inclusive of a growth rate in the first 10 years declared by Manitoba Hydro to be 0.9%.<sup>7</sup> But that masks an average annual growth rate of almost 1.7% in the final 10 years,

Whether or not this departure has a significant effect on domestic revenue will be examined later.

<sup>7</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404, page 417, and Table 6, page 418/1382, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

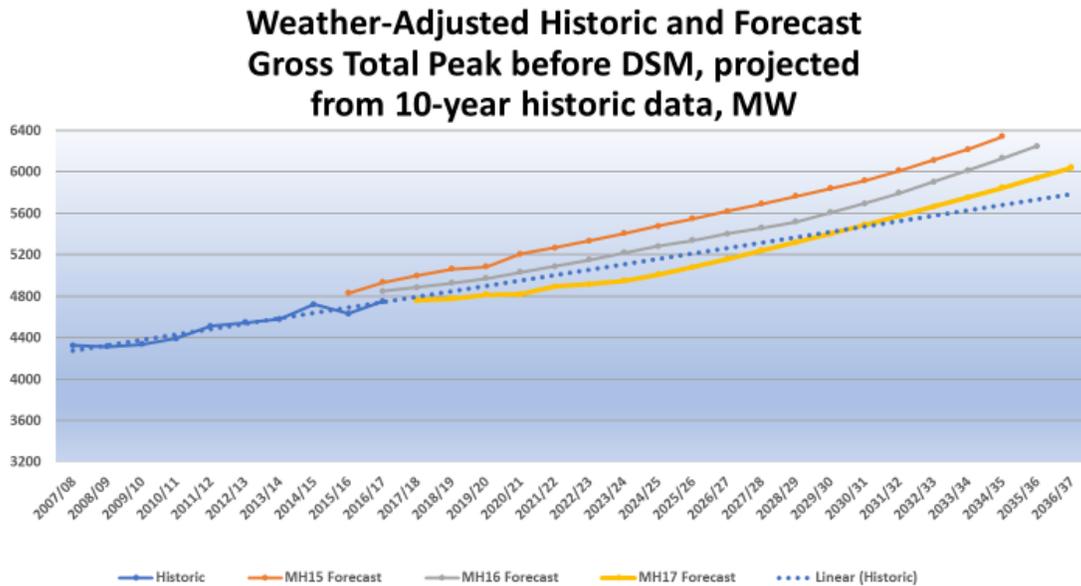


Figure 4: Weather-adjusted historic and forecast Gross Total Peak before DSM, projected from 10-year historic data.

Figure 4 reveals that Manitoba Hydro’s current forecast of peak power (yellow line) more closely reflects recent trends than its forecast of energy does. However, Manitoba Hydro’s peak power forecast does begin about 15 years out to depart from what past trends would indicate is likely.

**Current Electric Load Forecast Net of Demand Side Management:**

DSM has the potential to affect operating budgets. It can also delay when the next resource, possibly generation, is required, sometimes referenced as the year of need. Currently, responsibility for DSM is fluid in that The Efficiency Manitoba Act passed in the Legislature and given Royal Assent in 2017 has transferred responsibility for DSM to a new crown corporation called Efficiency Manitoba. At the present time, the appointment of a board for Efficiency Manitoba has not been announced and no programming appears to have been launched. In the circumstance, Manitoba Hydro has forecast DSM as part of its business plan, acknowledging, however, that responsibility for DSM will change as Efficiency Manitoba becomes operative.

It should be noted in this analysis that the Bipole III Coalition accepts Manitoba Hydro’s logic that only program-based DSM should be applied to load forecasts. Further, Manitoba Hydro’s rationale is accepted that, if DSM savings attributable to codes and standards are included in records of DSM, those savings should be first subtracted before applying the DSM values to load forecast. Finally, the Coalition also accepts Manitoba Hydro’s logic that historic DSM savings should be considered to have a continuing effect going forward but that future DSM savings should be considered as reducing load that has to be served.

## Weather-Adjusted Historic and Forecast Gross Firm Energy before and after DSM, GWh

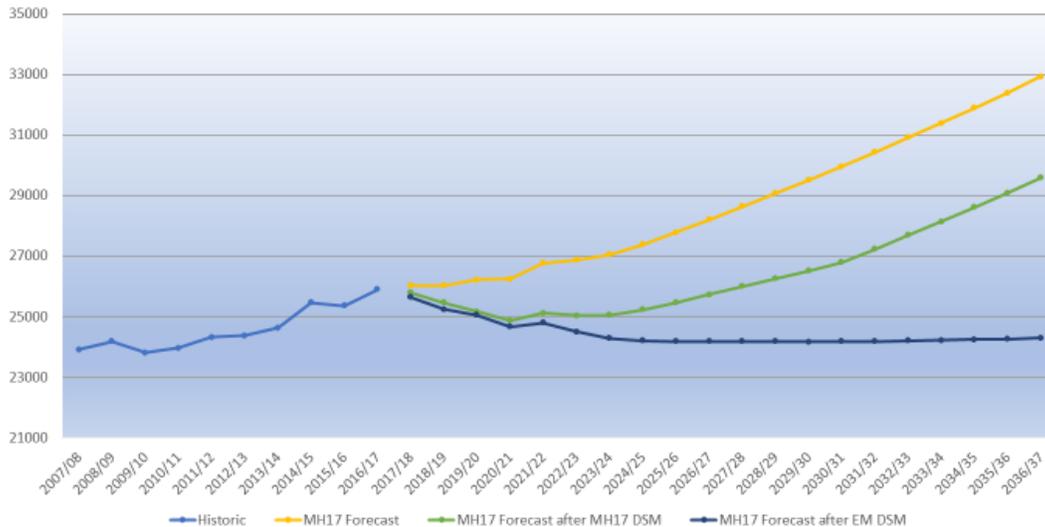


Figure 5: Weather-adjusted historic and forecast Gross Firm Energy before and after DSM.

Figure 5 presents the most recent historic 10 years of weather-adjusted data for Gross Firm Energy (blue line) and Manitoba Hydro’s current 20-year forecast for Gross Firm Energy (yellow line). It also presents Manitoba Hydro’s current 20-year forecast for Gross Firm Energy net of Manitoba Hydro’s DSM forecast (green line).

The Efficiency Manitoba Act mandates 15-year targets for energy totaling 22.5%, to be achieved in yearly increments of 1.5%. Figure 5 also presents a forecast of Gross Firm Energy net of Efficiency Manitoba’s 1.5% per year mandated target for DSM extended 20 years forward (navy line).

It needs to be emphasized here that the starting point in this analysis for determining Gross Firm Energy net of DSM is Manitoba Hydro’s current forecast for Gross Firm Energy. As such, this analysis of the energy load that has to be served is independent of the Bipole III Coalition’s perspective on Manitoba Hydro’s energy load forecast.

It is evident from Figure 5 that DSM has the potential to create a significant impact on Gross Firm Energy. Moreover, Figure 5 reveals how much more aggressive Efficiency Manitoba’s mandated targets for DSM are compared to Manitoba Hydro’s. Both plans depress Gross Firm Energy below its current value in the intermediate term (for the next 10 years). Efficiency Manitoba’s mandated targets force Gross Firm Energy well below its current value in the longer term (even beyond 20 years).

Whether or not the differential impact of Manitoba Hydro’s DSM plan and Efficiency Manitoba’s has a significant effect on domestic revenue will be examined later.

## Weather-Adjusted Historic and Forecast Gross Total Peak before and after DSM, MW

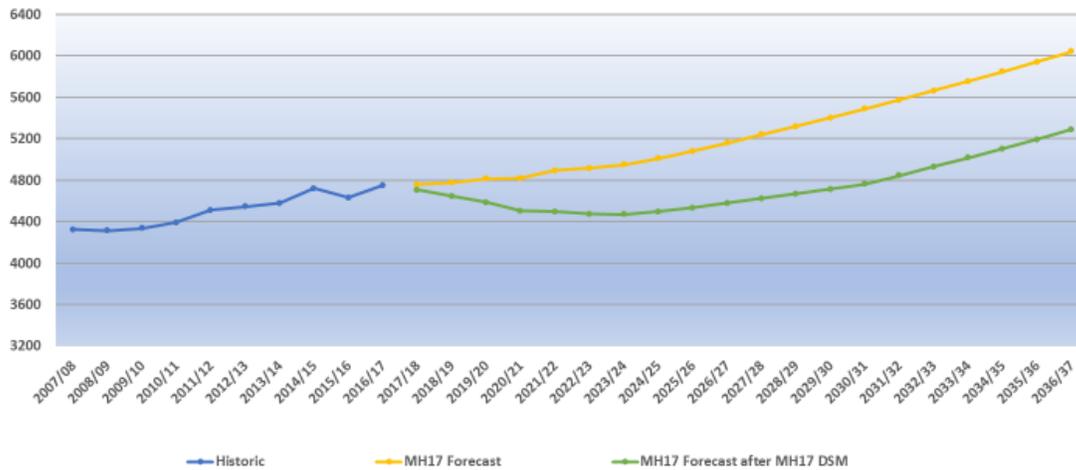


Figure 6: Weather-adjusted historic and forecast Gross Total Peak before and after DSM.

Figure 6 presents the most recent historic 10 years of weather-adjusted data for Gross Total Peak (blue line) and Manitoba Hydro’s current 20-year forecast for Gross Total Peak (yellow line). It also presents Manitoba Hydro’s current 20-year forecast for Gross Total Peak net of Manitoba Hydro’s DSM forecast (green line). The Efficiency Manitoba Act is silent on targets for peak power, so it is not possible to present Gross Total Peak net of DSM as envisioned by Efficiency Manitoba.

It is evident from Figure 6 that DSM has the potential to create a significant impact on Gross Total Peak. Even with Manitoba Hydro’s comparatively non-aggressive DSM forecast, Gross Total Peak can be expected to be depressed below its current value for the next 14 years. It is unclear what the impact of Efficiency Manitoba’s mandated targets for energy will be on Gross Total Peak but it is highly probable that, as with Gross Firm Energy, they will drive Gross Total Peak below its current value even further into the future than the next 14 years.

### Load Variability and Forecast Accuracy:

Turning our attention to the accuracy of load forecasts, Figure 7 extracts graphical and digital data used to support Manitoba Hydro’s analysis of the accuracy of its forecasts of Gross Firm Energy<sup>8</sup>.

<sup>8</sup> Forecast accuracy for Gross Firm Load from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Figure 22 and Table 35, page 457/1382.

Figure 22 - Energy Accuracy

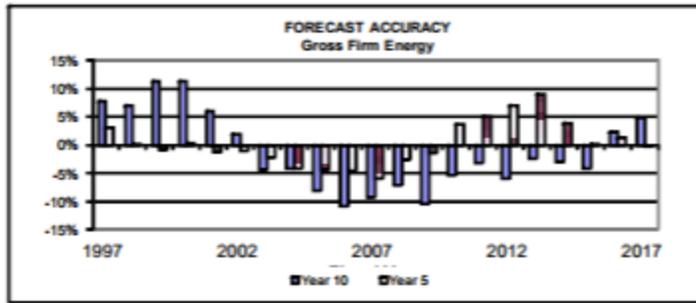


Table 35 - Energy Accuracy

Fiscal Year	Actual Gross Firm Energy	Forecast Prepared 5 Years Previous	W.A. Gross Firm Energy	5 Year Percent Accuracy	Forecast Prepared 10 Years Previous	W.A. Gross Firm Energy	10 Year Percent Accuracy
1996/97	19,321	19,395	18,810	3.1%	20,174	18,716	7.8%
1997/98	19,814	19,455	19,429	0.1%	20,661	19,320	6.9%
1998/99	19,273	19,675	19,818	-0.7%	21,919	19,708	11.2%
1999/00	18,971	19,767	19,783	0.3%	21,833	19,629	11.2%
2000/01	20,262	20,018	20,241	-1.1%	21,300	20,183	6.0%
2001/02	20,656	20,783	20,980	-0.9%	21,364	20,979	1.8%
2002/03	22,110	21,395	21,861	-2.1%	20,916	21,868	-4.4%
2003/04	22,869	21,134	22,862	-4.2%	21,191	22,187	-4.1%
2004/05	22,589	21,693	22,664	-4.3%	20,870	22,714	-8.1%
2005/06	22,757	22,216	23,277	-4.6%	20,812	23,346	-10.9%
2006/07	23,464	22,187	23,489	-5.9%	21,395	23,595	-8.3%
2007/08	24,122	23,353	23,962	-2.5%	22,328	24,034	-7.1%
2008/09	24,417	23,926	24,259	-1.4%	21,756	24,328	-10.5%
2009/10	23,412	24,734	23,850	3.7%	22,611	23,892	-5.4%
2010/11	23,892	25,239	24,820	5.1%	23,299	24,071	-3.2%
2011/12	23,605	25,989	24,202	7.1%	22,924	24,376	-6.8%
2012/13	24,750	26,464	24,270	9.8%	23,844	24,433	-2.4%
2013/14	25,625	25,510	24,538	4.8%	23,936	24,696	-3.1%
2014/15	25,585	25,491	25,469	0.1%	24,455	25,588	-4.1%
2015/16	24,665	25,787	25,366	1.3%	25,999	25,485	2.3%
2016/17	25,227	25,982	25,936	-0.1%	26,984	25,747	4.8%

Figure 7: Graphical and digital support extracted from Manitoba Hydro’s analysis of the accuracy of its energy forecasts (Source: Manitoba Hydro).

At the outset of any discussion on load variability and forecast accuracy, it is important to recognize that Manitoba Hydro acknowledges that load variability is a significant challenge to forecast accuracy. It cites “underlying changes in the population growth, economic growth, changes in the operations of Top Consumers, and overall use patterns” as important contributors to load variability.<sup>9</sup> All sources of variability considered, Manitoba Hydro’s current load forecast is considered to have only “an 80% probability of being accurate within  $\pm 1,737$  GWh or  $\pm 5.1\%$ ” by 2035/36. Manitoba Hydro declares that “Due to the inherent variability of the load, this is the best level of accuracy possible”.<sup>10</sup>

<sup>9</sup> Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), page 453/1382.

<sup>10</sup> Discussion of load forecast accuracy in Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), page 453/1382.

It is a conundrum for Manitoba Hydro that it recognizes the shortcomings and of its load forecasts, yet load forecasts are necessary for financial and resource planning. To illustrate, the confidence interval of  $\pm 1,737$  GWh that Manitoba Hydro places on its forecast for Gross Firm Energy represents almost eight years of growth at the 220.7 GWh annual growth rate in recent years. not the sign of a very accurate forecast.

A problem with the approach that Manitoba Hydro uses to generate its load forecasts is that the sectoral forecasts employ subjective assessments of variables that are regarded as driving the forecasts. Some of these variables, such as population forecasts and forecasts of per capita consumption, while subjective in nature, can be mathematically linked to some of the sectoral forecasts, for example, the residential and general service mass market sectors. Most though do not benefit from an algorithm tying them to the load. They can be said only to “inform” what in the end is a subjective guess at a forecast value. The rhetoric that Manitoba Hydro to describe the methodology on which its load forecasts are based bears testimony to this observation and to the limitation on the confidence that should be placed in these forecasts.<sup>11,12</sup>

Another problem with the approach that Manitoba Hydro uses to assess the accuracy of its load forecasts is that the analysis does not evaluate the accuracy of current forecasts as would be desirable. Instead, its five-years-ahead forecasts are at least five-years old and the ten-years-ahead forecast are at least 10 years old when their accuracy is judged. Most five-years-ahead and ten-years-ahead forecasts are even older.

Moreover, there is absolutely no evaluation of the accuracy of load forecasts further than 10 years out. It is understandable that, given the vagaries of electric load forecasting, no attempt is made to evaluate the accuracy of forecasts further into the future. At the same time, it should be noted that an outcome of this constraint is that, without any analysis of accuracy in the longer term, long-term forecasts are “immune” from accountability for being inaccurate, on either the high side or the low.

Examining nearer-term forecasts, the most recent five-years-ahead forecast evaluated in this General Rate Application was produced in 2012. All other five-years-ahead forecasts were produced even earlier than 2012. Likewise, the most recent 10-years-ahead forecast evaluated in this Application was produced in 2007. All others are even older. When it comes to forecasting accuracy, the performance of forecasts five and 10 years ago is gauged but present performance gets a pass. For example, there is not even a review of the accuracy of last year’s load forecast.

These serious deterrents to accurate forecasting notwithstanding, let’s examine Figure 7 to judge how well Manitoba Hydro’s electric load forecasts have been performing. An assessment of Gross Firm Energy forecast accuracy in Figure 7 reveals that the accuracy of Manitoba Hydro’s five-

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<sup>11</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), pages 426 to 429/1382, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>12</sup> Manitoba Public Utilities Board Transcript of Proceedings, Manitoba Hydro 2017/18 and 2018/19 General Rate Application, pages 24 to 26/255.

years-ahead forecasts ranged from -5.9% to +9.0% for the 21 years for which the analyses could be performed. That is a pretty wide range. Between 2005 and 2012, the forecasts ranged from 0.1% low to 9.0% high. It is not surprising to the Bipole III Coalition which warned the Public Utilities Board<sup>13</sup> of the trend toward over-forecasting back in 2014. It also validates the calculations in Table 3 to be considered momentarily in this presentation.

Apart from the inaccurate picture of domestic revenue produced by a forecast that is, for example, 9.0% high, perhaps an even more serious result is the distortion it causes for resource planning. If the recent average annual growth rate for Gross Firm Energy of 0.86% is a valid indicator of future growth, a forecast that is 9.0% high signals a need for new resources more than 10 years earlier than they are actually needed.

Seven out of the eight five-years-ahead forecasts during the period between 2005 and 2012 were high. This is unfortunate because that period coincided with the period when Manitoba Hydro's expansion plan was most actively being developed. Over-optimism about the domestic consumption of electricity during those years is no doubt one factor among many for Manitoba Hydro's current financial predicament.

Turning to the ten-years-ahead forecasts, the accuracy ranged from -10.9% to +12.5% over the 21 years analyzed. Except for 2006 and 2007, forecasts of Gross Firm Energy have essentially been low every year since 1992. Of course, no measures of accuracy for 10-years-ahead forecasts since 2007 are available because those more recent forecast have not "matured" to a point when they can be judged. But, if 2006 and 2007 are any indication, it is looking like 10-years-ahead forecasts may have also been heading into a period of over-forecasting starting in 2006. This too would have unjustifiably fed the enthusiasm for system expansion in those critical years.

As mentioned earlier, Table 1 at the end of this presentation presents a comparison of Manitoba Hydro's current forecast of Gross Firm Energy with values that would be predicted by a straight-line extrapolation of recent historical values of the variable. The year-by-year differential between these two future values of Gross Firm Energy is calculated in the fourth column in Table 3.

It is notable that the +2,623 GWh result (32,398 GWh minus 29,775 GWh) for the differential in 2035/36 between Gross Firm Energy as would be suggested by a straight-line extrapolation of this variable and Manitoba Hydro's 2027 forecast is well outside Manitoba Hydro's 80% probability envelope of  $\pm 1,737$  GWh for 2035/36. With an annual growth rate of 220.7 GWh, a differential of +2,623 GWh represents 12 years of growth. This finding challenges further Manitoba Hydro's claim that an 80% window is sufficient to gauge the accuracy of its electric load forecasts.

It is clear that the range of load variability considered by Manitoba Hydro in its analyses is not nearly wide enough. It is also significant that, in Table 3, 16 of the 20 values of the differential in the later years bear a + sign, indicating that Manitoba Hydro's forecasts tend to overpredict

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<sup>13</sup> Presentation by the Bipole III Coalition to the Needs For and Alternatives To (NFAT) review of Manitoba Hydro's Preferred Expansion Plan by the Public Utilities Board submitted on February 3, 2014 and accessible at [http://www.pubmanitoba.ca/v1/nfat/pdf/bipole\\_3\\_nfat\\_presentation.pdf](http://www.pubmanitoba.ca/v1/nfat/pdf/bipole_3_nfat_presentation.pdf).

regularly. With the scaling back of the 2017 load forecast significantly below the load forecasts for 2015 and 2016, it is likely that those earlier forecasts overpredicted on an even greater scale.

As noted previously, Manitoba Hydro's forecasts for electric load have been well above forecasts published by other utilities in North America for several years. Daymark Energy Advisors (formerly La Capra Associates), in a report currently before the PUB<sup>14</sup>, identified several issues that distort Manitoba Hydro's current load forecast.

Among them are: exclusion of three Potentially Large Industrial Loads from the top consumers sector, "multi-collinearity issues", use of trend and dummy variables in the average usage models for both residential and general service mass market sectors, suppression of price elasticity effects in the top consumers sector, use of third party population forecasts that are too low, failure to use "scenario analysis" to permit insights into the impact of future alternative scenarios, absence of consideration of the impact of fuel switching and differing treatment in consecutive forecasts of DSM attributable to codes and standards.

Given the significant number of issues identified by Daymark, it is not surprising that Manitoba Hydro's approach to load forecasting would produce a result that is different than the one presented here which extrapolates from recent past experience.

### **Impact of Load Forecast on Domestic Revenue:**

The question arises as to how important the impact of load forecasting is on future domestic revenue. Beyond presenting energy differentials resulting from differing future values of Gross Firm Load, Table 3 presents the opportunity for an analysis that puts a dollar value on the over-forecast energy. The area in Figure 3 between Manitoba Hydro's current forecast of Gross Firm Energy (yellow line) and an extrapolation of recent historic weather-adjusted values into the future (dotted line) is a proxy of the relative magnitude of the impact.

Manitoba Hydro has models that allow it to perform such an analysis easily. Because those models were not available to the Bipole III Coalition, we devised a methodology that evaluated, year-by-year, the at-meter values of energy (consumer sales). This would be the fundamental methodology that would allow the impacts to be cumulated over time.

First though, at-meter values of the energy differential were calculated by applying a factor of 0.86 to Manitoba Hydro's MH17 forecast values for Gross Firm Energy. This was necessary because Manitoba Hydro does not sell energy at generation.

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<sup>14</sup> Daymark Energy Advisors, Independent Consultant Report: Load Forecast Review, November 15, 2017, PUB Exhibit DEA-2.

This calculation allowed the exclusion of transmission and distribution line losses, station service, construction usage and other-non-revenue-producing consumption, estimated to average 14%, in estimating approximate at-meter values of the energy differential.<sup>15</sup>

Next, we calculated annual unit values of energy at the meter, averaged over all sectors, relying on values for forecast consumer sales revenue available from the Projected Operating Statement in the 20-year Outlook for Manitoba Hydro’s Electric Operations.<sup>16</sup>

The average annual unit values of the energy differential (\$M/GWh) were the applied to the year-by-year values of the energy differential (GWh) to produce annual dollar values of the energy differential (\$M) over the 20-year future period for which data were available. The result is presented in the last column of Table 3 identified as Revenue Differential (due to differing load forecasts).

Mathematically, the arithmetic sum  $R_{\Delta\text{LOAD}}$  of the Revenue Differential over the 20-year future period (attributable to the departure of Manitoba Hydro’s current load forecast from what would be suggested by recent history) is given by the equation.

$$R_{\Delta\text{LOAD}} = \sum_{n=2018}^{n=2037} (0.86 \Delta E_n P_n) \quad (\text{Eq. 1})$$

where

0.86 is a factor reflecting the difference between Gross Firm Energy and Total Consumer Sales introduced to reflect system losses and usage that does not produce revenue,

$\Delta E_n$  is the Gross Firm Energy differential, in a given year, between Manitoba Hydro’s current forecast and an extrapolation of recent 10-year historic values, in this presentation called Linear (Historic),

$P_n$  is the unit price at the meter, in a given year, of energy, and

$n$  is the year (identified in terms of the year end).

Table 3 shows that, over a period of 20 years, the arithmetic sum of the Revenue Differential  $R_{\Delta\text{LOAD}}$  resulting from a forecast of Gross Firm Energy which exceeds a straight-line extrapolation of recent history is \$2.329 million. Moreover, it demonstrates that, the annual revenue differential is much larger toward the end of the 20-year period and that it is growing each year. This analysis

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<sup>15</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), page 427/1382, updated in PUB-MH I-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>16</sup> Domestic revenue from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 3.3 Electric Operations (MH16 20-Year Outlook) Projected Operating Statement, pages 1 and 2/6.

indicates that **over-forecasting of load could result in over-predicting domestic revenue by more than \$2.3 billion over a 20-year period.**

It should be acknowledged that the value of the energy not consumed domestically will not be entirely lost because the energy will be available for sale on the export energy market. But, at current prices, the offset will be only about one third of the foregone value.

It is important also to recognize that the foregone revenue will actually have a greater impact on retained earnings in 2036/37 than the simple arithmetic sum produced by this analysis indicates. To calculate the actual impact of over-forecasting electric load on retained earnings in 2036/37, a future value analysis should be conducted that brings all annual values for revenue differential forward to 2036/37.

Another (undesirable) impact of an overstated load forecast (beside its effect on the balance sheet) is that it advances unrealistically the year of need for the next energy resource. To illustrate, a close inspection of Figure 3 reveals that some values of Gross Firm Energy currently forecast by Manitoba Hydro would be reached up to six years earlier than would be predicted by a linear extrapolation of weather-adjusted Gross Firm Energy. Clearly, an over-stated load forecast has negative consequences for system resource planning.

The range of load considered by Manitoba Hydro in the load variability and accuracy analyses reported in this Application is insufficiently wide to circumscribe a linear extrapolation of recent historic experience.<sup>17</sup> This has been a pattern in the Bipole III Coalition's experience for some time, including its 2014 presentation to the NFAT review.<sup>18</sup>

Daymark Energy Advisors, in its report currently before the PUB<sup>19</sup> notes the narrowness of the range of load forecast contemplated by Manitoba Hydro. Daymark suggests an approach that would be more robust than Manitoba Hydro's methodology which relies on the P10 and P90 levels of base load. The more sophisticated approach suggested by Daymark would evaluate, with the help of probabilistic risk assessments, the inherent characteristics of each fundamental variable that contributes to base load. Manitoba Hydro should re-evaluate its approach to load forecasting.

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<sup>17</sup> Load variability from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7: Appendix 7.1 (2016 Electric Load Forecast), pages 54 to 59/82, and corroborated by Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), pages 453 to 458/1382.

<sup>18</sup> Presentation by the Bipole III Coalition to the Needs For and Alternatives To (NFAT) review of Manitoba Hydro's Preferred Expansion Plan by the Public Utilities Board submitted on February 3, 2014 and accessible at [http://www.pubmanitoba.ca/v1/nfat/pdf/bipole\\_3\\_nfat\\_presentation.pdf](http://www.pubmanitoba.ca/v1/nfat/pdf/bipole_3_nfat_presentation.pdf).

<sup>19</sup> Daymark Energy Advisors, Independent Consultant Report: Load Forecast Review, November 15, 2017, PUB Exhibit DEA-2.

## Impact of Demand Side Management on Domestic Revenue:

As with load forecast accuracy, the question arises as to how important the impact of DSM is on future domestic revenue. The area in Figure 5 between Manitoba Hydro's current forecast for Gross Firm Energy (yellow line) and Gross Firm Energy under its current DSM Plan (green line) invites a calculation that can evaluate that impact. Table 4 presents an analysis that evaluates the dollar value of domestic revenue foregone by Manitoba Hydro's current DSM Plan. But it also evaluates the dollar difference between Manitoba Hydro's current DSM Plan and Efficiency Manitoba's more aggressive DSM Plan. Neither analysis considers the delivery cost of these DSM Plans.

The methodology we devised for this analysis puts year-by-year values on projections of at-meter energy (consumer sales). The methodology shares some common approaches with the methodology we devised to evaluate the impact of load forecast differences on domestic revenue. It starts with Manitoba Hydro's current forecast of load so that any impact on domestic revenue will not reflect load forecast assumptions.

Mathematically, the arithmetic sum  $R_{\Delta\text{DSM}}$  of the Revenue Differential over the 20-year future period attributable to the choice of DSM Plan is given by the equation

$$R_{\Delta\text{DSM}} = \sum_{n=2018}^{n=2037} (0.86 \Delta E_n P_n) \quad (\text{Eq. 2})$$

where

0.86 is a factor reflecting the difference between Gross Firm Energy and Total Consumer Sales introduced to reflect system losses and usage that does not produce revenue,

$\Delta E_n$  is the Gross Firm Energy differential, in a given year, between Manitoba Hydro's current DSM Plan and Efficiency Manitoba's DSM Plan,

$P_n$  is the unit price at the meter, in a given year, of energy, and

$n$  is the year (identified in terms of the year end).

Table 4 reveals that, over a period of 20 years, the cumulative impact on domestic revenue of Manitoba Hydro's current DSM Plan can be expected to be in excess of \$5.7 billion. It also reveals that, over a period of 20 years, the cumulative impact on domestic revenue of Efficiency Manitoba's more aggressive DSM Plan can be expected to be in excess of \$10.8 billion. **The additional cumulative impact on domestic revenue of Efficiency Manitoba's Demand Side Management Plan above Manitoba Hydro's current DSM Plan is about \$5.1 billion.** Coincidentally, this is about the value of the current cost estimate for Bipole III. This is much more serious than perhaps has been understood as the Government proceeded with passing the Efficiency Manitoba Act in the summer of 2017.

Like load forecast, a future value analysis of the choice of DSM Plan would show an even larger impact on retained earnings in 2036/37 than is indicated by an arithmetic approach. Also, like load forecast, the 'lost' revenue would be somewhat offset by revenue from additional sales on the energy export market. However, unlike load forecast, this analysis does not consider the additional cost of Efficiency Manitoba's more aggressive DSM Plan. If the Government passes the cost of Efficiency Manitoba's DSM Plan to Manitoba Hydro as is provided for in The Efficiency Manitoba Act, the additional delivery cost of that Plan will show up as a further negative impact on Manitoba Hydro's retained earnings. Table 4 demonstrates that most of that impact will occur in later years.

The transfer of responsibility for DSM from Manitoba Hydro to the Government is probably the least understood action this Government has taken. Its financial impact is on a par with the previous Government's routing decision for Bipole III, now roundly regarded as a serious mistake.

### **Outcomes:**

For several years now, the linear extrapolation approach described in this presentation has consistently produced projected load that is in the same ballpark as load forecasts in other North American jurisdictions. Until the past few years, Manitoba Hydro's forecast has produced load forecasts that are an outlier among load forecasts in other relevant jurisdictions. Even today, Manitoba Hydro's load forecast is still well above what the majority is projecting.

Prior to 2015, Manitoba Hydro produced load forecasts with annual growth in the range 1.5% to 1.6%, well above recent historic trends.<sup>20</sup> Currently, Table 1 in this analysis demonstrates that Manitoba Hydro is forecasting 10-year growth for Gross Firm Energy at 0.81%, expressed by Manitoba Hydro as 0.9%. This is significantly down from earlier forecasts and from 1.46% in 2014<sup>21</sup>. Annual growth of 0.9% for the next 10 years is close to the 0.86% indicated by a linear extrapolation of recent historic values of weather-adjusted Gross Firm Energy presented here.

However, it is concerning that Manitoba Hydro's current forecast features a decided upturn in growth at the end of this 10-year forecast period. Manitoba Hydro's forecast for the second 10-year forecast period (2026/27 until 2036/37 in Table 1) reflects an annual growth rate of 1.7% during this 10-year period. Expressing growth rate over 20 years masks the highly optimistic forecast in the final 10 years of the forecast period. Manitoba Hydro justifies the upturn in terms of a return to 20-year historic growth patterns as a result of forecast population increases and a recovery from price elasticity impacts driven by seven years of 7.9% rate hikes currently under review.<sup>22</sup>

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<sup>20</sup> Presentation by the Bipole III Coalition to the Needs For and Alternatives To (NFAT) review of Manitoba Hydro's Preferred Expansion Plan conducted by the Public Utilities Board submitted on February 3, 2014 and accessible at [http://www.pubmanitoba.ca/v1/nfat/pdf/bipole\\_3\\_nfat\\_presentation.pdf](http://www.pubmanitoba.ca/v1/nfat/pdf/bipole_3_nfat_presentation.pdf).

<sup>21</sup> Daymark Energy Advisors, Independent Consultant Report: Load Forecast Review, November 15, 2017, PUB Exhibit DEA-2.

<sup>22</sup> Manitoba Public Utilities Board Transcript of Proceedings, Manitoba Hydro 2017/18 and 2018/19 General Rate Application, page 24/255.

It is significant how far out of line Manitoba Hydro's forecasts continue to be with relevant projections by reputable agencies. The U. S. Energy Information Administration, for example, is projecting annual growth rates out to 2040 for electricity use in the United States in the range from 0.6% to 1.0%.<sup>23</sup> This metric includes not only sales but also direct use. Comparing Manitoba Hydro's forecast of 1.2% annual growth in domestic energy consumption between now and 2036/37 reveals how overstated Manitoba Hydro's load forecast likely still is, even after scaling back since 2015.

The cumulative impact on domestic revenue of Manitoba Hydro's current DSM Plan, over the next 20 years, is \$5.8 billion. Presumably, that impact and the cost of delivering that Plan is reflected in the current Integrated Financial Forecast. However, the additional impact on domestic revenue attributable to the Government's decision to establish legislatively mandated energy savings targets adds an additional \$5.1 billion to that cost. In addition to absorbing the impact on domestic revenue, Manitoba Hydro will have to cover program delivery costs given that these costs are planned to be passed on from Efficiency Manitoba. These financial impacts are not reflected in the Integrated Financial Forecast. These impacts should be part of Manitoba Hydro's discussion with the Government to safeguard its financial health.

### **Consequences:**

The combined cumulative impact on domestic income over the next 20 years attributable to load forecast choices and the more aggressive DSM Plan mandated by The Efficiency Manitoba Act is \$7.4 billion (\$2.3 billion plus \$5.1 billion). Neither of these impacts are reflected in Manitoba Hydro's current Integrated Financial Forecast. Both are future impacts. Unless alternate funding sources are found, Manitoba Hydro will be requesting 7.9% rate increases even farther into the future than 2024.

### **Future Work:**

Manitoba Hydro's focus for the past 18 months has been primarily on debt management. It does not appear to have devoted very much effort to increasing consumption of the glut of energy that it will own once Keeyask is in service. Electric energy export markets are uneconomical at current low export market prices, benefiting economies outside of Manitoba while not being useful to develop our own provincial economy. A concerted effort to advance electric transportation (cars, trucks and buses) and to promote a western Canadian transmission grid could change the prospects for both domestic revenue and extra-provincial revenue based on the potentially more profitable capacity and energy imbalance markets. Future work should reflect those opportunities.

The analysis in this presentation takes into account price elasticity only to the extent that the forecast values of Total Consumer Sales embedded in Manitoba Hydro's Integrated Financial

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<sup>23</sup> U. S. Energy Information Administration Annual Energy Outlook 2017 with projections to 2050, Electricity Use growth projections (three-year rolling average) out to 2040, pages 67 to 88 but, in particular, page 75.

Forecast used in the analysis takes that factor into consideration.<sup>24</sup> A future analysis should assess whether price elasticity is adequately considered in Manitoba Hydro's electric load forecasting. Given that even short-term forecasts of load are currently at about the same level as recent historic trends when rate increases have been half or less of the 7.9% rate increases being requested for the next seven years, price elasticity impacts appear to be inadequately reflected.

### **Recommendations:**

- 1. The Public Utilities Board should direct Manitoba Hydro to revise its electric load forecast downward to more adequately reflect recent historic experience, price elasticity impacts and insights into factors driving load forecasts in other North American jurisdictions for consideration in its current General Rate Application.**
- 2. The Public Utilities Board should direct Manitoba Hydro to conduct its own analysis of the impact on Manitoba Hydro's balance sheet of the Government's legislated plan for Demand Side Management of electric energy and to report its findings to the Public Utilities Board as part of its next General Rate Application.**

### **About the Bipole III Coalition:**

The Bipole III Coalition is a grass-roots organization of concerned citizens established in November 2010 to promote public awareness among Manitobans that a route for Manitoba Hydro's planned Bipole III transmission line on the east side of Lake Winnipeg would be superior to the route chosen on the west side of the province. Soon after its establishment, the Bipole III Coalition broadened its mission in order to promote public awareness of its concern that Manitoba Hydro's corporate plan is not very well aligned with the interests of its ratepayers and not even with the interests of the citizens of Manitoba. It is concerned that Manitoba Hydro's corporate plan is not very well aligned with market challenges and opportunities. The Bipole III Coalition is not affiliated with any political party.

The presenter, Dr. Garland Laliberte, is Vice-President of the Bipole III Coalition.

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<sup>24</sup> Manitoba Hydro 2017/18 and 2018/19 General Rate Application, transcript of proceedings for public hearing, pages 213-219 and 244-247 containing testimony on 7 December 2017 by Lois Morrison and Jamie McCallum of Manitoba Hydro confirming that, despite that the Chair of the Manitoba Hydroelectric Board had been publicly warning about the need for double-digit annual rate increases as early as 21 September 2016, the analysis of price elasticity impact on load forecasts included in filings on 5 May 2017 and in later summer updates, those forecasts contemplated a maximum annual rate increase of only 3.95% and not 7.9% as is presently being requested.

Table 1: Historic and forecast values of Gross Firm Energy before and after Manitoba Hydro and Efficiency Manitoba Demand Side Management Plans

Year	Gross Firm Energy, GWh <sup>1</sup>					DSM, GWh <sup>7</sup>		Gross Firm Energy Net of DSM, GWh			
	Historic <sup>2</sup>	MH15	MH16	MH17	Linear	MH Plan	EM Plan	MH17 Forecast		Linear (Historic)	
		Forecast <sup>3</sup>	Forecast <sup>4</sup>	Forecast <sup>5</sup>	(Historic) <sup>6</sup>	Forecast <sup>8</sup>	Forecast <sup>9</sup>	MH plan <sup>10</sup>	EM plan <sup>11</sup>	MH plan <sup>12</sup>	EM plan <sup>13</sup>
1996/97	18674										
1997/98	19286										
1998/99	19660										
1999/00	19597										
2000/01	20119										
2001/02	20830										
2002/03	21716										
2003/04	21948										
2004/05	22641										
2005/06	23200										
2006/07	23423										
2007/08	23910										
2008/09	24181										
2009/10	23808										
2010/11	23965										
2011/12	24321										
2012/13	24367										
2013/14	24634										
2014/15	25461	25505									
2015/16	25355	26145	24665								
2016/17	25896	26792	26385	25227	25583						
2017/18		27126	26596	26029	25803	238	390	25791	25639	25565	25413
2018/19		27486	26785	26026	26024	570	781	25456	25245	25454	25243
2019/20		27600	27060	26220	26245	1052	1174	25168	25046	25193	25071
2020/21		28449	27410	26238	26465	1368	1568	24870	24670	25097	24897
2021/22		28786	27729	26766	26686	1657	1969	25109	24797	25029	24717
2022/23		29197	28082	26877	26907	1837	2372	25040	24505	25070	24535
2023/24		29590	28435	27055	27127	2006	2778	25049	24277	25121	24349
2024/25		29999	28785	27389	27348	2163	3189	25226	24200	25185	24159
2025/26		30408	29110	27780	27569	2325	3606	25455	24174	25244	23963
2026/27		30823	29447	28208	27789	2482	4029	25726	24179	25307	23760
2027/28		31243	29762	28641	28010	2647	4458	25994	24183	25363	23552
2028/29		31664	30106	29068	28231	2818	4894	26250	24174	25413	23337
2029/30		32094	30602	29510	28451	2993	5337	26517	24173	25458	23114
2030/31		32531	31108	29962	28672	3163	5787	26799	24175	25509	22885
2031/32		33101	31666	30428	28893	3195	6243	27233	24185	25698	22650
2032/33		33684	32273	30914	29113	3227	6707	27687	24207	25886	22406
2033/34		34317	32896	31399	29334	3257	7178	28142	24221	26077	22156
2034/35		35011	33532	31895	29555	3285	7656	28610	24239	26270	21899
2035/36			34193	32398	29775	3311	8142	29087	24256	26464	21633
2036/37				32930	29996	3337	8636	29593	24294	26659	21360

Explanatory Notes appear on next page.

**Explanatory Notes:**

- <sup>1</sup> Gross Firm Energy at generation net of forecast savings attributable to codes and standards.
- <sup>2</sup> Weather-adjusted values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7: Appendix 7.1 (2016 Electric Load Forecast), Table 29, page 47/82 and Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382.
- <sup>3</sup> MH15 Forecast values of Gross Firm Energy from Manitoba Hydro 2015/16 and 2016/17 General Rate Application Attachment 25 (2015 Electric Load Forecast and Power Smart Plans MFR 1), Table 2, page 6/81, updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.
- <sup>4</sup> MH16 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 7.1 (2016 Electric Load Forecast), Table 1, updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.
- <sup>5</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382 updated in PUB-MH 1-56a-c Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.
- <sup>6</sup> Values produced by extrapolating a linear regression of weather-adjusted values of Gross Firm Energy for the 10-year period from 2007/08 to 2016/17. The slope of this regression line is 220.7 GWh/year (0.86% of the 25,583 GWh calculated value for 2016/17).
- <sup>7</sup> Planned program-based Demand Side Management.
- <sup>8</sup> Impacts (at generation) exclusive of contribution from codes and standards from Manitoba Hydro 2017/18 and 2018/19 General Rate Application: Response on 5 September 2017 updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.
- <sup>9</sup> Assumed DSM programming by Efficiency Manitoba beginning in 2017/18 and incremented upward each year by 1.5% of Manitoba Hydro's 2017 Load Forecast for that year.
- <sup>10</sup> MH17 Forecast for Gross Firm Energy minus Manitoba Hydro's current DSM Plan.
- <sup>11</sup> MH17 Forecast for Gross Firm Energy minus Efficiency Manitoba's DSM Plan.
- <sup>12</sup> Linear (Historic) values for Gross Firm Energy minus Manitoba Hydro's current DSM Plan.
- <sup>13</sup> Linear (Historic) values for Gross Firm Energy minus Efficiency Manitoba's DSM Plan.

Table 2: Historic and forecast values of Gross Total Peak before and after Manitoba Hydro and Efficiency Manitoba Demand Side Management Plans

Year	Gross Total Peak, MW <sup>1</sup>					DSM, MW	Gross Total Peak Net of DSM, MW	
	Historic <sup>2</sup>	MH15	MH16	MH17	Linear	MH17 Forecast	MH17	Linear
		Forecast <sup>3</sup>	Forecast <sup>4</sup>	Forecast <sup>5</sup>	(Historic) <sup>6</sup>	MH Plan <sup>7</sup>	Forecast <sup>8</sup>	(Historic) <sup>9</sup>
1996/97	3486							
1997/98	3640							
1998/99	3610							
1999/00	3645							
2000/01	3677							
2001/02	3793							
2002/03	3972							
2003/04	4025							
2004/05	4129							
2005/06	4169							
2006/07	4182							
2007/08	4325							
2008/09	4314							
2009/10	4336							
2010/11	4392							
2011/12	4514							
2012/13	4547							
2013/14	4578							
2014/15	4723	4713						
2015/16	4634	4829	4479					
2016/17	4751	4936	4850	4822	4746			
2017/18		5000	4885	4759	4798	52	4707	4746
2018/19		5063	4928	4778	4850	130	4648	4720
2019/20		5086	4971	4816	4902	229	4587	4673
2020/21		5210	5033	4820	4954	314	4506	4640
2021/22		5267	5089	4895	5007	396	4499	4611
2022/23		5337	5154	4916	5059	441	4475	4618
2023/24		5406	5218	4949	5111	478	4471	4633
2024/25		5476	5282	5009	5163	512	4497	4651
2025/26		5547	5341	5081	5215	547	4534	4668
2026/27		5619	5402	5161	5267	582	4579	4685
2027/28		5692	5458	5242	5319	617	4625	4702
2028/29		5765	5520	5321	5371	652	4669	4719
2029/30		5840	5608	5403	5424	688	4715	4736
2030/31		5915	5696	5487	5476	722	4765	4754
2031/32		6012	5796	5574	5528	728	4846	4800
2032/33		6112	5905	5665	5580	733	4932	4847
2033/34		6220	6017	5756	5632	739	5017	4893
2034/35		6341	6131	5848	5684	744	5104	4940
2035/36			6250	5943	5736	749	5194	4987
2036/37				6043	5788	754	5289	5034

Explanatory Notes appear on next page.

**Explanatory notes:**

<sup>1</sup> Gross Total Peak at generation net of forecast savings attributable to codes and standards.

<sup>2</sup> Weather-adjusted values of Gross Total Peak from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 7: Appendix 7. (2016 Electric Load Forecast), Table 32, page 49/82 and Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382.

<sup>3</sup> MH15 Forecast values of Gross Total Peak from Manitoba Hydro 2015/16 and 2016/17 General Rate Application Attachment 25 (2015 Electric Load Forecast and Power Smart Plans MFR 1), Table 2, page 6/81, updated in PUB-MH I-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>4</sup> MH16 Forecast values for Gross Total Peak from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 7.1 (2016 Electric Load Forecast), Table 1, page 5/82, updated in PUB-MH I-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>5</sup> MH17 Forecast values for Gross Total Peak from Manitoba Hydro 2017/18 and 2018/19 General Rate Application: Tab 11: Public Utilities Board (PUB) MFRs, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382, updated in PUB-MH I-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>6</sup> Values produced by extrapolating a linear regression of weather-adjusted values of Gross Total Peak for the 10 years from 2007/08 to 2016/17. The slope of this regression line is 52.1 MW/year (1.10% of the 4,746 MW calculated value for 2016/17).

<sup>7</sup> Impacts (at generation) exclusive of contribution from codes and standards from Manitoba Hydro 2017/18 and 2018/19 General Rate Application: Response on 5 September 2017 to Information Request Round 1 COALITION/MH I-40a-d pages 186-188/1268, updated in PUB-MH I-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>8</sup> MH17 Forecast for Gross Total Peak minus Manitoba Hydro's current DSM Plan.

<sup>9</sup> Linear (Historic) values for Gross Total Peak minus Manitoba Hydro's current DSM Plan.

Table 3: Domestic revenue differential resulting from the differential between Manitoba Hydro's 2017 Forecast of Gross Firm Energy and a linear extrapolation of the most recent 10-year historic record of weather-adjusted Gross Firm Energy

Fiscal Year	Forecast Gross Firm Energy			Consumer Sales	Forecast Consumer Sales Revenue			Unit Price <sup>6</sup>	Revenue Differential <sup>7</sup>
	MH17 <sup>1</sup>	Linear (Historic) <sup>2</sup>	Differential	Differential <sup>3</sup>	Approved <sup>4</sup>	Additional <sup>5</sup>	Total		
	GWh	GWh	GWh	GWh	\$M	\$M	\$M	\$M/GWh	\$M
2017/18	26029	25803	226	194	1569	88	1657	0.074706	17
2018/19	26026	26024	2	2	1561	255	1816	0.082952	0
2019/20	26220	26245	-25	-22	1552	397	1949	0.090046	-2
2020/21	26238	26465	-227	-195	1551	551	2102	0.098278	-22
2021/22	26766	26686	80	69	1552	717	2269	0.105077	8
2022/23	26877	26907	-30	-26	1559	766	2325	0.107967	-3
2023/24	27055	27127	-72	-62	1567	817	2384	0.110667	-8
2024/25	27389	27348	41	35	1577	870	2447	0.112794	5
2025/26	27780	27569	211	181	1584	923	2507	0.114520	24
2026/27	28208	27789	419	360	1593	979	2572	0.116252	49
10-yr total	268588	267963	625	538	15665	6363	22028		67
2027/28	28641	28010	631	543	1599	1034	2633	0.117782	74
2028/29	29068	28231	837	720	1608	1093	2701	0.119646	100
2029/30	29510	28451	1059	911	1623	1158	2781	0.121949	129
2030/31	29962	28672	1290	1109	1639	1225	2864	0.124267	160
2031/32	30428	28893	1535	1320	1667	1304	2971	0.126855	195
2032/33	30914	29113	1801	1549	1698	1389	3087	0.129647	233
2033/34	31399	29334	2065	1776	1730	1478	3208	0.132550	274
2034/35	31895	29555	2340	2012	1762	1571	3333	0.135462	317
2035/36	32398	29775	2623	2256	1796	1669	3465	0.138518	363
2036/37	32930	29996	2934	2523	1829	1773	3602	0.141533	415
20-yr total	575733	557993	17740	15256	32616	20057	52673		2329

**Explanatory Notes:**

<sup>1</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/1382, and updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>2</sup> Values produced by extrapolating a linear regression of weather-adjusted values of Gross Firm Energy for the 10 years from 2007/08 to 2016/17. The slope of this regression line is 220.7 GWh/year (0.86% of the 25,583 GWh value calculated for 2016/17).

<sup>3</sup> Forecast Gross Firm Load Differential x 0.86 to reflect 14% system losses, station service and construction usage.

<sup>4</sup> Domestic revenue at approved rates from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 3.3 Electric Operations (MH16 20-Year Outlook) Projected Operating Statement, pages 1 and 2/6; estimated value for 2036/37.

<sup>5</sup> Domestic revenue additional from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 3.3 Electric Operations (MH16 20-Year Outlook) Projected Operating Statement, pages 1 and 2/6; estimated value for 2036/37.

<sup>6</sup> Forecast Total Consumer Sales Revenue divided by (Forecast Gross Firm Energy Net of Manitoba Hydro's DSM Plan multiplied by 0.86).

<sup>7</sup> Revenue Differential attributable to the MH17 Forecast compared to Linear (Historic) values calculated as Forecast Gross Firm Energy.

Table 4: Reduction in domestic revenue attributable to Manitoba Hydro's and Efficiency Manitoba's Demand Side Management Plans

Fiscal Year	MH17 <sup>1</sup>	DSM		MH17		Unit Price <sup>6</sup>	Revenue Differential attributable to DSM	
		MH Plan <sup>2</sup>	EM Plan <sup>3</sup>	Net of DSM MH Plan <sup>4</sup>	Net of DSM EM Plan <sup>5</sup>		MH Plan <sup>7</sup>	EM Plan <sup>8</sup>
	GWh	GWh	GWh	GWh	GWh	\$/GWh	\$M	\$M
2017/18	26029	238	390	25791	25639	0.074706	18	29
2018/19	26026	570	781	25456	25245	0.082952	47	65
2019/20	26220	1052	1174	25168	25046	0.090046	95	106
2020/21	26238	1368	1568	24870	24670	0.098278	134	154
2021/22	26766	1657	1969	25109	24797	0.105077	174	207
2022/23	26877	1837	2372	25040	24505	0.107967	198	256
2023/24	27055	2006	2778	25049	24277	0.110667	222	307
2024/25	27389	2163	3189	25226	24200	0.112794	244	360
2025/26	27780	2325	3606	25455	24174	0.114520	266	413
2026/27	28208	2482	4029	25726	24179	0.116252	289	468
10-yr total	268588	15698	21856	252890	246732		1687	2365
2027/28	28641	2647	4458	25994	24183	0.117782	312	525
2028/29	29068	2818	4894	26250	24174	0.119646	337	586
2029/30	29510	2993	5337	26517	24173	0.121949	365	651
2030/31	29962	3163	5787	26799	24175	0.124267	393	719
2031/32	30428	3195	6243	27233	24185	0.126855	405	792
2032/33	30914	3227	6707	27687	24207	0.129647	418	869
2033/34	31399	3257	7178	28142	24221	0.132550	432	951
2034/35	31895	3285	7656	28610	24239	0.135462	445	1037
2035/36	32398	3311	8142	29087	24256	0.138518	459	1128
2036/37	32930	3337	8636	29593	24294	0.141533	472	1222
20-yr total	575733	46931	86894	528802	488839		5726	10846

**Explanatory Notes:**

<sup>1</sup> MH17 Forecast values of Gross Firm Energy from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Tab 11: Public Utilities Board (PUB) Minimum Filing Requirements, PUB MFR 65 (Updated) (2017 Electric Load Forecast), Table 1, page 404/138; and updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>2</sup> Impacts (at generation) exclusive of contribution from codes and standards from Manitoba Hydro 2017/18 and 2018/19 General Rate Application: Response on 5 September 2017 and updated in PUB-MH 1-56a-c (Revised) filed by Manitoba Hydro as Exhibit MH70 on 7 December 2017.

<sup>3</sup> Assumed DSM programming by Efficiency Manitoba beginning in 2017/18 and incremented upward each year by 1.5% of Manitoba Hydro's 2017 Load Forecast for that year.

<sup>4</sup> MH17 Forecast for Gross Firm Energy minus Manitoba Hydro's DSM Plan.

<sup>5</sup> MH17 Forecast for Gross Firm Energy minus Efficiency Manitoba's DSM Plan.

<sup>6</sup> Domestic revenue additional from Manitoba Hydro 2017/18 and 2018/19 General Rate Application Appendix 3.3 Electric Operations (MH16 20-Year Outlook) Projected Operating Statement, pages 1 and 2/6.

<sup>7</sup> Manitoba Hydro's DSM Plan multiplied by Unit Price.

<sup>8</sup> Efficiency Manitoba's DSM Plan multiplied by Unit Price.