CNF/RCM/TREE I NFAAT - 1

INTERROGATORY

1. In the TREE/RCM NFAAT TSA Submission at page 9, l.20 ff., Manitoba Hydro's initial screening exercises is described as "superficial" and "qualitative". Please clarify which parts of Manitoba Hydro's NFAAT evidence are being referred to in this context, and provide further elaboration of why it is found to be superficial and qualitative.

RESPONSE:

The initial screening exercise being referred to here is the analysis described in Chapter 4, "Resource Options", of Volume 1 of Manitoba Hydro's April 2003 NFAAT submission. Manitoba Hydro acknowledges that this is not a detailed analysis, but an initial step designed to identify where more detailed analysis should be done.

In this exercise a list of possible resource options is put forward, including:

- Undeveloped hydroelectric sites, including Wuskwatim
- Enhancements to existing hydro and thermal stations
- Enhancements to the transmission system
- Natural gas combustion turbines
- New coal-fired power plants
- "Alternative" Energy, including wind power
- Imports
- Nuclear fission
- Nuclear fission
- Demand side management

The options are discussed, mostly in qualitative terms, and estimates of the range of levelized costs (present value cents per kilowatt-hour) are presented (NFAAT Vol 1, Chap 4, p. 35 ff) for some of the options, listed here in increasing order of Manitoba Hydro's upper limit to the estimated levelized costs:

- Average DSM
- New hydro
- Wind generation
- Combined cycle gas turbine
- Simple cycle gas turbine
- Coal fired steam
- Biomass
- Fuel cells
- Photovoltaic

There is no detailed analysis of the environmental impacts at this stage, although estimates of the life cycle greenhouse gas emissions (per kilowatt-hour) are presented which conclude that the fossil fuel burning options (coal, gas turbines) have eCO_2 emissions in the range of 500-1000 grams per kilowatt-hour and wind, hydro and biomass options have emissions in the range of 4 (wind) to 70 (biomass) grams per kilowatt-hour.

Specifically with regard to DSM, it is important to note that when the NFAAT materials were prepared in April 2003 Manitoba Hydro did not have an up-to-date assessment of the size of the DSM resource in the province, and so for purposes of the initial screening exercise, they used only the quantities *they were already committed to achieving* in the current Power Smart program. *Increased DSM was not even included in the initial screening.*

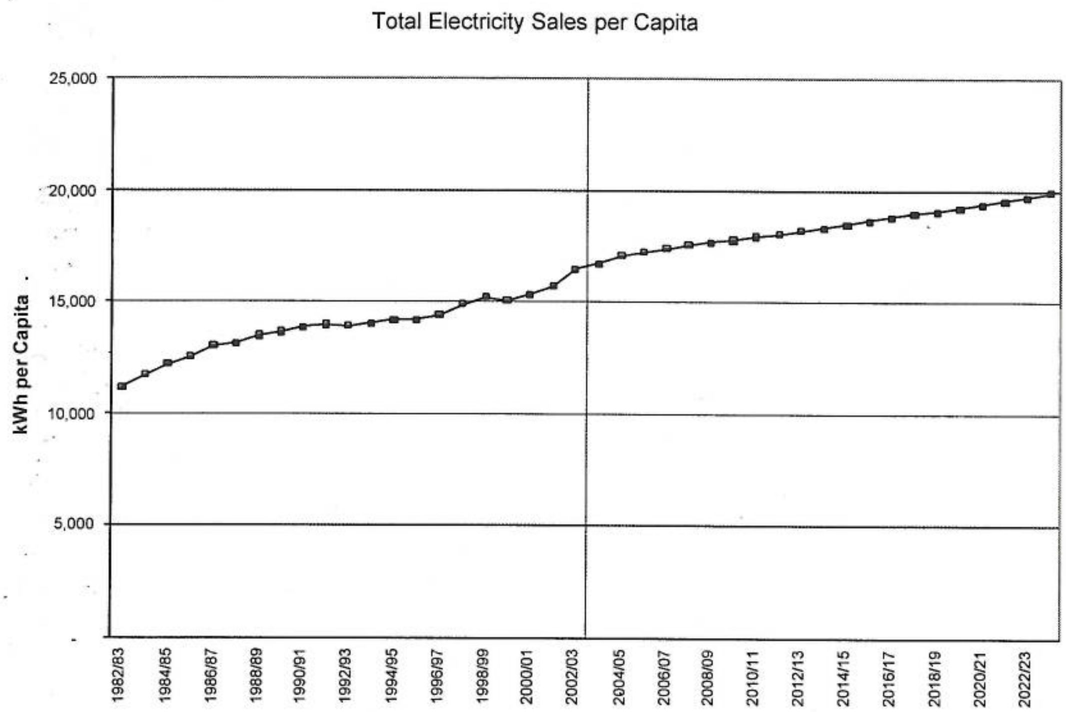
Nevertheless, the discussion in Chapter 4 acknowledges that DSM is effective at "allowing additional energy to be sold on the export market or, in the long term, deferring the domestic requirement for new generation" (NFAAT Vol 1, Chap 4, p.15). This is significant in the context of Manitoba Hydro's central argument for building the Wuskwatim plant before its domestic need date. The screening analysis also indicates that DSM exhibits the lowest emissions per kilowatt-hour of any of the options included (Chap 4, p. 31) and that is has the lowest levelized cost per kilowatt-hour of any of the options considered.

> "... the Wuskwatim Project is considered to be a superior resource to biomass, solar photovoltaic, fuel cells, and coal generation. It is likely that other opportunities will be available that are also very attractive such as increased DSM, SSE and alternative energy especially wind generation. *Development of the Wuskwatim Project will not preclude the development of these opportunities*.[Emphasis added.]
>
> Chapter 6 provides a more detailed evaluation of the Wuskwatim Project's economics relative to other hydro opportunities (Gull and Conawapa), wind and gas-fired generation."

Even though DSM emerges from the screening exercise as the cheapest and cleanest option for meeting domestic needs, it is the advancement of the Wuskwatim dam that is put forward as the preferred option.

From this point forward in Manitoba Hydro's NFAAT submission, alternatives to Wuskwatim Advancement are not considered. The italicized sentence in the above quoted conclusion of Manitoba Hydro's screening analysis introduces an argument that is used repeatedly throughout the rest of Manitoba Hydro's NFAAT case for Wuskwatim Advancement, an argument that confuses sensitivity analysis of the preferred option with an assessment of alternatives to the preferred option. After all, the conclusion of the screening analysis would more accurately reflect the discussion in NFAAT Vol. 1, Chapter 4 if the terms "DSM" and "Wuskwatim Project" were interchanged in the passage quoted above.

Figure TREE/RCM - CNF2. 1



This indicator provides an overall picture of the "electricity intensity" of Manitoba society, bother historically and as forecast in the 2003 Load Forecast. The growth in per capita electricity consumption is being driven by growth in per capita GDP, and is only slightly moderated by the ongoing but modest improvements in the electricity productivity of the Manitoba economy

CNF/RCM/TREE I NFAAT - 2

INTERROGATORY:

2. In the TREE/RCM NFAAT TSA Submission at page 12, in response to Question 8, reference is made to "highly aggregate ratios" that are used by Manitoba Hydro in developing its Load Forecast, and that "these aggregate ratios can exhibit and have exhibited significant variation in the past". Please provide more detail about the variation of these ratios in the past and their possible trends in the future.

RESPONSE:

The Load Forecast utilizes the historical, empirical correlations between GDP and electricity demand, and between the rates of change of these factors. Clearly, this is a highly aggregate and complex relationship that is affected by:

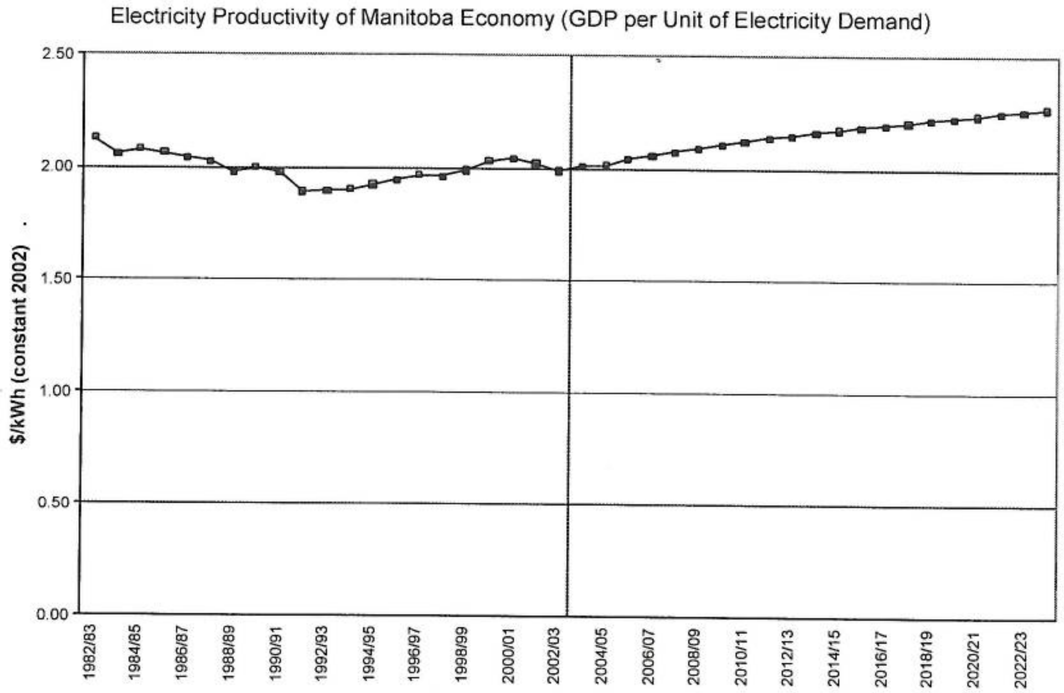
- the structure of the economy (some industries require much more electricity than others)
- production technology evolution, particularly in electricity intensive industries
- improvements in the efficiency of electricity using technologies, techniques, buildings, etc.
- changes in the mix of products within any particular industry or segment of the economy, especially those that change (usually increase) the ratio of value added to electricity input
- changes in electricity's share of the space and water heating market

During times when these factors are changing rapidly, models that attempt to predict the future on the basis of the past relationship between electricity demand and GDP are most likely to be in error.

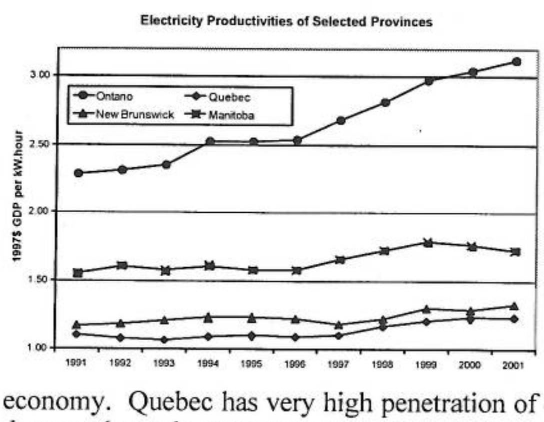
Utilizing the most recent Load Forecast (2003), combined with data from the Manitoba Hydro's Economic Outlook (2003), we have constructed a number of graphs that illustrate the historical and forecast relation of the following aggregate indicators:

- Total Electricity Sales per Capita
- Electricity Productivity of Manitoba Economy (2002$ of GDP/kW.hour)
- Manitoba GDP per Unit of General Service Electricity Demand (2002$ of GDP/kW.hour)
- Residential Electricity Sales per Standard (non-electric heat) Customer
- Residential Electricity Sales per Electric Heat Customer

Figure TREE/RCM - CNF2. 2

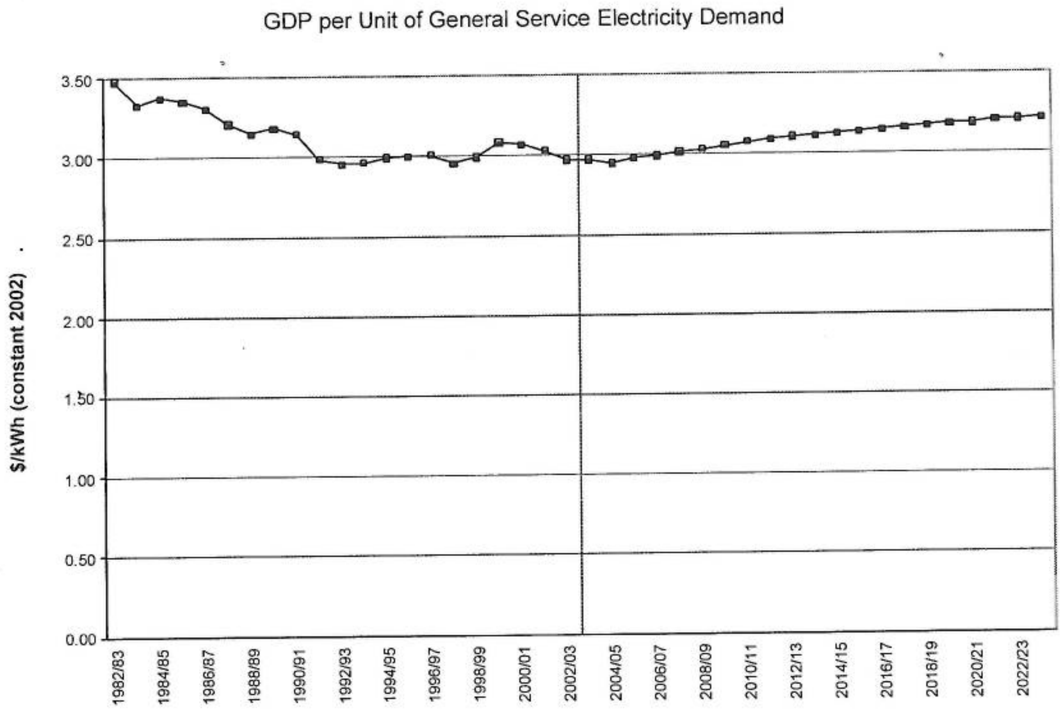


This indicator shows the variations in the overall electricity productivity of the Manitoba economy, as measured by dividing the provincial GDP by domestic consumption of electricity. The uptake of electric heating in the 1980's and growth in electricity industry in the 1980's is reflected in the declining electricity productivity in Manitoba during that time. As with other North American jurisdictions, electricity productivity has been increasing in the 1990's and in the 2003 Load Forecast it continues to improve at about the same rate as it did in the 1990's.



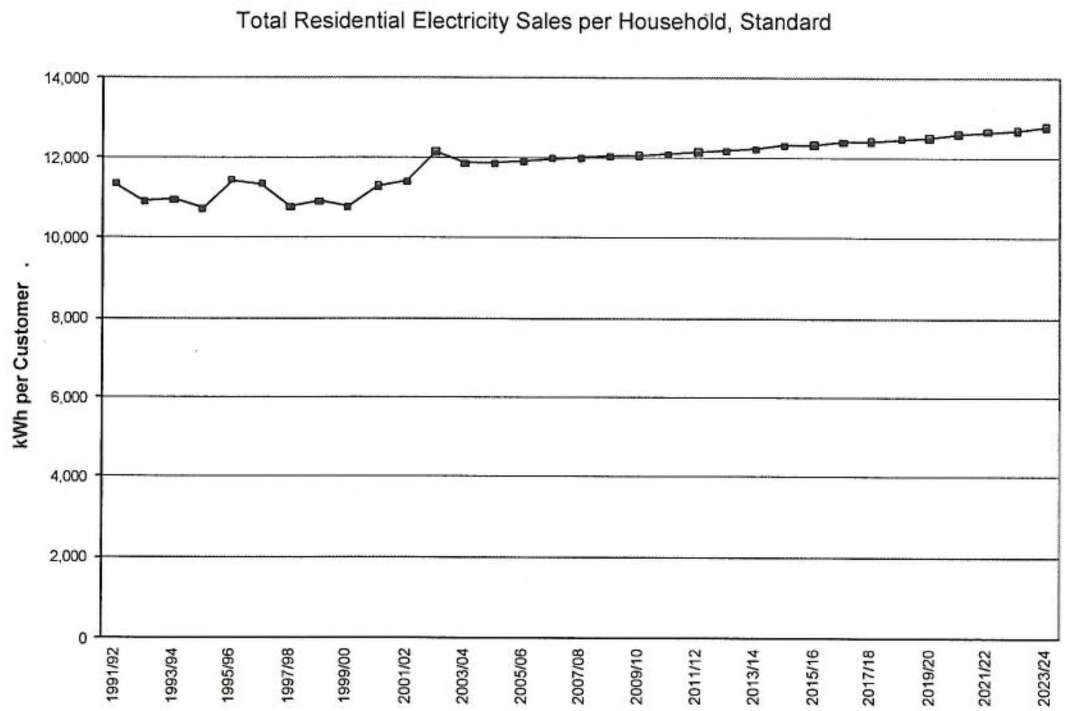
The chart on the left shows the same ratio as above (but in 1997$ per kW.hour rather than 2002$, and based on Statistics Canada final consumption data rather than utility data). As illustrated, Manitoba has an electricity productivity that is higher than Quebec and New Brunswick, but well below that of Ontario. Electricity productivity has also been increasing in Ontario at a faster pace than in other provinces, reflecting the relatively high growth rates of high value added businesses and services in the Ontario economy. Quebec has very high penetration of electric heating and although New Brunswick does not have the same access to cheap hydropower as does Quebec, their economy is very strongly based on energy intensive, primary resource industries, and electric heating is also widely used throughout New Brunswick.

Figure TREE/RCM - CNF2. 3



General Service electricity demand is comprised mainly of Manitoba Hydro's industrial and commercial and institutional customers, the non-residential load. The above chart shows the ratio of Manitoba Hydro's GDP to the historical and forecast electricity consumption of these customers. It is the electricity productivity of the Manitoba Hydro GDP when only the non-residential component of electricity demand is included. This indicator exhibits the same declining trend in the 1980's as did the previous indicator of overall electricity productivity, followed by a period of stability in the 1990's. Manitoba Hydro's 2003 Load Forecast predicts a gradual improvement in this indicator in the future, reflecting implicit assumptions that value added will be growing faster than electricity consumption in Manitoba's business economy.

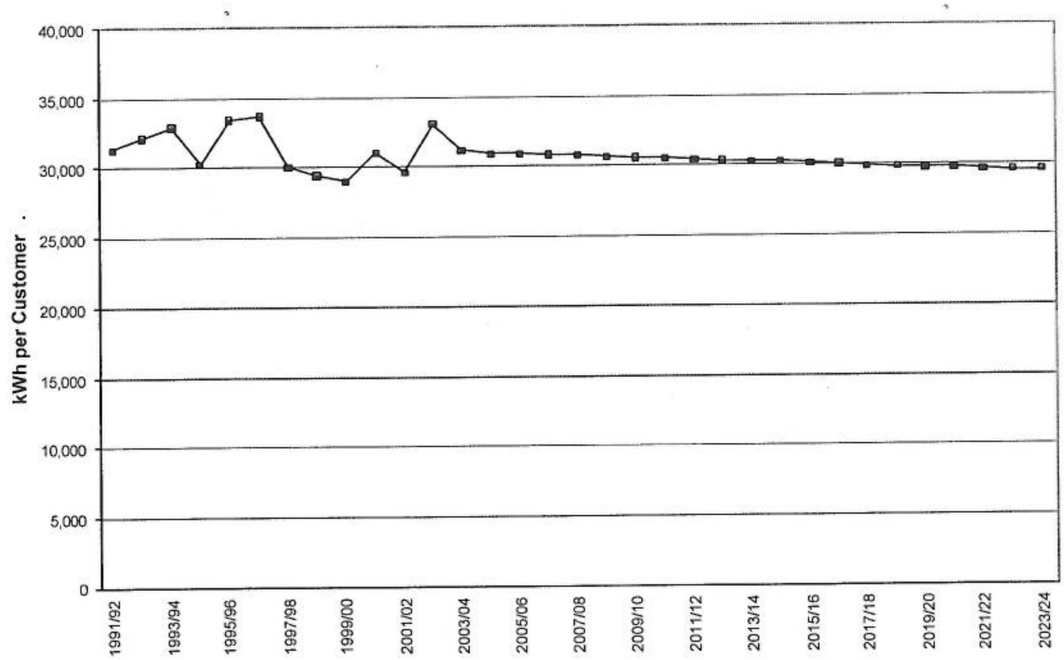
Figure TREE/RCM - CNF2. 4



This indicator isolates the electricity consumption of electricity by "standard" residential customers (those who are not equipped to heat their homes with electricity). The historical data for this (and the following) indicator were not available in a weather-corrected format, so the variation in the historical series is largely due to weather variations. The Manitoba Hydro 2003 Load Forecast predicts that increased uses for electricity in the home will outstrip efficiency improvements and that per household electricity consumption will increase throughout the entire forecast period.

Figure TREE/RCM - CNF2. 5

Total Residential Electricity Sales per Household, All Electric



This indicator isolates the electricity consumption per "electric" residential customer (those equipped to heat their homes with electricity). The average consumption per household is more than twice as high for this group as for the "standard" customers and, interestingly, the 2003 Load Forecast predicts that their average electricity consumption will *decline* over time, indicating that ongoing improvements in household energy efficiency (tertiary space heating requirements) will more than offset the increase in average plug load that is predicted for the standard (and presumably also the electric) customers.

CNF/RCM/TREE I NFAAT - 3

INTERROGATORY

3. In the TREE/RCM NFAAT TSA Submission, in response to Question 10, reference is made to the calibration of the Manitoba Hydro Load Forecast to an end use model. Please provide further explanation of the method employed, the results obtained, and how the results are relevant to the question of the need for and alternatives to Wuskwatim Advancement.

RESPONSE:

<u>Creation and Calibration of an End Use Model</u>

The general indicators discussed in CNF/RCM/TREE I NFAAT - -CNF 2 provide some "big picture" indications of the electricity future forecast by Manitoba Hydro, but the calibration of an end use model of electricity demand to the load forecast is a more effective method for doing a "reality" check on the levels of electricity demand predicted by the load forecast. End use models typically represent the demand for electricity as the product of an activity variable (e.g. a household of a particular type, industrial output for a particular industry, square metres of floor area for a particular type of building), a set of energy utilization indices (EUI) that characterize the electricity use per unit of activity for various end uses (e.g. kW.hour per square metres for office building lighting, etc.). Some models further disaggregate the EUI into an energy intensity, a saturation factor, and a market share for electricity. Synergistic effects between end uses (e.g. between electric lighting and building heat and air conditioning loads) are either modeled explicitly or captured by whole building or whole system simulations.

We used a two step method. First, we constructed a disaggregated end use model of electricity use in Manitoba in the base year 2002/03. Second, we calibrated this model to the Manitoba Hydro 2002 Load Forecast.[1] The first task is necessary to replace the macro-economic variables that underlie Manitoba Hydro's forecast model with the end-use activity variables that underlie an end-use model. The second task is necessary to ensure that our end use analysis and DSM potential analysis are consistent with the load forecast. This is similar to the method employed in the DSM Market Potential Study except that consultants did not tune their reference projections to the Load Forecast, with the result that the DSM Market Potential Study estimates of DSM potential are not consistent with Manitoba Hydro's load forecast.

We forced our model into agreement with the Load Forecast by using the 2003 Load Forecast relations between Winnipeg Hydro and Manitoba Hydro electricity demand to adjust the Residential and General Service categories in the 2002 Load Forecast. For example, by comparing both the historical and forecast electricity demand in the residential sector in the 2003 Load Forecast (which included the residential portion of the former Winnipeg Hydro demand)

[1] Although the 2003 Load Forecast was availablefor this exercise (and has the advantage of having the former Winnipeg Hydro demand folded into its Residential and General Service categories), the 2002 Load Forecast was chosen because it is the "forecast of reference" for most of the material that Manitoba Hydro has tabled in support of Wuskwatim Advancement, and because it is the forecast that was the reference point for the Manitoba Hydro DSM Market Potential studies which contain the best available sector, subsector and end use breakdowns of Manitoba electricity consumption. We calibrated only for the "bookend" years – 2002/3 and 2017/18.

with the residential portion of the 2002 Load Forecast (which did not include the Winnipeg Hydro demand), we were able to revise the 2002 Load Forecast residential sector demand numbers so that they included the residential portion of the Winnipeg Hydro demand.

For the residential and commercial sectors, our general approach was to adopt the MH DSM Market Potential Study subsector and end use definitions, activity levels, saturation factors and fuel shares. We also started with the DSM Market Study EUI's. In the case of the residential sector, we then made adjustments to the EUI's – very slight for the base year and somewhat larger but still small for 2017/18 – to "force" our results into agreement with the 2002 Load Forecast. This is what we mean by "calibration". In the case of the commercial sector, we reallocated the "Small Commercial" building floor area to the "medium" building categories (and renamed them "small and medium") and reallocated the "Other Commercial" sector in the DSM Market Potential Study to the "Other Institutional" segment so that our model represented all commercial electricity use and so that all commercial electricity was assigned to a particular building type.

For the industrial sector, DSM Market Potential Study was used for creating the end use profile of electricity use. However, in order to bring the 2002/03 calibration into line with the 2002 Load Forecast , the sum of the Commercial and Industrial sectors need to be about equal to the sum of the Top Consumers and Mass Market categories in the 2002 Load Forecast (as adjusted). Our assessment of the DSM Market Potential studies for the commercial and industrial sectors was that the adjustment should be made disproportionately to the industrial sector numbers in the reference projection in the DSM Market Potential study. (The DSM Market Potential Study for the Industrial Sector used output growth rates that were relatively high and not directly tied to the Manitoba Hydro Forecast and that resulted in industrial sector electricity use that is relatively high compared to the Load Forecast.) At the same time, the 2002/03 industrial sector electricity intensities were adjusted upward so that the calibrated model would yield a result in line with the General Service category in the Load Forecast.

The table on the following page compares the total sector electricity demand from the Manitoba Hydro DSM Market Potential Study, the 2002 Load Forecast (as adjusted), the 2003 Load Forecast, and the Torrie Smith (TSA) calibration to the 2002 Load Forecast. The TSA calibration lines up with the 2002 Load Forecast with respect to both absolute levels of demand and growth rates.

Table TREE/RCM - CNF3. 1

Comparison of DSM Potential Study Reference Projections, Manitoba Hydro Load Forecasts and TSA End Use Calibration

	2002/03	2007/08	2012/13	2017/18	15 year growth rate
A. DSM Market Potential Study Reference Projection					
1. Residential	6,199	6,309	6,410	6,553	0.4%
2. Commercial	4,814	5,208	5,638	6,107	1.6%
3. Industrial	7,200	8,703	9,603	10,157	2.3%
4. Commercial plus Industrial	12,014	13,911	15,241	16,264	2.0%
5. Total	18,213	20,220	21,651	22,817	1.5%
B. Manitoba Hydro 2002 Forecast (Adjusted)*					
1. Residential	6,101	6,287	6,463	6,654	0.6%
2. General Service	12,369	13,311	14,368	15,258	1.4%
3. Total	18,470	19,598	20,831	21,912	1.1%
C. Manitoba Hydro 2003 Forecast					
1. Residential	6,171	6,309	6,510	6,724	0.6%
2. General Service	12,796	14,117	14,939	15,865	1.5%
3. Total	18,857	20,426	21,449	22,589	1.2%
D. TSA Calibration					
1. Residential	6,100			6,650	0.6%
2. Commercial	4,800			5,679	1.1%
3. Industrial	7,550			9,500	1.5%
4. Commercial plus Industrial	12,350			15,179	1.4%
5. Total	18,450			21,829	1.1%

* The MH 2002 Forecast has been adjusted by allocating the Winnipeg Hydro consumption (net of distribution losses) to the residential and General Service categories. Theadjustment is based on the relation between Winnipeg Hydro and Manitoba Hydro data contained in the MH 2003 Forecast. Also, the entry for 2002/03 in the MH 2002 forecast is not an actual but a forecast.

There are two main reasons why this type of calibration is relevant to the question of the need for and alternatives to Wuskwatim Advancement.

First, it can shed light on unrealistic assumptions embedded in the load forecast, and the load forecast is one of the foundation documents in the case for advancing Wuskwatim and for the timing of its eventual domestic need date. If it requires unreasonable assumptions to "tune" an end use model to the Load Forecast, it indicates that aggregate and correlative methods used to produce the forecast need to be deconstructed and reconsidered.

Second, measures for efficiency improvements are assessed relative to the load forecast, and so the end use calibration of the load forecast is necessary to ensure that engineering estimates of DSM potential are neither double counted nor undercounted. As illustrated in the above table, the DSM Market Potential Study residential reference projection (line A.1) is in reasonable agreement with the 2002 Load Forecast residential numbers (line B.1), as adjusted to include

Winnipeg Hydro, although it starts a bit higher and ends a bit lower, reflecting a growth rate that is considerably lower than the forecast. With regard to the sum of the Commercial and Industrial sector reference projections in the Market Potential Study (line A.4), the 15 year growth rate of 2%/annum is much higher than the 2002 Load Forecast rate for General Service of 1.4%/annum (line B.2.) The 2.3%/annum growth in the industrial sector is particularly high relative to Manitoba Hydro, and reflects the lack of a rigorous or end use based method in the DSM Market Potential Study for producing the reference projection in this sector.

Comparison of TSA Model Calibration with DSM Market Potential Study Reference Projection

The TSA calibration for the residential sector (line D.1) is not very different from the DSM Market Potential Study reference projection for the residential sector (line A.1). We found the DSM Market Potential Study assumed values for the end use inputs to be reasonable, and made only slight adjustments to the EUI's so that our calibration would be in agreement with the Load Forecast (line B.1), as adjusted to include the former Winnipeg Hydro.

For the commercial sector, we found that the assumed values for EUI's, fuel shares, and saturation levels for new and existing buildings that were used in the DSM Market Potential Study were reasonable. With regard to activity levels (floor area), Manitoba Hydro does not have an estimate of floor area by building type for the province, and so base year floor areas in the Market Potential Study were derived by dividing Manitoba Hydro data on sales to different building types by the consultants' estimate of average EUI's by end use for those building types. This of course guarantees that the product of floor area and EUI will reproduce the sales data for the base year, and we adopted these floor areas in our base year calibration.

In the DSM Market Potential study, it is stated that the 2002 Load Forecast contains electricity growth in the commercial sector of 1.6% per year[2], and the consultants then used floor area in future years as the swing variable to "tune up" their model so that electricity consumption grows at 1.6% per year. Because there are some improvements in the EUI values in future years, this means that floor area growth rates are actually somewhat higher than 1.6% in the DSM Market Potential reference projection for the commercial sector.

The 1.6% growth rate in electricity presumed in the DSM Market Potential appears to be the overall forecast growth rate for the Mass Market portion of General Service demand in the Load Forecast, but that rate includes both commercial and industrial customers, including the Top Customers. In addition, the overall growth rate for General Service in the 2002 Load Forecast is only 1.6% per year, and given that the Top Customer category has historically grown much

[2] The 2002 Load Forecast does not contain a forecast of commercial electricity use, and we were unable to find the reference in the 2002 Load Forecast to the 1.6% per year forecast growth that was used to calibrate the consultants' reference projection for the commercial sector in the DSM Market Potential study. The forecast growth rate for the General Service category is about (just under) 1.6% per year for the 2002/03 period, but this incorporates commercial and industrial customers. Historically in Manitoba, the growth rate for electricity consumption by Top Customers has been much higher than for the Mass Market portion of the General Service demand (i.e. other industrial and commercial). In the 2002 forecast, a similar growth rate (about 1.6% per year) was forecast for both Top Customer and Mass Market (although slightly higher for the Top Customer category). In the 2003 Forecast, Manitoba Hydro forecasts the 15 year growth rate of the Top Customers will be 50% higher than for the Mass Market customers, and on overall growth rate for General Service of about 1.4% per year.

faster than the Mass Market category, and that in the most recent forecast Manitoba Hydro projects that this will continue to be the case, and that the overall growth rate for General Service demand will be less than 1.6% per year, the assumed growth rate for commercial electricity in the DSM Market Potential Study (line A.2) seems high.

But the key weakness with the method in the Commercial Sector DSM Market Potential study is that it lacks an independent projection for commercial building floor area. In general, economic output in the commercial sector grows faster than floor area, and in the context of historical growth in output of service sector industries the 1.6%-plus floor area growth rates in the DSM Market Potential study seem too high (even though without such high floor area growth rates the consultants would have fallen short of the load forecast for General Service electricity demand of 1.6% per year).[3]

With regard to the industrial sector, the DSM Market Potential Study reference projection reflects a fifteen year growth rate (2002/03 to 2017/18) for grid electricity consumption of 2.3% per year. This results in a combined growth rate for the commercial and industrial sectors in the DSM Market Potential Study of 2.0% per year (line A.4 in the table), as compared with the 2002 Load Forecast rate of 1.4% per year (line B.2 in the table). Industrial electricity consumption grows faster than output in the DSM Market Potential Study, which assumes that electricity productivity will deteriorate in every market segment of the Manitoba industrial economy. The resulting 2.3% per year growth in electricity consumption compares with the 1.9% GDP growth in Manitoba Hydro's 2002 Economic Outlook; in that context it implies at best constant industrial electricity productivity, with little or no shift to greater efficiency or to higher value added products or services in the Manitoba economy.

While Manitoba Hydro utilizes a fairly intensive, customer-specific process for forecasting the electricity demand from the all-important "Top Customer" category, it understandably only extends for a few years into the future (as far ahead as their Top Customers have plans for expansion or contraction) and isn't much use on the time scale of the Wuskwatim Advancement . In the 2002 Load Forecast, starting in 2006/07 the forecast method involves the simple assumption that there will be 60 million kilowatt-hours of new industrial demand that year, increasing to 90 million kilowatt-hours per year of new demand by 2012/13, and continuing to the end of the forecast period. This single, broad assumption accounts for two thirds of the proposed Wuskwatim dam output by the time of the forecast "domestic need date".

In the TSA model calibration, in order to keep electricity growth in line with the Load Forecast, industrial electricity demand in 2017/18 (line D.3 in the table) is held to 9,500 GW.hours, as compared with the 10,157 GW.hours in the DSM Market Potential reference projection for this sector (line A.3 in the table). Even at 9,500 GW.hours, we had to assume that there would be no improvement in the electrical productivity of Manitoba industry in the next fifteen years.

The Manitoba Hydro Load Forecast does not contain enough information on industrial electricity use to support a detailed "reality check" of the numbers it produces, and neither does the DSM Market Potential Study. It may be that industrial electricity productivity in Manitoba will

[3] Manitoba Hydro has not invested in measuring and tracking economic output and floor area growth by market segment in the commercial and institutional market that it serves, and this is a significant weakness it the utility's ability to analyze market trends and possibilities in this vitally important sector of the electricity market.

stagnate or even deteriorate (as projected in the DSM Market Potential Study), although this would run counter to recent and current trends in other jurisdictions, including other jurisdictions with hydro-based electricity systems. Perhaps the lure of cheap hydropower will continue to attract industries to Manitoba with relatively high electricity intensities (and relatively low employment intensities), but these are precisely the industries that are working hardest to find ways to increase value added relative to electricity consumption.

In the five years from 1996 to 2001, the electricity productivity of most industries in Canada improved, and the overall electricity productivity of industrial manufacturing GDP increased by 10.1% between 1996 and 2001. Further, some of the largest gains were in the electricity intensive industries that are such important players in the Manitoba economy, with GDP per kilowatt-hour up by 46% in metals smelting and refining, 39% in fertilizer and pesticide production, 34% in the machinery industries, and 20-33% in food and beverage industries.[4]

The importance to load forecasting of understanding electricity productivity trends and developments at the industry-specific level was underlined by a recent attempt to calibrate a detailed industrial end use model (ISTUM) to B.C. Hydro's forecast.[5] The ISTUM model, which represents industrial production processes at a detailed level and which also tracks the impact of natural capital stock turnover in at an industry-specific level, was used to develop a reference projection (i.e. no new DSM programs) of industrial electricity demand in B.C. Starting with projected activity levels provided by the B.C. Hydro load forecast department, the ISTUM simulation predicted a significantly lower demand for electricity (2,800 GW.hours or 13.5% lower after 15 years) than contained in the B.C. Hydro Load Forecast.

<u>Summary Conclusion</u>

Our overall conclusion from the calibration exercise is that the Manitoba Hydro Load Forecast cannot be represented in an end use model without assuming activity levels that are higher than the demographic and economic forecasts underlying the Load Forecast would suggest, and without assuming electricity efficiencies that are lower than recent trends would suggest. In other words, while it is true that the Manitoba Hydro Load Forecast is forecasting lower growth in electricity consumption than previous forecasts, the forecasting method is continuing its historical tendency to bias the results in the direction of higher electricity demand than the assumed growth in population and economic activity would likely require. As Manitoba Hydro's NFAAT case makes clear, the forecast growth in domestic demand is a foundation for their case that the Wuskwatim dam should be built before it is needed, but it is a shaky foundation for a billion dollar decision, and except for the residential sector the Load Forecast does not stand up well to end use analysis.

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[4] Electricity intensities and productivities based on industry-specific GDP and electricity consumption data from the NRCan Office of Energy Efficiency Comprehensive Energy Use Database, available online at http://oee.nrcan.gc.ca/Neud/dpa/trends_id_ca.cfm.

[5] Marbek Resource Consultants and Willis Energy Services, "BC Hydro Conservation Potential Review 2002: Industrial Sector Report (Base Year: Fiscal 2000/01)", prepared for B.C. Hydro, July 2003.

CNF/RCM/TREE I NFAAT - 4

INTERROGATORY

4. In the TREE/RCM NFAAT TSA Submission, in response to Question 11, there is reference to a "reference scenario of future electricity demand in Manitoba". Please provide additional details of this reference scenario and how and why it differs from Manitoba Hydro's Load Forecast.

RESPONSE:

In order to tune our end use model of Manitoba electricity use to Manitoba Hydro's Load Forecast, we found that we had to make assumptions that did not seem reasonable with respect to commercial sector floor area growth and with respect to industrial sector electricity productivity. These conclusions are described in response to CNF/RCM/TREE I NFAAT - -CNF3.

We therefore made two adjustments to our reference projection, both of which had the effect of lowering the projected future electricity demand from the levels contained in the 2002 Basic Load Forecast.

With regard to commercial and institutional sector floor areas and floor area growths, Manitoba Hydro does not have estimates of floor area in the province for different building types. The floor area numbers in the DSM Market Potential Study are in fact derived from Manitoba Hydro sales data and the estimates of electricity use per square metre for different building types. We have generally accepted these floor areas as a starting point, but the DSM Market Potential Study only models about 86% of commercial sector electricity use; the residual 14% is left in an "Other" sector which is not represented in the model. The TSA end use model calibration includes all commercial/institutional building energy use; this is why total floor area in 2002/03 in the TSA column is about 14.5% greater than the DSM Market Potential study.

In addition to including this additional floor area in the total, the TSA base year calibration reallocates the "Small Commercial" segment to particular building types. The resulting total commercial electricity use was about equal to the base year total in the DSM Market Potential study.

With regard to projected growth in the commercial sector, we adopted the EUI's in the DSM Market Potential Study reference case, as they seemed reasonable and are well supported by audit data. As discussed in CNF/RCM/TREE I NFAAT - -CNF3, however, the "floor area" growth rates in the DSM Market Potential study seem too high for the level of population and economic growth used for the 2002 Load Forecast. For example, in the DSM Market Potential Study, floor area in institutional sectors such as schools, universities, and hospitals grows several times faster than population and growth in retail and office building space grows nearly as fast as economic output in these segments, counter to historical trends and common sense. The consultants adopted these high growth rates so that the reference projection of electricity consumption would come up to 1.6% per year (the rate of growth of the General Service load in the 2002 Load Forecast), but the result is activity growth that is inconsistent with the low population growth and industry-led economic growth embedded in the Load Forecast.

We therefore adopted lower growth rates for the commercial/institutional building types, with some segments growing slightly faster than population (schools, universities, food retail, recreation), and with retail, offices and warehousing space growing at about half the rate projected in the DSM Market Potential Study, reflecting the continuing trend for output growth to outpace floor area growth in these segments. The floor areas we used are compared with the floor areas in the DSM Market Potential Study in the table below.

Table TREE/RCM - CNF4. 1

Commercial and Institutional Building Floor Area, DSM Market Potential Study Vs. TSA Reference Projection

	2002/03		2017/18		Percent Growth over Fifteen Years	
	DSM Study	**TSA Model**	**DSM Study**	**TSA Model**	**DSM Study**	**TSA Model**
Small and Medium Offices		3,443,426		4,198,183		22%
Medium Offices	891,119		1,158,820		30%	
Large Offices	2,063,452	2,056,574	2,723,173	2,507,350	32%	22%
Small and Medium Non-food Retail		2,987,593		3,442,835		15%
Medium Non-food Retail	975,288		1,280,801		31%	
Large Non-Food Retail	1,854,143	1,847,963	2,399,340	2,129,551	29%	15%
Food Retail	506,132	504,444	645,365	535,573	28%	6%
Medium Hotels/Motels	428,930	427,500	582,962	453,881	36%	6%
Large Hotels/Motels	508,547	506,852	704,843	538,129	39%	6%
Personal Care Homes	485,879	493,056	634,954	523,482	31%	6%
Health	1,040,412	1,036,944	1,294,349	1,100,934	24%	6%
Small and Medium Schools		2,748,889		2,918,521		6%
Medium Schools	1,582,404		2,119,268		34%	
Large Schools	588,722	586,759	769,344	622,968	31%	6%
Universities/Colleges	1,057,878	1,054,352	1,382,452	1,119,415	31%	6%
Franchise Restaurants	196,302	195,648	254,024	220,487	29%	13%
Warehouses	1,700,483	2,840,000	2,168,274	3,248,522	28%	14%
Recreation Facilities	812,802	1,280,000	1,067,415	1,379,434	31%	8%
Religious		410,000		435,301		6%
Large Urban Religious	180,509		229,037		27%	
Small Commercial	5,276,570		6,695,104		27%	
Other	Unspecified*	650000	Unspecified*	862,037		33%
Total/Average	**20,149,573**	**23,070,000**	**26,109,525**	**26,236,605**	**30%**	**14%**

* The DSM Market Potential Study only models about 86% of commercial sector electricity use; the residual 14% is left in an "Other" sector which is not represented in the model. The TSA end use model calibration includes all commercial/institutionalbuilding energy use; this is why total floor area in 2002/03 in the TSA column is about 14.5% greater than the DSM Market Potential Study.

The result of these revisions to the floor areas (while still adopting the EUI's used in the DSM Market Potential reference projection) is a decrease in annual electricity use in 2017/18 of225 GW.hours per year by 2017/18.

With regard to the industrial sector, we maintained the output growth rates assumed from the Load Forecast calibration, but increased the electricity productivity of industrial production by 0.9% per year over the 2002/03 to 2017/18 period. This results in a total electricity productivity improvement of 14.4% by 2017/18, compared to the 10% improvement in electricity productivity that took place in Canadian industry in only five years from 1996-2001. The impact of this change is to reduce electricity use in 2017/18 by 1,150 GW.hours relative to the load forecast calibration.

The resulting reference scenario for future electricity use in Manitoba is therefore 1,375 GW.hours below the 2002 Load Forecast by 2017/18.

It is important to note that this difference is distinct from the difference Manitoba Hydro projects by 2017/18 between its Basic Forecast and Medium Low Forecast (about 2,100 GW.hours by 2017/18). In the case of the adjustments we made, we did not change any of the assumptions or forecasts for population and economic growth that underlie the Load Forecast. Instead, we changed either the physical activity levels (in the case of the commercial sector) or the electricity productivities (in the case of the industrial sector) that correspond to the population and economic projections incorporated in Manitoba Hydro's 2002 Basic Load Forecast. In contract, the Medium High and Medium Low forecasts produced by Manitoba Hydro are based on changed assumptions about the underlying demographic and economic drivers of the econometric equations used to generate the forecast. Whereas the Medium Low and Medium High forecasts illustrate how the output of econometric equations changes under conditions of lower or higher economic growth, end use representations are useful for testing the "believability" of the econometric predictions in the real world of energy end uses.

The reference projection that we used as a baseline for DSM assessment is summarized in Table TREE/RCM CNF4.2.

While this exercise was necessarily restricted to a cursory end use audit of the Load Forecast, there are clear indications that the forecast is high relative to the level of demographic and economic growth being projected. Interestingly, the exception is the residential forecast, where Manitoba Hydro does employ end use modeling. For the commercial and industrial/agricultural sectors, however, end use modeling suggests that commercial sector floor area growth rates are too high and that industrial electricity productivity improvements are underestimated. Adjusting for these two factors reduces the projected electricity demand in 2017/18 by over 2,000 GW.hours.

Table TREE/RCM - CNF4. 2

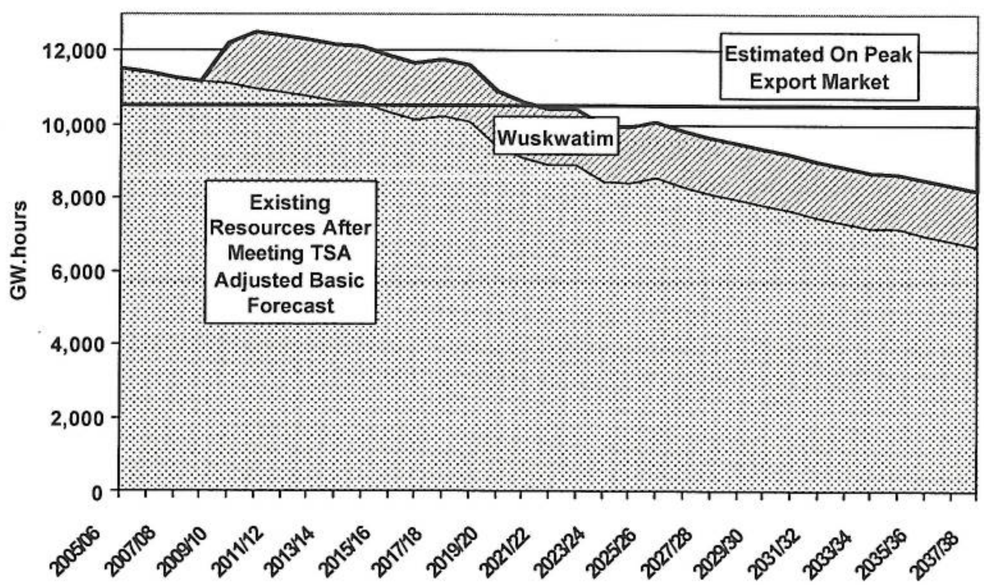
Summary of TSA Reference Projection

	Electricity Consumption			
	2002/03	2017/18		
		Existing	New	Total
RESIDENTIAL				
Pre-1986 SFD	3,530	3,272	404	3,676
1986-Present SFD	732	678	45	723
Northern SFD	378	353	46	398
Reserve SFD	379	362	3	365
Row/Duplex	360	346	31	377
Apartment	597	576	46	622
Mobile Home	209	198		198
TOTAL RESIDENTIAL	**6,185**	**5,785**	**576**	**6,360**
COMMERCIAL/INSTITUTIONAL				
Small & Medium Offices	550	523	118	642
Large Offices	441	423	83	506
Large Non-Food Retail	340	316	53	370
Small & Medium Non-Food Retail	556	518	77	595
Food Retail	266	257	17	273
Franchise Restaurants	130	123	15	138
Large Hotel/Motel	113	103	6	109
Medium Hotel/Motel	88	82	4	87
Large Schools	102	98	7	105
Small & Medium Schools	374	357	26	384
University/Colleges	166	158	9	167
Health	275	272	19	291
Recreation Facilities	382	367	28	394
Warehouses	333	333	45	378
Personal Care Homes	115	113	6	119
Religious Facilities	34	31	3	34
Other Institutions	117	111	-	111
Apartment Common Areas	402	349	80	429
TOTAL COMMERCIAL	**4,784**	**4,534**	**597**	**5,131**
INDUSTRIAL				
Primary Metals	2,084			2,309
Chemical Treatment	1,506			1,850
Petroleum	780			917
Pulp & Paper	786			924
Misc. Industrial/Mfg.	700			860
Food & Beverage	487			572
Mining	223			262
Hog Ag.	395			464
Other Ag.	154			181
TOTAL INDUSTRIAL/AGRICULTURE	**7,115**			**8,338**
TOTAL ELECTRICITY DEMAND	**18,084**			**19,830**

The figure below illustrates the effect these adjustments have on the "energy available for export". Our calibration and adjustment was done to the 2002 Load Forecast and does not reflect the higher than forecast actual demand that occurred in 2002/03. According to Manitoba Hydro, the actual, weather corrected demand in 2002/03 was 400 GW.hours higher than forecast in the 2002 Load Forecast.

Our scenario is also based on the population and economic growth reflected in the 2002 Load Forecast, and specifically the Base Forecast. We have not assumed lower population or economic growth in adjusting the scenario, only changes in the rate of floor area growth relative to economic growth and in the baseline electricity productivity of industry. It is interesting to note, however, that the effect of these adjustments results in a greater reduction in future electricity demand (relative to Manitoba Hydro's Base Forecast) than the population and economic assumptions that underlie the Medium Low Forecast. What our exercise shows is that there are quite plausible, reasonable, and even probable scenarios in which the forecast electricity demand will come out lower than the Base Forecast, without assuming lower population or economic growth.[6]

Wuskwatim Advancement with TSA Adjusted Basic Forecast



[6] Exhibit TREE/RCM 1001, tabled at the hearings on March 10, 2004 presented a figure similar to the one above that showed the impact on "energy available for export" of assuming the Medium Low Forecast. The data for the Medium Low forecast in that figure were taken from Table A.8 (Manitoba Hydro NFAAT Vol. 1 Attachment 3). However, it would appear that the there is systemic error in both Table A.7 (Dependable Energy Medium High variation) and Table A.8 (Dependable Energy Medium Low variation). The "2002 Base Load" row in these tables should be Gross Energy (Net Firm plus Station Service), but it appears that station service has been subtracted from rather than added to the forecast Net Firm energy, resulting in all the numbers for both the Medium Low and Medium High forecasts being too high, by about 400 GW.hours per year. We do not know if the error is restricted to these tables or affects other figures in Manitoba Hydro's evidence that portray results associcated with the Medium Low or Medium High forecasts.

CNF/RCM/TREE I NFAAT - 5

INTERROGATORY

5. In the TREE/RCM NFAAT TSA Submission, in response to Question 12, it is stated that "there are economic benefits associated with the DSM/DG resource that are not captured in the 6.15 cents/kW.hour evaluation" used by Manitoba Hydro as the cutoff for "economic" DSM/DG resources. Please identify these benefits.

RESPONSE:

In the DSM Market Potential Study, measures for using electricity more efficiently are evaluated using the "cost of conserved electricity" (CCE) method. In this technique, the (mostly capital) costs of the electricity saving measure are annualized over the life of the measure, and the annualized costs are then divided by the annual kW.hour of savings to obtain a "cost of conserved electricity" (CCE), expressed in cents per kilowatt-hour. In the DSM Market Potential Study, the primary CCE calculation was done using a 6.08% discount rate, intended to reflect the social opportunity cost of capital, or the pre-tax rate of return on public and private investments in the economy.

The 6.15 cents per kilowatt-hour threshold against which DSM CCE's are compared to determine whether they are "economic" is determined using a method described in CAC/MSOS/MH/NCN I – NFAAT – 115a. The DSM Market Potential Study was done using this single threshold value for DSM, with no differentiation according to the load shape of the saved electricity and with no dynamic analysis of how the value of saved electricity would change under different load forecast and DSM scenarios.

The method used for determining the cutoff for DSM resources will therefore underestimate the economic potential for DSM under circumstances where the saved electricity is worth more than 6.15 cents/kilowatt-hour and it will underestimate the economic potential to the extent that the CCE method fails to capture all the financial benefits of DSM.

The first point is a restatement of the fundamental weakness of Manitoba Hydro's case for Wuskwatim Advancement – the failure to present alternative scenarios, including least cost scenarios, for achieving the underlying purpose of the undertaking. As we have noted elsewhere, the central purpose of the undertaking is also not clearly stated in Manitoba Hydro's evidence, but it would appear to be the maximization of export revenues between now and 2020. In this regard, integrated scenario analysis showing different ways, including the least cost path, for combining supply and demand side resources would have been at the heart of the NFAAT case. With this approach, instead of a single, simple threshold for evaluating whether demand side resources are economic, there would have been an integrated analysis of the costs, benefits and risks of achieving the underlying purpose of the undertaking under different conditions with respect to export prices, domestic demand, and DSM program effectiveness. Such an analysis would attribute different values to different types of DSM measures, depending for example on whether they are discretionary or lost opportunity, peak or off-peak. Such analysis would also capture the benefits to Manitoba Hydro and its customers of strategies that can increase export revenue between now and 2010.

On the latter point, the CCE method is a very narrowly focused financial computation that assigns the costs (whether incremental or full) of a measure that reduces electricity use to kilowatt-hour reduction. In this regard it does not capture any of the benefits to the end user beyond the financial value of the kilowatt-hour savings, any of the system wide benefits of increased DSM (beyond those captured in the calculation of the 6.15 cents/kW.hour threshold), or any of the social and environmental benefits of DSM (including the benefits of the respending of savings on electricity bills).

Electricity efficiency improvements represent the ultimate distributed resource in the sense that they are by definition perfectly matched to the size, thermodynamic quality and timing of end use needs for services. While on the face of it, applying the CCE (cost of saved energy) methodology would appear to put demand side resources on an equal footing with power plants, there are a number of benefits of demand side resources that will not be adequately captured by this type of narrow, engineering assessment.

Lovins has catalogued over 200 types of "hidden" economic benefits of smaller, distributed generation, including DSM.[7] Here, taken directly from Lovins, are a few examples of the types of benefits delivered by DSM and distributed generation that are not adequately captured in simple computations of CCE for individual measures:

- ✓ Distributed resource's generally shorter construction period leaves less time for reality to diverge from expectations, thus reducing the probability and hence the financial risk of under or overbuilding.
- ✓ Distributed resources smaller unit size also reduces the consequences of such divergence and hence reduces its financial risk.
- ✓ The frequent correlation between distributed resources' shorter lead time and smaller unit size can create a multiplicative, not merely an additive, risk reduction. The more closely a resource approaches the ideal of "build as you need pay-as-you-go", the lower the financial risk.
- ✓ Forecasting errors will themselves be reduced through the use of shorter lead time resources, thus reducing the financial risk by reducing errors' amplification with the passage of time.
- ✓ Smaller, more modular capacity not only ties up less idle capital, but also does so for a shorter time because the demand can "grow into" the added capacity sooner, thus reducing the cost of capital per unit of revenue.
- ✓ The small scale and short lead times of distributed resources also make it easier to take ongoing advantage of any declining real costs that occur due to technological advances and reduced equipment production costs.

[7] Amory B. Lovins, Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size, Rocky Mountain Institue, 2002. Available from www.rmi.org.

- ✓ Shorter lead time and smaller size both reduce the accumulation of interest during construction – an important benefit in both accounting and cash flow terms.

- ✓ Where the multiplicative effect of faster and smaller units reduces financial risk and hence the cost of project capital the correlated effects – of that cheaper capital, less of it, and needing it over a shorter construction period – can be triply multiplicative. This can in turn improve the enterprise's financial performance, gaining it access to still cheaper capital. This is the opposite of the effect often observed with large-scale, long lead time projects, whose enhanced financial risk not only raises the cost of the project capital but may cause general deterioration of the developer's financial indicators raising its cost of capital and making it even less competitive.

- ✓ Shorter-lead time resources can also improve cash flow by starting to earn revenue sooner – through operational revenue-earning or regulatory rate-basing as soon as each module is built – rather than waiting for the entire total capacity to be completed.

- ✓ The high velocity of capital may permit self-financing of subsequent units from early operating revenues.

- ✓ Smaller plants with lower local impacts may qualify them for regulatory exemptions or streamlined approvals processes, further reducing construction time and hence financing costs.

- ✓ Where smaller plants' lower local impacts qualify them for regulatory exemptions or streamlined approvals processes, the risk of project failure and lost investment due to regulatory rejection or onerous conditions decreases, so investors may demand a smaller risk premium.

- ✓ Lessons learned during the rapid evolution can be applied incrementally and immediately in current production, not filed away for the net huge plant a decade or two later.

- ✓ Distributed resources move labour from field worksites, where productivity gains are sparse, to the factory where they are huge.

- ✓ Distributed resources' construction tends to be far simpler, not requiring an expensively scarce level of construction management talent.

- ✓ Faster construction means less workforce turnover, less retraining, and more craft and management continuity than would be possible on a decade-long project.

- ✓ Distributed resources exploit modern and agile manufacturing techniques, highly competitive innovation, standardized parts, and commonly available production equipment shared with many other industries. All of these tend to reduce costs and delays.

- ✓ Distributed resources allow capacity expansion decisions to become more routine and hence lower in transactions costs and overheads.
- ✓ Distributed resources typically do little or no damage to their sites, and hence minimize or avoid site remediation costs if redeployed, salvaged, or decommissioned.
- ✓ Efficiency and cogeneration can provide insurance against uncertainties in load growth because their output increases with electricity demand, providing extra capacity in exactly the conditions in which it is most valuable, both to the customer and to the electric service provider.
- ✓ When the real cost of distributed resources is declining (through ongoing R and D and growing volume of production), the small scale and short lead time of the resources makes it easier to take advantage of and scale economies.
- ✓ Distributed resources, and this is especially true of DSM, are typically sited at the downstream (customer) end of the traditional distribution system, where they can most directly improve the system's lowest load factors, worst losses, and highest marginal grid capital costs – thus creating the greatest value.
- ✓ Certain distributed generators' high technical availability is an inherent per-unit attribute – not achieved through the extra system costs of reserve margin, interconnection, dispersion, and unit and technological diversity required for less reliable central units to achieve the equivalent supply reliability.
- ✓ Demand side resources can largely or wholly avoid every category of grid costs on the margin by being already at or near the customer and hence requiring no further delivery.
- ✓ Demand side resources avoid the siting problems that can occur when building new transmission lines.
- ✓ Distributed resources allow for local control of generation, providing both economic development and political benefits.
- ✓ Certain distributed nonelectric supply-side resources such as daylighting and passive ventilation can valuably improve non-energy attributes (such as thermal, visual, and acoustic comfort), hence human and market performance.