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La Capra Associates

NEEDS FOR AND ALTERNATIVES TO (NFAT) REVIEW OF MANITOBA HYDRO'S PROPOSAL FOR THE KEEYASK AND CONAWAPA GENERATING STATIONS

Technical Appendix 1

Resource Planning

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This report contains information that has been deemed Commercially Sensitive Information and is, therefore, subject to a protective order.

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Technical Appendix 1: Resource Planning

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Acronyms

Technical Appendix 1

DSM	Demand Side Management
LCA	La Capra Associates
MH	Manitoba Hydro
NFAT	Needs For and Alternatives To
SOW	Scope of Work
US	United States

I. Introduction and Scope

A. Scope of Report

La Capra Associates (LCA) has prepared this Technical Appendix to address two elements of our Needs For and Alternatives To (NFAT) Scope of Work (SOW) and support other elements of our work that rely on the materials in this report. The two specific LCA SOW elements addressed here are:

Power Resource Planning and Economic Evaluation

1. *From a supply perspective, assess the extent to which the Plan addresses the reliability and security requirements of Manitoba's electricity supply; and*

7. *Incorporate exports (bilateral contracts and opportunity market pricing) into power resource planning.*[1]

The Manitoba Hydro (MH) NFAT is premised on a need for additional generation resources to serve Manitoba load. MH determined that need with an assessment of energy and capacity requirements in accordance with their resource planning criteria. MH applies its defined planning criteria to assess when new resources are needed, evaluates various alternative development plans that fulfill the need, and conducts economic and financial analyses to determine the preferred development plan. Export opportunities are considered in the criteria and in the economic analysis of the development plans.

The specific focus of this Technical Appendix is to review and critique MH's resource planning criteria and determination of need for energy and capacity resources. Technical Appendix 3: Alternative Resource Plans, reviews the evaluation of the alternative development plans.

[1] This report addresses the treatment of exports in the context of the planning criteria and resource needs assessment. La Capra Associates' Technical Appendices 3: Alternative Resource Plans, 6: Export Markets, and 7: Export Contracts, address other issues related to exports and their importance to the NFAT analysis.

B. La Capra Associates' Approach to Reviewing Manitoba Hydro's Resource Planning

Our approach to evaluating MH's resource planning criteria and assessment of resource needs included the following:

1) LCA reviewed materials relevant to this assessment, including:
   - The information contained in the NFAT submission pertaining to resource planning criteria and MH's assessment of need for capacity and energy;
   - Recent MH annual Power Resource Plans;
   - MH's responses to Information Requests and information provided to LCA in lieu of responses to IRs; and
   - Resource planning criteria information from other hydropower systems.
2) LCA held discussions with MH personnel to discuss planning criteria and needs assessment analysis.
3) LCA conducted independent analysis related to MH's needs assessment using data provided in the NFAT submission, particularly Appendix 4.2[2].

The following review and analysis is the product of this approach.

[2] All work papers created during this analysis will be provided separately.

II. Manitoba Hydro's Planning Criteria

This section of the report describes MH's planning criteria, compares the criteria to other utility practices, and provides LCA's assessment and critique of the appropriateness of the criteria.

A. Description of Planning Criteria

MH maintains generation planning criteria which provides the basis for determining when new resources are needed. The planning criteria define the parameters for the evaluation of resource need. The criteria are described in corporate policy P195 and MH currently maintains planning criteria for both capacity and energy requirements.[3]

MH's current planning criteria are reproduced below.

Capacity Criterion

MH will plan to carry a minimum reserve against breakdown of plant and increase in demand above forecast of 12% of the Manitoba forecast peak demand each year plus the reserve required by any export contract in effect at the time.[4]

Energy Criterion

The Corporation will plan to have adequate energy resources to supply the firm energy demand in the event that the lowest recorded coincident water supply conditions are repeated. Imports may be considered as dependable energy resources provided they utilize Firm Transmission Service and are sourced from either an Organized Power Market or a bilateral contract. The total quantity of energy considered as dependable energy from imports shall be limited to that which can be imported during the Off Peak Period, and shall not exceed the quantity of export contracts in effect at the time plus 10% of the Manitoba load.[5]

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[3] NFAT Submission, Appendix 4.1, p. 1.

[4] *Id.*

[5] *Id.*, p. 4.

B. History of Manitoba Hydro Planning Criteria

While MH has maintained planning criteria as far back as 1962, it first established planning criteria similar to their current form in 1977.[6] In 1977, MH completed planning analysis and created formal energy and capacity planning criteria. Since this initial establishment, MH's planning criteria requirements have evolved over time. In 1985, MH updated the criteria,[7] and most recently, MH completed a review of its generation planning criteria in July 2012 and made some significant modifications to the criteria as a result.[8] The report produced by the review was not completed, however, until September 2013.[9]

Capacity Criterion History

MH's capacity criterion has been largely unchanged since 1977, when it completed a comprehensive planning criteria review.[10] The 1977 report determined that MH should maintain a planning reserve margin of 12% of peak demand. Prior to this change, MH had a requirement for a capacity reserve margin of 12% of total installed capacity. As noted by MH's review, this change from a reserve criterion based on installed capacity to one based on peak demand is consistent with industry practices.[11]

Since 1977, the capacity criterion has remained unchanged aside from small wording changes during a criteria review in 1985.[12]

Energy Criterion History

MH's energy criterion has changed more significantly over time.

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[6] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, p. 7-8.

[7] *Id.*

[8] NFAT Submission, Appendix 4.1, pp. 4-5.

[9] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013.

[10] *Id.*, pp. 7-8.

[11] *Id.*, p. 7.

[12] *Id.*, p. 7-8.

As a result of the 1977 report, MH developed a standard energy criterion to fulfill system demand under the lowest coincident historic river flows. The 1977 criterion indicates that MH should meet Manitoba energy requirements using any combination of the following resources:

i. *The dependable energy generatable [sic] at all Manitoba Hydro facilities, plus;*

ii. *The thermal generation, plus;*

iii. *Any Firm Energy Purchases from out-of-province sources, plus;*

iv. *Any Non-Firm Energy Commitments from out-of-province sources provided the quantity does not exceed 10% of the annual energy demand.*[13]

The notable component of this 1977 criterion was that to meet the dependable energy requirements, MH could use all <u>firm</u> energy imports plus <u>non-firm</u> imports up to 10% of annual demand.

As a result of the 1985 review, the energy criterion was revised as follows:

> *The corporation will plan to have adequate energy resources to supply the firm (dependable) energy demand in the event that the lowest recorded coincident river flow conditions are repeated. Planning studies, to meet the firm energy demand, may include up to a maximum of 10% of the energy demand in Manitoba to be supplied from the energy reserves on interconnected utilities, provided an energy purchase contract is or will be in effect during the time being studied.*[14]

This 1985 version of the energy planning criterion limited the allowable imports for dependable energy requirements to 10% of demand in total, and only known imports with a purchase contract in place are considered.

The planning criteria review changed the energy criterion again in July 2012, the criterion used in the NFAT analysis.[15] The new criterion has additional conditions on

[13] *Id.*, p. 8.

[14] *Id.*

[15] NFAT Submission, Appendix 4.1, pp. 4-5.

the source and disposition of imports. Imports must utilize firm transmission service, and the total quantity cannot exceed the lesser of:

- 10% of Manitoba load plus export contracts in effect; or
- The total energy that can be imported during the off-peak period. [16]

The notable change in the first of these is that the requirement that any energy imports relied upon had previously been limited to contractual commitments for imports, a requirement that has been removed due to access to the MISO market. The second change caps the imports based on the ability to import across firm transmission ties during off peak hours. This piece of the criterion would adjust if and when transfer limits are increased due to the installation of new transmission to neighboring systems.

C. Comparison to Planning Criteria in other systems

As discussed in MH's recent planning criteria review, a survey of planning criteria in other North American systems demonstrates that MH's criteria are similar in some aspects, yet feature some significant differences.[17]

Comparison of capacity criteria

A review of capacity reserve margins in other systems demonstrates that MH's reserve margin is no more stringent than typical reserve margins, and at 12%, it is in fact lower than many other systems.

In Saskatchewan, SaskPower maintains a reserve margin of between 15-20%.[18] Systems dependent on primarily thermal generation (such as SaskPower) typically experience higher forced outage rates and therefore often must maintain higher reserve margins.

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[16] *Id.*, p. 4.

[17] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, Appendix D, pp. 39-40.

[18] Powering Saskatchewan's Future, SaskPower, May 2009.

In British Columbia, BC Hydro has an annual reserve margin of 14%.[19] The reserve margin for the Quebec balancing authority varies, with an 11.4% margin in 2014/15 and 12.2% in 2015/16.[20] These reserve margins are more typical of hydro-dependent systems.

In the United States (US), MISO reduced its reserve requirement to 14.2% for summer 2013 from 16.7% in summer 2012.[21,22] Summer 2012 reserve margins for other regions in the US varied by system and are depicted below in Figure 1-1 below (second number listed for each region is the target reserve margin).

[19] BC Hydro. Integrated Resource Plan. August 2013, p. 1-13. http://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/irp-chap-1-20130802.pdf

[20] NPCC 2011 Quebec Balancing Authority Area Comprehensive Review of Resource Adequacy, Hydro-Quebec Distribution, November 29, 2011.

[21] MISO 2013 Summer Resource Assessment, p. 1. https://www.misoenergy.org/Library/Repository/Study/Seasonal%20Assessments/2013%20Summer%20Resource%20Assessment.pdf

[22] MISO 2012 Summer Resource Assessment, p. 6. https://www.misoenergy.org/Library/Repository/Study/Seasonal%20Assessments/2012%20Summer%20Resource%20Assessment.pdf

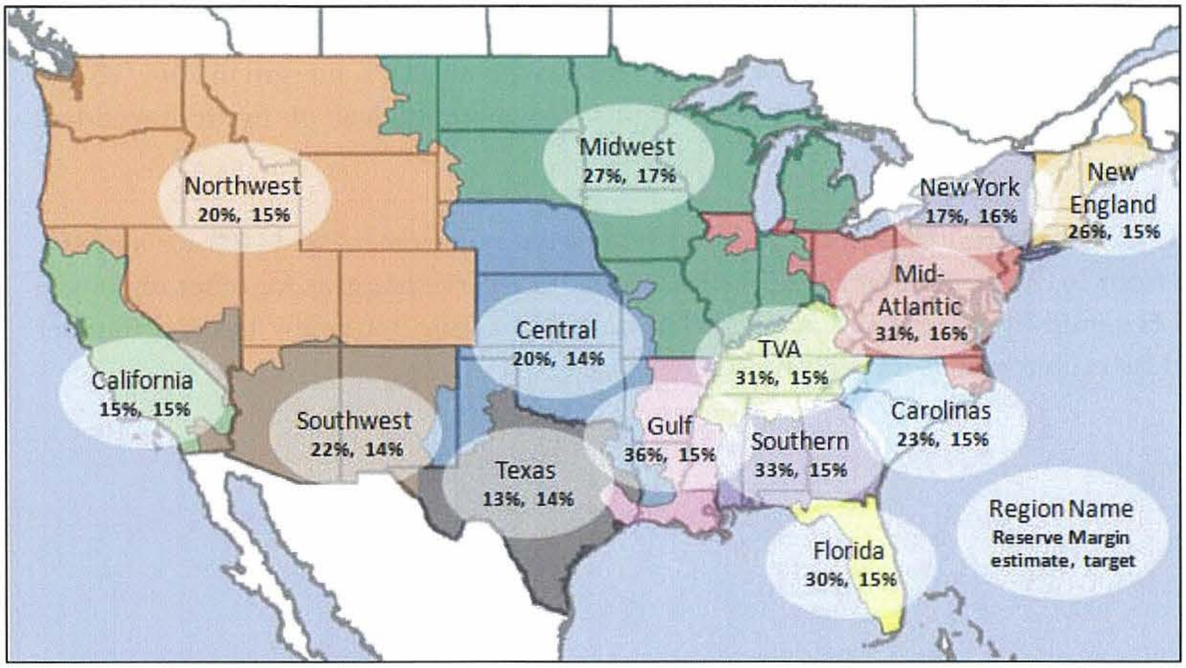

Figure 1-1: US regional reserve margin estimates and targets for summer 2012[23]

MH's approach to determining dependable energy requirements is largely similar to other hydro-dependent systems. Both BC Hydro and the United States Bonneville Power Administration in the Pacific Northwest are heavily dependent on hydro resources and both use the driest historical flow year to determine the minimum dependable energy available from its hydro generating units. BC Hydro's criterion requires "firm" energy, defined as "the ability to meet load requirements under the most adverse sequence of stream flows as experienced by BC Hydro's Heritage hydroelectric assets within the 60-year period between October 1940 and September 2000."[24] The Bonneville Power Administration in the US uses a similar standard of

[23] US Energy Information Administration, based on data from NERC's 2012 Summer Short-Term Reliability Assessment. http://www.eia.gov/todayinenergy/detail.cfm?id=6510. Note that this chart does not reflect the more recent reduction in the MISO target to 14.2% or other changes in the actual installed reserves or the targets that have occurred since 2012.

[24] BC Hydro. Integrated Resource Plan. August 2013, p. 1-10. http://www.bchydro.com/content/dam/BCHydro/customer-

planning for the driest year on record.[25]

Where the systems differ is in treatment of out-of-system resources. MH initially developed its planning criteria, in part, to answer the question "How dependent on out-of-province energy sources can we afford to become?"[26] MH's focus was on deciding the extent to which it would be dependent on imported energy to meet MH firm load. Thus, it was an effort to define how self-sufficient Manitoba's electric supply should be. BC Hydro also has a self-sufficiency component of its planning criteria. *The Clean Energy Act* requires BC Hydro to be self-sufficient in energy supply by 2016. Until 2012, self-sufficiency was defined in relation to the lowest flow year (i.e., BC Hydro needed to have domestic resources to meet load under extreme conditions). Self-sufficiency is now defined during average water conditions, a change which gives BC Hydro significant flexibility to utilize external resources.[27] This criterion is essentially a more codified version of the component of MH's planning criteria review that asked "How dependent on out-of-province energy sources can we afford to become?" This criterion is discussed in more detail below.

D. Critique of Planning Criteria

Capacity criterion

As discussed above, MH's 12% capacity reserve criterion is generally consistent with similar hydro-dependent systems and are somewhat lower than other nearby systems. In its recent review of planning criteria, MH concluded that it is prudent to continue utilizing this planning standard. The review did recommend, however, that in the

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portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/irp-chap-1-20130802.pdf

[25] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, p. 33

[26] *Id.*, p. 7.

[27] B.C. Hydro. Integrated Resource Plan. August 2013. Chapter 1. http://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/irp-chap-1-20130802.pdf

future MH should undertake additional probabilistic studies to determine the capacity reserve in accordance with current industry practices and NERC expectations.[28]

There is no available evidence upon which to conclude that MH's capacity reserve requirement should be any different than the current 12% standard. LCA believes this to be a reasonable assumption for the NFAT analysis.

<u>**Energy criterion**</u>

Regarding MH's energy criterion, the use of the historically lowest flow year to determine dependable energy is consistent with the practices of similarly hydro dependent systems. However, MH's other recent changes to the energy criterion have not been fully supported and have a quantifiable impact on the resulting year of need for new energy resources.

First, the limitation on import energy to 10% of Manitoba load plus export obligations is not fully justified in the NFAT or in MH's criteria review. It appears to be an approximate figure that was established in the 1977 criteria revisions in response to the specific question "How dependent on out-of-province energy sources can we afford to become?" In 1977, MH answered the question by limiting <u>non-firm</u> imports to no more than 10% of load. Over time, this standard was revised to make 10% the total limit, whether the imports were firm or non-firm.[29] However, the planning criterion review does not provide a specific analysis supporting MH's justification for the 10% limit included in this criterion.[30]

The second limitation restricts the amount of energy imports to be considered in meeting the dependable energy requirement to the amount that can be imported during the off-peak period. The basis for this limit is not described or supported with any

[28] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, p.22.

[29] *Id.*, pp. 7-8. See also Planning Criteria for Manitoba Hydro Firm Energy Supply. July 1977. (*SP-123 NFAT Confidential - Criteria Ref 4 Planning Criteria for Firm Energy Supply 1977.pdf*)

[30] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, p. 25.

analysis in the NFAT or in the 2013 criteria review. The only explanation of this limit appears in MH's response to an Information Request: "It is not appropriate to permit on-peak imports as an energy supply in the 2022-2025 period as MH has on-peak energy export obligations during this period."[31] Despite this explanation, MH's current planning criterion, as written in corporate policy P195, makes no distinction between periods when MH does or does not have on-peak export obligations.

Assuming the current thermal import limit of 700 MW, this off-peak criterion limits the import energy to no more than 3,068 GWh.[32] Without the limitation to off-peak hours, the import limitation using the 700 MW max would be 6,443 GWh.

Figure 1-2 below demonstrates the impact of the import limitations using 2013 assumptions of load and exports. The binding limitation is depicted by the dotted line.

[31] MIPUG/MH I-041d.

[32] This figure is derived by the following calculation: [700 MW] * [47.62% off-peak hours] * [365.25 days/year] * [24 hour/day] * [1 + 0.05% loss factor].

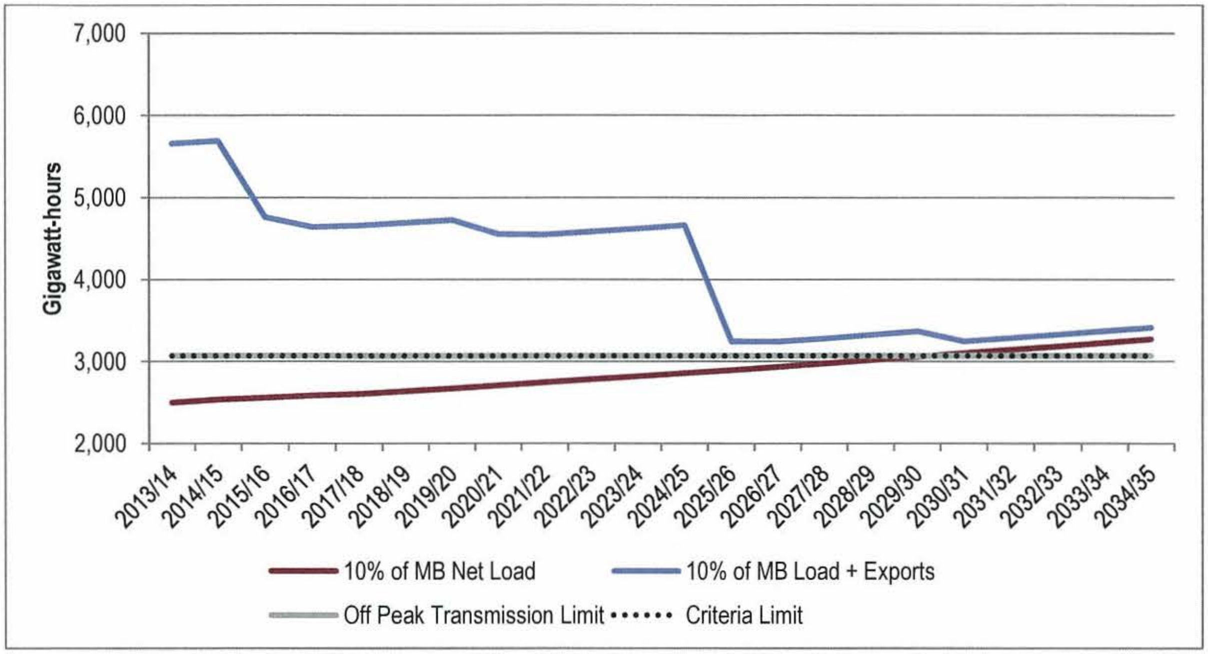

Figure 1-2: Import limit criterion (existing transmission case)

As demonstrated in the figure above, the binding export limitation is the limit defined by the amount of energy that can be imported during the off-peak period. The sum of exports plus 10% of MH's load will consistently exceed 3,068 GWh per year under the reference assumptions. If the import transmission capacity is increased, or if the limitation on imports to the off-peak period is relaxed, the binding limitation could change to the limit based on 10% of Manitoba load plus imports. Figure 1-3 below shows how the binding limitation changes assuming MH removes the off-peak limitation on imports.

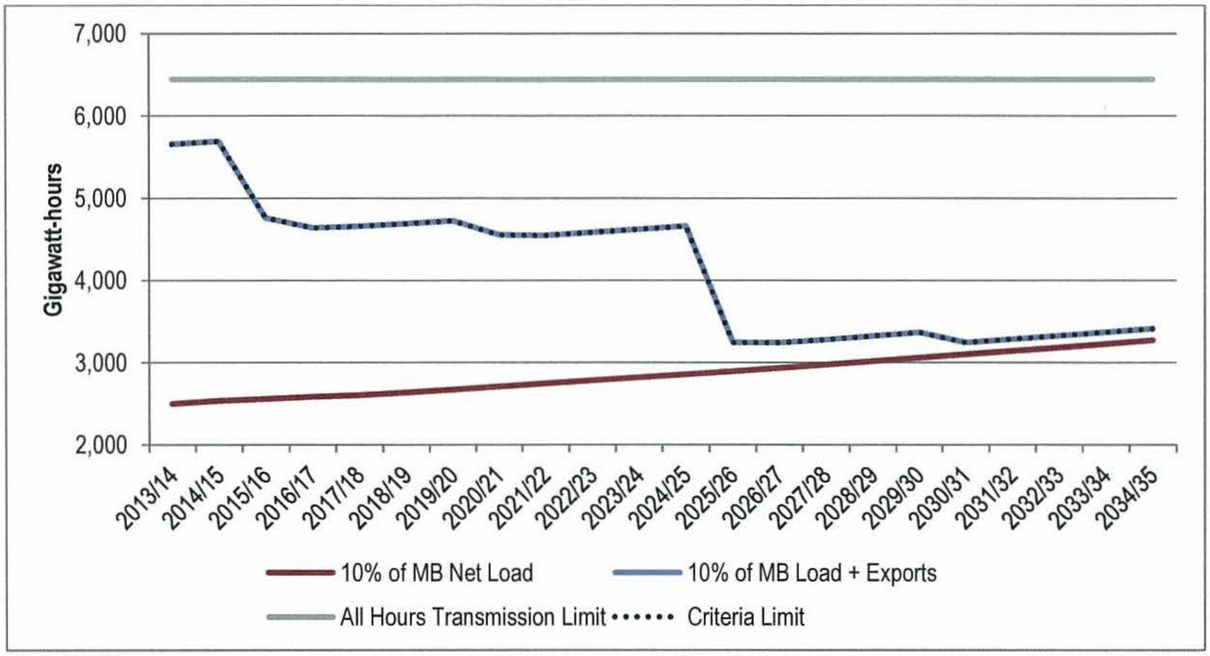

Figure 1-3: Import limit criterion without the off-peak only limitation (existing transmission case)

This figure demonstrates that if MH allows imports beyond just the energy that can be imported during the off-peak hours, the limit defined by 10% of Manitoba load plus exports could become the limiting criterion. In this case, the allowable exports would vary significantly depending on export contracts.

<u>Energy criterion ignores system changes</u>

MH's energy criterion has limited the dependence on imports in its energy planning criterion since 1977. While MH has modified the criteria over time in some aspects, the criterion still relies on this 10% limitation. The recent review of the planning criteria notes that this component of the criterion "is intended to be generally consistent with the 1977 Report that observed a break point on a flow duration curve for which imports above 10% of the Manitoba load required disproportionally more flow years in which imports would be required."[33]

The continuation of this 10% limit constrains imports to very conservative levels. This is particularly important in alternative development plans that do not add new transmission to expand transfer limits.

Manitoba's interconnections with other systems and markets are much different today than in 1977, yet the 10% limitation has not changed. The concern with reliability of supply and new generation developments is not as relevant in the current Manitoba system for three primary reasons: a) the expansion of transmission interconnections with neighboring systems, and b) the development of transmission open access, and c) the creation of MISO's Day 2 market.

Figure 1-4 below lists the interconnections with the US. While the transfer capability between the systems has expanded greatly over the past 40 years, MH's planning criterion has not adequately incorporated these changes.

Circuit Name	Voltage	Location	In Service Date
L20D	230kV	Letellier, Manitoba to Drayton/Grand Forks, North Dakota	1970
R50M	230kV	Winnipeg, Manitoba to Duluth, Minnesota	1976
D602F	500kV	Winnipeg, Manitoba to Minneapolis, Minnesota	1980
G82R	230kV	Glenboro, Manitoba to Rugby, North Dakota	2002

Figure 1-4: Manitoba Hydro interconnections with the US[34]

In addition to the increase in transfer capability, the development of open access transmission systems and the organized Day 2 MISO market in 2005 provided a new

[33] Attachment to CAC/MH I-051. Review of Generation Planning Criteria. Manitoba Hydro Resource Planning & Market Analysis Department, Power Planning Division. September 12, 2013, p.25.

[34] NFAT Submission, Chapter 5, Table 5.6, p. 16.

resource available to Manitoba. MH now has access to a liquid market that substantially enhances MH's ability to make non-firm energy purchases from a broad market.[35]

Despite the changes in markets and interconnections over the past 40 years and the evolution of the system into a more fluid and open system, MH's planning criteria have become progressively more restrictive in its treatment of imports from neighboring systems.

Treatment of exports in energy criterion

There is a discrepancy in MH's treatment of exports in the context of its exclusion of on-peak imports in the second limitation criterion. In the first limitation on imports, exports are essentially netted out of MH's energy requirements prior to applying the 10% import limitation since it is defined as "*the quantity of export contracts in effect at the time plus 10% of the Manitoba load.*" This criterion effectively allows for export loads to be met with purchases in the export market (and therefore not actually being a physical import of power to MH, but financial imports) and allowing the 10% to be imported for domestic load. However, the limitation on imports during the on-peak period in the second provision of the criterion ignores this option. The only justification MH provides for limiting imports to energy that can be imported during the off-peak period is that it would be inappropriate to permit on-peak import energy as a resource because it has on-peak export obligations during the 2022-2025 time period.[36] As in the first provision of the criterion, imports during on-peak could be either physical or financial. The second provision is a reduction in the reliance on import energy in the dependable energy criterion that is unsubstantiated and not reflective of changes in the system since first established.

Self-sufficiency criterion

MH's limitation on imports is in part a result of the desire for self-sufficiency and to limit the dependence on out-of-province resources. The criterion developed in

[35] For more on the history of transmission open access and details of the MISO market and the export opportunities it provides, see Technical Appendix 6: Export Markets.

[36] MIPUG/MH I-041d.

furtherance of this goal can be contrasted with BC Hydro's similar goal and its target of energy self-sufficiency during average water conditions.

The difference between the two utilities' approaches becomes clear when examining the drastic difference between the average generation from the hydro facilities and the generation that can be relied on for dependable energy purposes (i.e., generation given the historic minimum flow). MH provided the following figure in the NFAT:

Flow Condition	Energy (GWh)
Dependable	22,420
Average	31,110
Maximum	37,492

Figure 1-5: Energy produced under flow conditions[37]

These data demonstrate that, due to the high hydro capacity and wide variability in water conditions, on an average flow year nearly one-third of MH's generation is excess above dependable energy need. BC Hydro's self-sufficiency standard requires it to have domestic resources to fulfill load during an average flow year. The Figure above demonstrates the significance of that standard versus one based on a minimum flow condition.

[37] NFAT Submission, Chapter 5, Table 5.10, p. 30.

E. Summary on Planning Criteria

As part of the NFAT submission and subsequent information disclosures, MH has provided significant detail on the history and current status of its energy planning criterion. LCA has reviewed the information provided and we find that in some respects MH's planning criteria are reasonable and consistent with industry practice, but in others MH is overly conservative. Specifically we find that:

- MH's capacity reserve criterion includes a planning margin that is similar to other similar hydro-dependent systems.
- MH's energy criterion requires dependable resources to be available in the event of a repeat of the driest flow conditions, which is generally consistent with other hydro-dependent systems.
- The limitation on imports to 10% of Manitoba load plus export obligations has not been supported by any analysis. This threshold does not appropriately incorporate changes in the transmission system or markets since the policy was first established in 1977.
- Limiting amount of dependable energy to the quantity that can be imported during the off-peak period similarly is not supported by any analysis and is very conservative.

III. Manitoba Hydro Resource Need Analysis

MH's resource need analysis applies the planning criteria reviewed in Section II to compare the forecasted demand for capacity and energy with available corresponding resources to determine the timing of need for new resources.

This process is completed as part of the annual Power Resource Plan and is the foundation of the NFAT.

The following sections detail and critique MH's processes for determining the forecasted supply of and demand for capacity and energy, and consequently the year of need for new resources.

A. Capacity need analysis

As with all utility systems, MH must plan its system to meet instantaneous load at its peak. Peak demand is defined as "the maximum average hourly load, measured in MW, in Manitoba to be served by MH's system."[38] MH experiences peak demand during the winter heating season. The need analysis compares the future forecast of this peak demand with the various capacity resources available to MH.

The following figure compares MH's capacity supply with forecasted demand associated with domestic load and firm export commitments. These values are the results of MH's analysis and support its claim, based on the 2012 analysis, that there will be a "winter peak capacity surplus until the year 2025/26 at which time there will no longer be sufficient capacity…"[39] For comparison, both the 2012 and 2013 peak demand forecasts are included.[40]

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[38] NFAT Submission, Chapter 4, p. 5.

[39] *Id.*, p. 46.

[40] Manitoba Hydro's capacity supply forecasts varied slightly between the 2012 and 2013 estimates, primarily due to the timing of import contract expiration. For the purposes of this analysis we have used the more current 2013 figures.

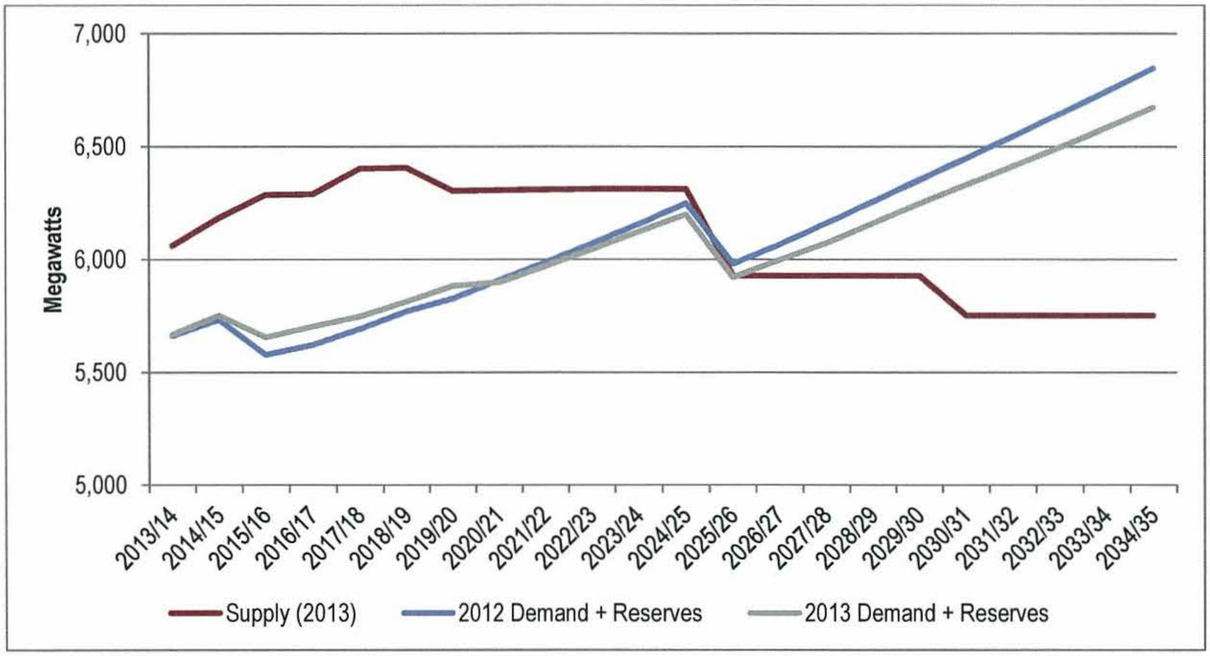

Figure 1-6: Existing Capacity Supply vs. Demand[41]

This figure demonstrates that the demand exceeds existing supply in 2025/26 using the 2012 load forecast and 2026/27 using the 2013 load forecast. The following section details the calculation of these components.

Determination of capacity demand

The capacity demand consists of three components: MH load, plus existing and proposed export contracts, reduced by the forecasted savings from Demand Side Management (DSM). The net peak demand represents the highest annual system load.

Load forecast

MH forecasts its weather-adjusted peak load on an annual basis for its service area. The service area is primarily Manitoba's domestic load, but also includes a small amount of load from one resale customer in Saskatchewan and one in Minnesota.[42]

[41] NFAT Submission, Appendix 4.2.

[42] NFAT Submission, Appendix D, 2013 Electric Load Forecast, Manitoba Hydro, June 2013, p. 1.

The load forecasting process incorporates forecasts of population (customer) growth, economic changes, weather, and other criteria that impact electricity usage such as increased use of electric heat.[43] The load forecast represents MH's best estimate of weather-adjusted future demand, with the expectation that there will be a 50% chance the actual demand will be higher and a 50% chance it will be lower.[44]

Manitoba peak demand has grown at an average annual growth rate of 1.4% from 2001/02 through 2011/12. In the 2012 analysis, MH assumed a 20 year average annual growth rate of 1.6%.[45] In the 2013 updated load forecast MH assumes a 20-year growth rate of 1.5%.[46]

In addition to the reference forecast, MH also evaluates the uncertainty in long-term forecasting based on potential variability in factors such as weather and economic indicators. In the 2013 forecast, MH found that the standard deviation of annual energy or peak demand due to weather changes is approximately 2% of load. During the resource planning process, however, MH uses weather-adjusted load so this sensitivity was not tested for planning purposes.[47]

The reference forecast's sensitivity to economic uncertainty, however, is reviewed by MH as part of the planning process. MH uses its uncertainty analysis to prepare 90th percentile and 10th percentile load forecast bands. Figure 1-7 below depicts the long-term load sensitivity cases.[48]

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[43] NFAT Submission, Chapter 4, pp. 5-15.

[44] *Id.*, p. 16.

[45] *Id.*, pp. 7-8.

[46] NFAT Submission, Appendix D. 2013 Electric Load Forecast. Manitoba Hydro. June 2013, p. i.

[47] *Id.*, p. 43-46.

[48] The figure depicts the sensitivity cases for the 2012 load forecast. Manitoba Hydro also prepared a sensitivity analysis in its 2013 load forecast, but only projected the values through 2032/33. Therefore the 2012 analysis is included in the graphic.

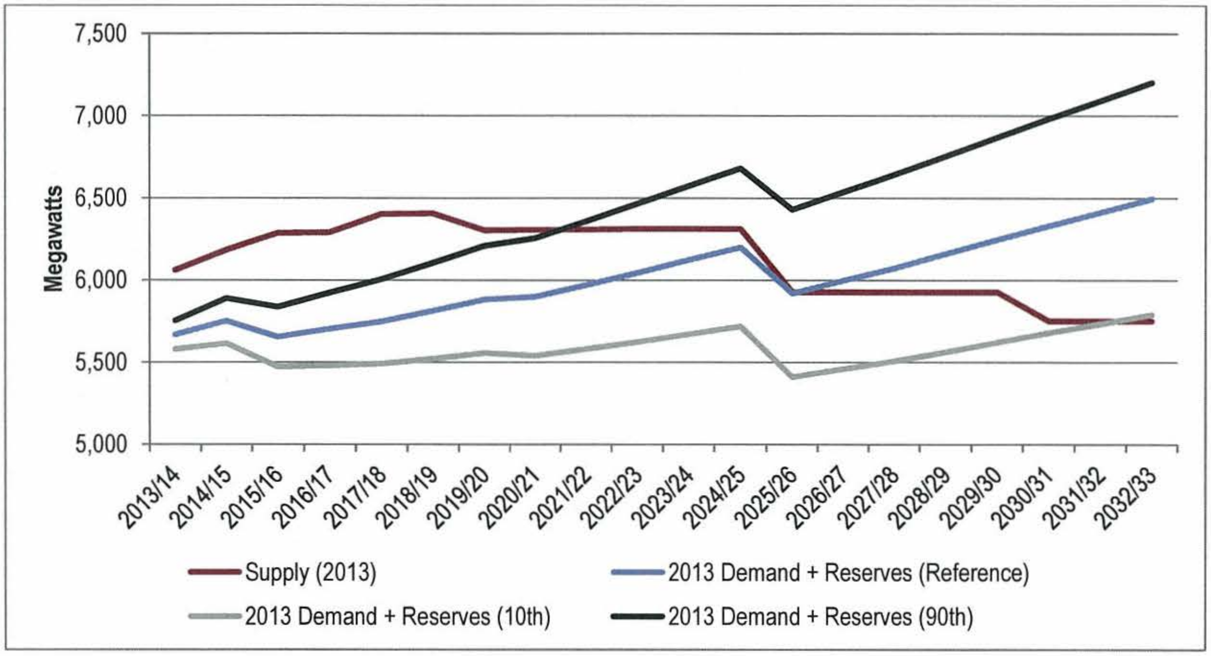

Figure 1-7: Existing Capacity Supply vs. Demand Sensitivities[49]

Keeping all other assumptions the same, under the lower 10th percentile forecast the year of capacity resource need is extended from 2026/27 in the reference case to 2032/2033. Conversely, under the higher 90th percentile load forecast the year of need is 2021/22.

Contracted Exports

The second component of the total system demand is capacity required by export contracts. MH currently has several executed export contracts that are in effect, or will be taking effect over the next few years. Figure 1-8 below provides the details of existing or executed export contracts included in the 2012 planning assumptions.

[49] NFAT Submission, Appendix 4.2.

Customer	Contract Name	Capacity (MW)	Type	Term	Status
Great River Energy	GRE 150 SD	150	Seasonal Diversity	5/1995 – 10/2014	Existing
	GRE 200 SD	200	Seasonal Diversity	11/2014 – 4/2025	Term Sheet
Minnesota Municipal Power Agency	MMPA 30	30	System Participation	5/2000 – 4/2012	Existing
Minnesota Power	MP 50	50	System Participation	5/2009 – 4/2015	Existing
Northern States Power	NSP 150 SD	150	Seasonal Diversity	5/1995 – 4/2015	Existing
	NSP 200 SD	200	Seasonal Diversity	11/1996 – 4/2015	Existing
	NSP 350 SD	350	Seasonal Diversity	5/2015 – 4/2025	Signed
	NSP 500	500	System Participation	5/2005 – 4/2015	Existing
	NSP 375	375/325	System Participation	5/2015 – 4/2025	Signed
Ontario Power Generation	Lake St. Joseph Agreement	0	Energy Only	Indefinite	Existing
Southern Minnesota Municipal Power Agency	SMMPA 30	30	System Participation (Apr. - Nov.)	4/2008 – 3/2013	Existing
Wisconsin Public Service	WPS 100	0	Energy Only	6/2009 – 5/2012	Signed

Figure 1-8: Manitoba Hydro long-term export contracts[50]

In addition to the contracts in the Figure above, MH has extended the 50 MW contract with Minnesota Power an additional five years and extended the expiration of the Great River Energy Agreement from 2025/26 until 2030/31. These changes are assumed in the 2013 updated analysis.[51]

[50] NFAT Submission, Appendix 9.3, Table 1.4, p. 16. This list does not include the export contracts contingent on new hydro or transmission development. For more on export contracts, see Technical Appendix 7: Export Contracts.

[51] NFAT Submission, Chapter 12, p. 8.

Not all of MH's export contracts must be incorporated into the peak demand calculated for planning purposes. Only contracts which commit exports during Manitoba's winter peak demand period need to be included. These contracts are identified as "System Participation" contracts. The "Energy Only" contracts do not have a corresponding capacity component, and the "Seasonal Diversity" contracts contain capacity commitments only during MISO's summer peak period.[52]

Figure 1-9 below provides MH's 2012 and 2013 assumptions of total export contact capacity obligations during the winter peak.

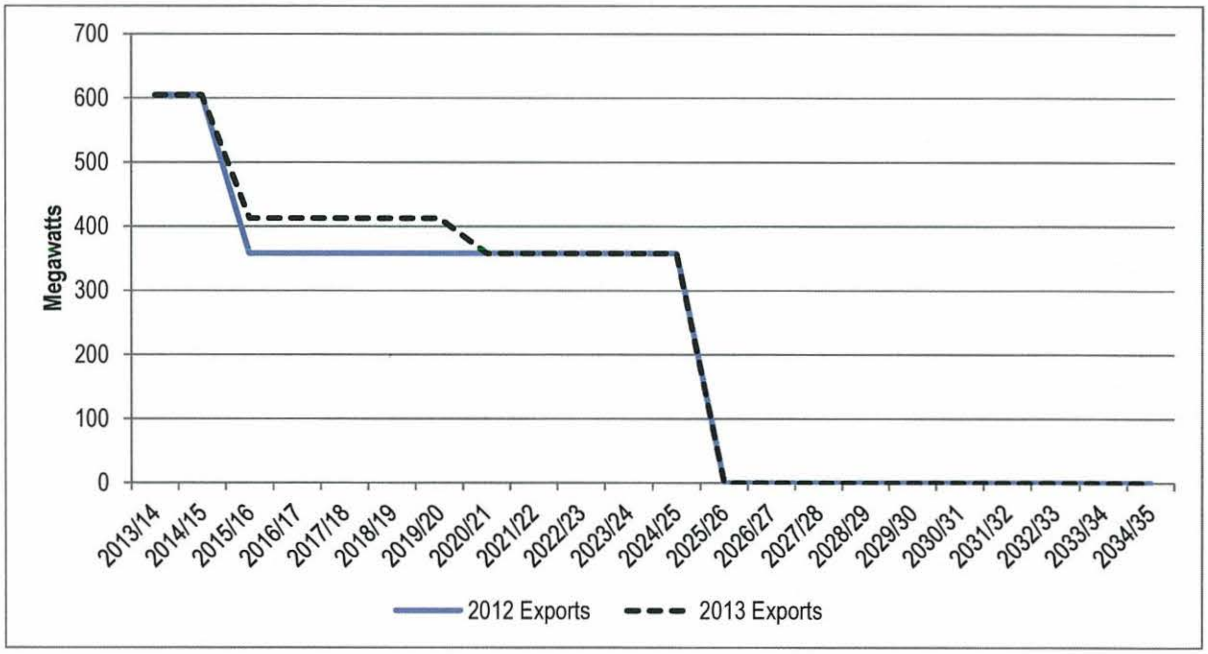

Figure 1-9: Winter peak export obligations[53]

MH has not assumed that these export contracts will be extended. As a consequence, as the contracts expire, the export obligations are eliminated. This impacts the total system

[52] NFAT Submission, Chapter 4, p. 34.

[53] NFAT Submission, Appendix 4.2.

demand, and the effect of the contract expirations is visible as the dips in the demand lines in Figure 1-6 above.

Demand-Side Management

For planning purposes, the total demand from MH load plus the contracted exports is reduced by the available and forecasted DSM resources. MH's DSM initiatives are detailed in its 2013-2016 Power Smart Plan. The Base DSM forecast resulting from this plan is included in the resource needs analysis to offset demand.

The 2012 NFAT analysis included a DSM-related reduction in load based on an update to the 2011 Power Smart Plan.[54] Between the 2012 NFAT analysis and the 2013 update, MH completed a new DSM forecast and engaged a consultant to complete a long-term DSM potential study.[55] The study, completed in July 2013, evaluated the different types of potential for additional DSM resource development, including "market potential" and "achievable potential." The report defines market potential as:

> *[The] theoretical maximum threshold for the EE savings that are available in the market but does not take into account the wide range of more specific market barriers that will prevent a willing customer from pursuing the EE option (e.g., even in the presence of a program, the customer does not currently prioritize EE and will not participate).*[56]

As a subset of market potential, "[a]chievable potential recognizes that market conditions are not ideal and reflects expected program participation given significant barriers to customer acceptance, and non-ideal implementation conditions such as lack of availability and imperfect marketing."[57]

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[54] NFAT Submission, Chapter 4, p. 19.

[55] NFAT Submission, Chapter 7, p. 21.

[56] NFAT Submission, Appendix 4.3, Demand Side Management Potential Study, EnerNOC Utility Solutions Consulting, July 2013, pp. 1-1 – 1-2.

[57] *Id.*

The DSM potential study found that the 15-year market potential for DSM in Manitoba is approximately four times the amount assumed in the 2013 analysis. The achievable potential is approximately one and a half times MH's assumptions.[58]

MH provided analysis testing the sensitivity of the needs analysis utilizing the higher DSM penetrations. Figure 1-10 below provides the various DSM assumptions utilized or tested by MH. These data demonstrate that between 2012 and 2013 the base DSM forecast decreased slightly, but based on the results of the external DSM potential study; there is significant additional potential for development.

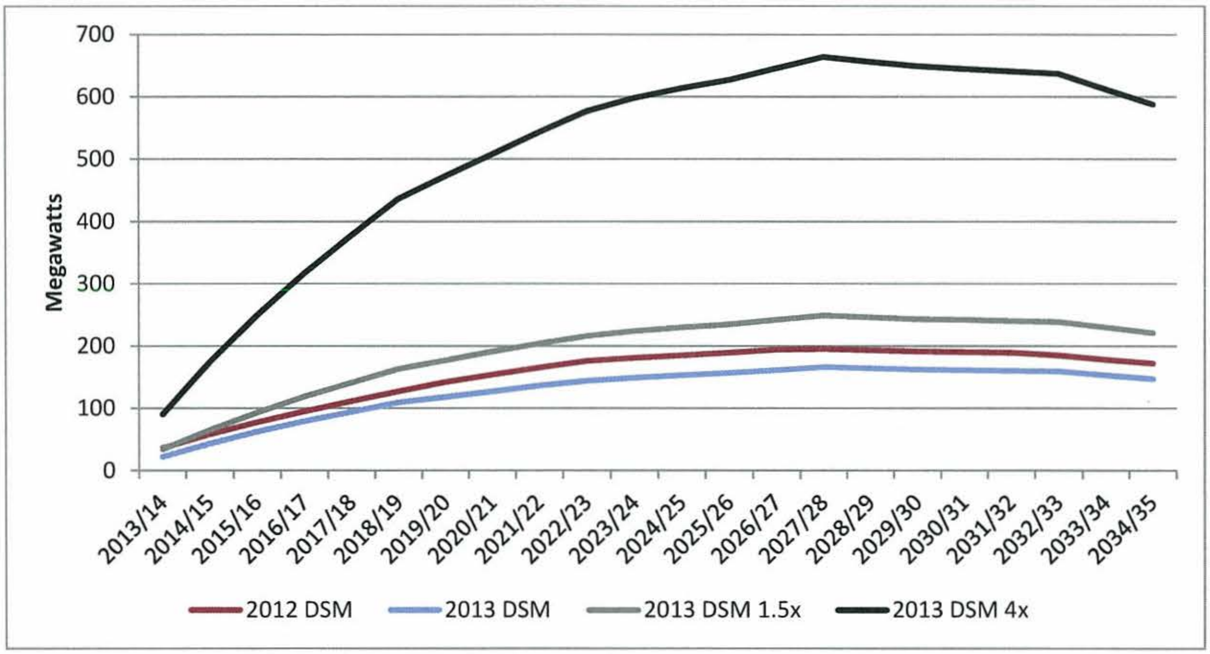

Figure 1-10: Manitoba Hydro DSM potential (MW)[59]

If these alternate DSM assumptions are applied to the overall supply-demand balance depicted in Figure 1-6 above, the year of need for new resources changes significantly.

[58] NFAT Submission, Chapter 7, pp. 21-22.

[59] NFAT Submission, Appendix 4.2.

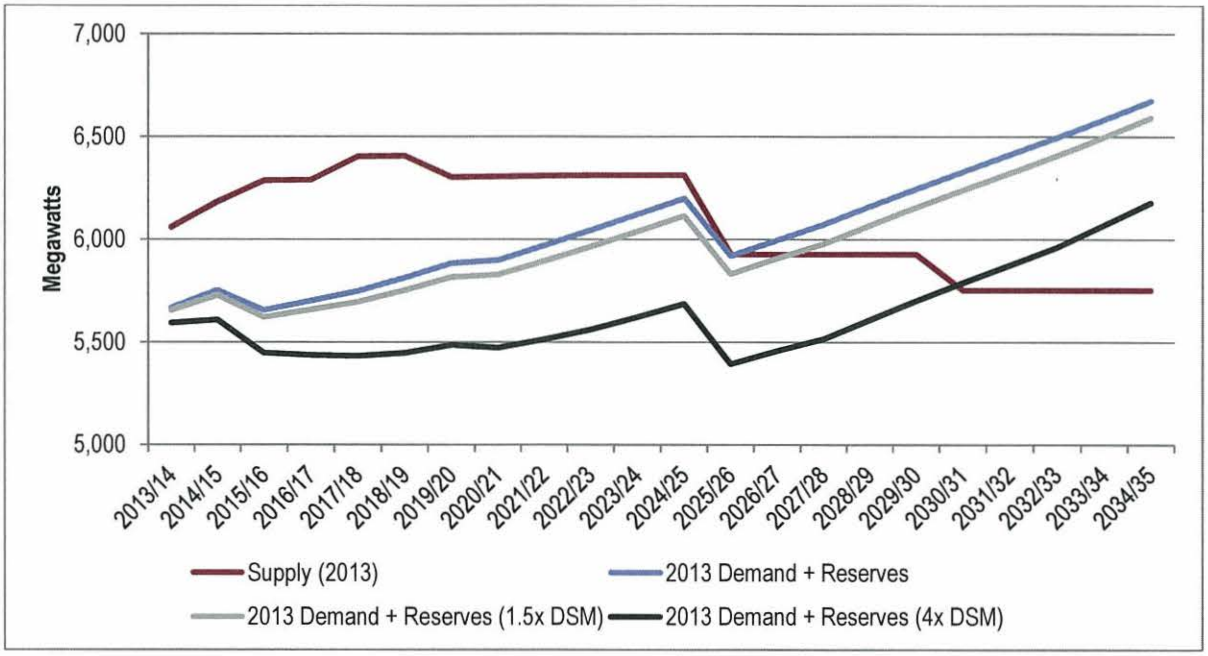

Figure 1-11: Capacity supply-demand balance with 2013 DSM sensitivities[60]

This figure demonstrates that additional DSM can significantly delay the year of need for capacity, keeping all other assumptions constant. Adopting the achievable potential assumption delays the year of need by one year and adopting the market potential for DSM delays the year of capacity need to 2030/31, a five year delay.

Reserve Margin

The final component of net demand is the required capacity reserve margin. As discussed in Section I above, MH maintains a 12% planning reserve margin, as required by its planning criteria. This is calculated based on the total peak demand and added to this total to yield the total resource need for planning purposes:

([Manitoba Peak Demand] + [Exports] – [DSM Savings]) * (1 + [12% Reserve Margin])

[60] NFAT Submission, Appendix 4.2.

Available capacity resources

The capacity need described in the preceding section must be fulfilled on an annual basis using resources available to MH. There are several sources of capacity available to MH for planning purposes. The primary source is the portfolio of hydro generators, but other resources provide significant capacity as well (see Figure 1-12). These resources are discussed individually below.

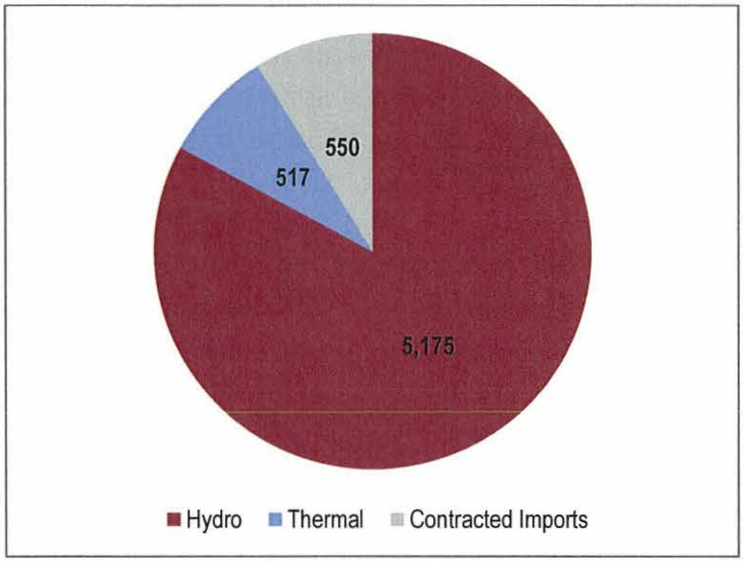

Figure 1-12: Manitoba Hydro's current winter peak capacity by resource type (MW)[61]

Existing hydro

MH's 15 hydroelectric generating stations supply approximately 5,175[62] MW, or nearly 90% of the total peak generating capacity owned by MH.[63]

There is a small difference between the nominal capacity of the hydro generators and the net system addition of the generators related to the winter peak capacity requirement.[64]

[61] NFAT Submission, Chapter 5, p. 3.

[62] This figure cited in the NFAT contradicts hydro capacity figures cited in the supply-demand tables in Appendix 4.2.

[63] NFAT Submission, Chapter 5, p. 4.

[64] This derating is discussed in La Capra Associates' Technical Appendix 8: Transmission Economics.

Thermal

MH's two thermal generating stations are Brandon and Selkirk. The station at Selkirk was built in 1960 with two coal units which were subsequently converted to natural gas in 2002. The Brandon station has one coal unit built in 1969 and two natural gas units completed in 2002.[65]

As with all thermal generators, the Brandon and Selkirk units have maximum capacities that vary depending on the season and ambient temperature. For the purposes of resource planning and needs analysis, MH has assumed that during the winter peak, the Selkirk units can provide 132 MW, the Brandon gas units can provide 280 MW, and the Brandon coal unit can provide 105 MW of capacity.[66]

MH assumes that the gas units stay in service through the planning period, but that the Brandon coal unit (Unit #5) is retired after 2019. This retirement is reflected in the decrease in supply seen in Figure 1-6 above. The rationale for this retirement has not been supported by MH.

In 2010, *The Manitoba Climate Change and Emissions Reduction Act* took effect, limiting the use of coal as an electricity source. The Brandon coal unit is now permitted to be used to support emergency operations, which means that it can be included as a capacity resource for planning purposes, but its operation is limited unless drought or other emergency conditions exist.[67] Since the intention is to limit use to emergencies only, Brandon Unit #5's capacity cannot, be included in the determination of exportable surplus.[68]

Despite this legislation, it is not clear that MH is required to retire the Brandon coal unit. MH has declined to provide an opinion on whether or not any federal or provincial legislation prohibits the continued operation of the unit, stating only that the

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[65] NFAT Submission, Chapter 5, p. 5.

[66] *Id.*

[67] *Id.*

[68] NFAT Submission, Appendix 4.2, p. 6.

status is "uncertain."[69] Regardless of the rationale, for the purposes of the NFAT Submission, MH assumes the retirement of the 105 MW Brandon Unit #5 in 2019.[70]

Keeping the Brandon Unit #5 as an emergency capacity resource in the supply-demand balance would delay the need for additional capacity by one additional year. MH has provided no evidence that it must remove Brandon from service in 2019,[71] and could keep the unit in service for capacity purposes.

As noted above, MH converted the Selkirk coal units to natural gas in 2002, but did not convert the Brandon Unit #5, even though it is newer by nine years. MH has stated that it has considered conversion of the Brandon coal unit, but has in the past rejected such a proposal due to age of the unit, lower efficiency expected upon conversion, and uncertainty regarding the regulatory future of natural gas units. MH has also indicated that it may complete a renewed assessment of conversion potential and, when complete, will incorporate the results into future power resource plans.[72]

Imports

Beyond the generation owned and operated by MH, for planning purposes import contracts are an additional capacity resource. The seasonal diversity agreements with Northern States Power and Great River Energy provide capacity resources of 385 MW and 220 MW, respectively.[73,74]

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[69] LCA/MH I-422.

[70] Based on the review of the CSI resource plans, Manitoba Hydro started making the retirement assumption in 2011 based on carbon emission legislation then under discussion which would have likely required retirement of the Brandon #5 unit by 2020. The legislation has since been abandoned, but Manitoba Hydro is still assuming the retirement. See Manitoba Hydro's 2011/12 Power Resource Plan, pp. 13-14, and the 2012/13 Power Resource Plan, pp. 10-11.

[71] LCA/MH I-422.

[72] CAC/MH I-066.

[73] NFAT Submission, Chapter 5, pp. 6-7. See also NFAT Appendix 4.2.

[74] The capacity credit quantities for planning purposes do not exactly match the reported contract quantities due to assumed losses between generation and load.

The capacity provided by import contracts is only assumed by MH through the end of the contract term. Therefore, upon expiration of the contracts the capacity supply is consequently reduced. This can be seen in the significant decreases in supply in 2025/26 and 2030/31 in Figure 1-6 above.

The expiration of the import contracts in 2025/26 is the direct cause of the timing of new capacity resource need assumed in the NFAT analysis. Figure 1-13 demonstrates that simply assuming the extension of existing import contracts will delay the year of capacity need to 2031/32 keeping all other 2013 assumptions constant.

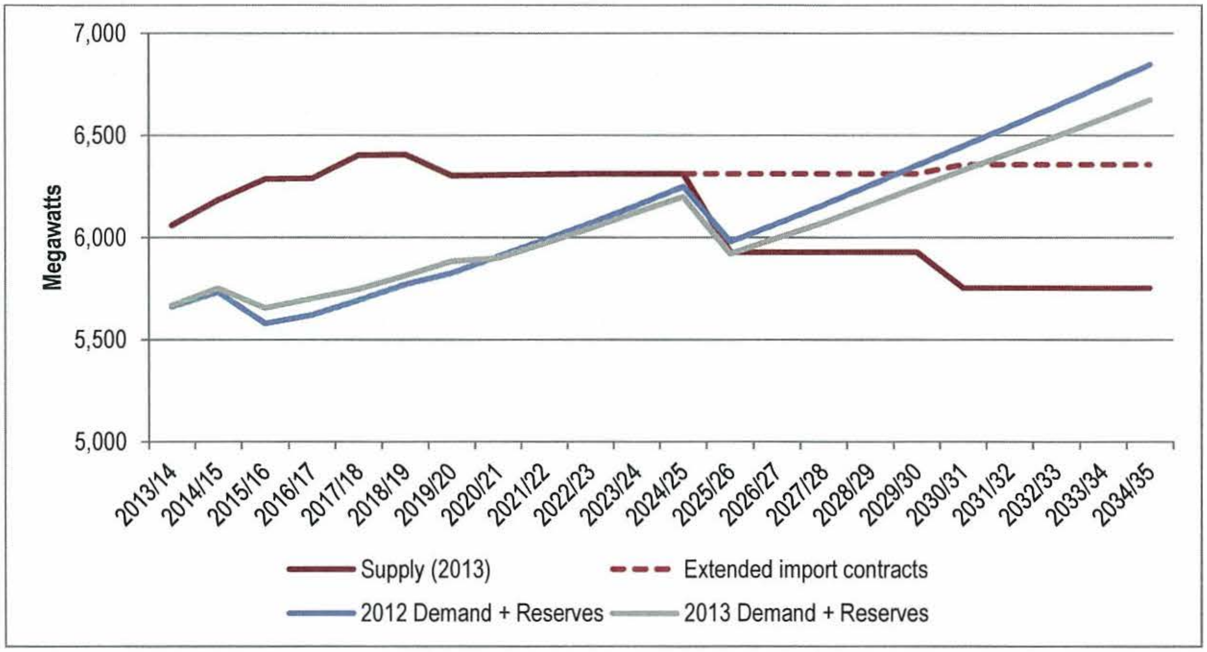

Figure 1-13: Existing capacity supply vs. demand, plus extended import contracts[75]

[75] LCA Analysis, NFAT Submission, Appendix 4.2.

Wind

MH has two wind contracts to purchase all the output of the St. Leon and St. Joseph wind farms. However, MH assumes that wind projects provide zero winter peak capacity "due to the intermittent nature of the resource and the fact that wind generators cannot operate reliably at temperatures below -30°C."[76]

Other capacity resources

There are two additional capacity resources assumed in the NFAT needs analysis. MH is planning to rebuild the Pointe du Bois powerhouse, which will provide an additional 43 MW of capacity in 2030/31.[77]

The second resource derives from the construction of the Bipole III transmission project. Upon completion in 2017, MH is assuming for planning purposes that there will be a reduction in capacity losses equivalent to 90 MW.

B. Energy need analysis

As discussed in Section I of this Appendix, MH has an energy planning criterion to ensure sufficient resources are available to meet the annual energy demand (megawatt-hours). As a heavily hydro-dependent system, MH has specific requirements to ensure that it can meet demand during drought conditions. MH therefore plans its system to have sufficient "dependable energy" to meet load from the following resources:[78]

- Hydro-electric generating stations
- Thermal generating stations
- Wind generation
- Planned DSM
- Imports

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[76] NFAT Submission, Chapter 5, p. 6.

[77] NFAT Submission, Appendix 4.2, p. 4

[78] NFAT Submission, Chapter 4, p. 38.

As with the capacity needs analysis, MH completed an analysis of energy need using the 2012 reference assumptions, and then updated the analysis with 2013 assumptions. The figure below compares the forecasted energy supply with forecasted demand under both the 2012 and the 2013 reference load forecast assumptions.[79]

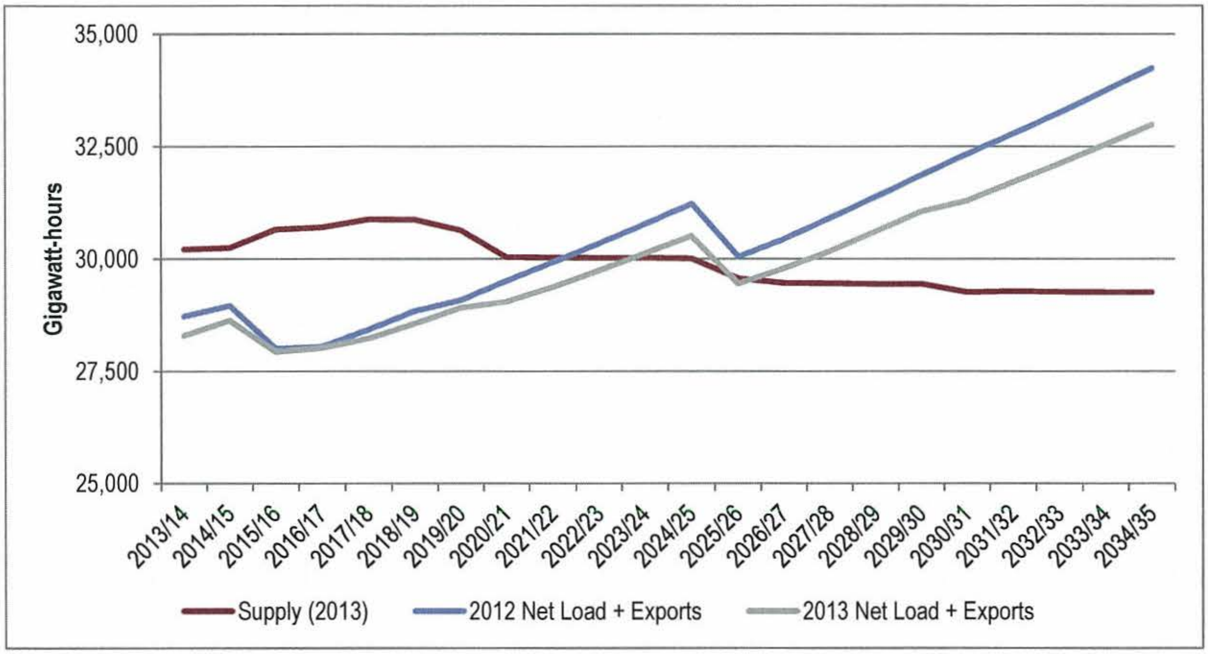

Figure 1-14: Existing energy supply vs. demand[80]

The figure above demonstrates that, under the 2012 assumptions, the MH system will have a need for energy beginning in 2022/23. Under the updated 2013 assumptions, the year of first need is delayed one year, to 2023/24. The demand then declines to a level below forecasted supply due to expiring export contracts. Domestic load growth pushes demand back above supply in 2026/27, creating a second year of need.

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[79] Manitoba Hydro's energy supply forecasts varied slightly between the 2012 and 2013 estimates, primarily due to the extension of export contracts. For the purposes of this analysis we have used the more current 2013 figures.

[80] NFAT Submission, Appendix 4.2

Determination of energy demand

The energy demand consists of five components. MH load is the primary component. Energy needed for existing and proposed export contracts is added to this total, as well as construction power needed for the new hydro project. This quantity of energy demand is reduced by the forecasted savings from DSM as well as "adverse water," which is a reduction in energy that must be delivered under certain export contracts. The net dependable energy demand represents the total annual requirement for which MH plans its system.[81]

Load forecast

MH's load forecasting process was described above. In addition to forecasting peak demand, MH also forecasts annual need for dependable energy.

The same factors previously discussed as impacting the peak demand forecast are also relevant to the energy forecast–population (customer) growth, economic changes, weather, and other criteria that impact electricity usage such as increased use of electric heat. And as noted in the discussion of peak demand forecasting, the energy load forecast represent MH's best 50/50 chance estimate.[82]

MH's energy demand grew at an average annual growth rate of 1.7% from 2001/02 through 2011/12. In the 2012 analysis, MH assumed a 20 year average annual growth rate of 1.6%.[83] In the 2013 updated load forecast MH assumes a 20-year growth rate of 1.5%.[84]

MH's long-term energy forecast declined significantly between the 2012 and 2013 forecasts. The forecasted total energy demand for 2047/48 decreased from 40,542 GWh to 38,393 GWh, a 5% decline.[85]

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[81] *Id.*

[82] NFAT Submission, Chapter 4, p. 16.

[83] *Id.*, p. 2.

[84] NFAT Submission, Appendix D, 2013 Electric Load Forecast, Manitoba Hydro, June 2013, p. i.

[85] NFAT Appendix 4.2, pp. 19, 123.

As discussed with Figure 1-7 above, MH reviewed the reference forecast's sensitivity to economic factors and prepared high- and low-sensitivity forecasts.

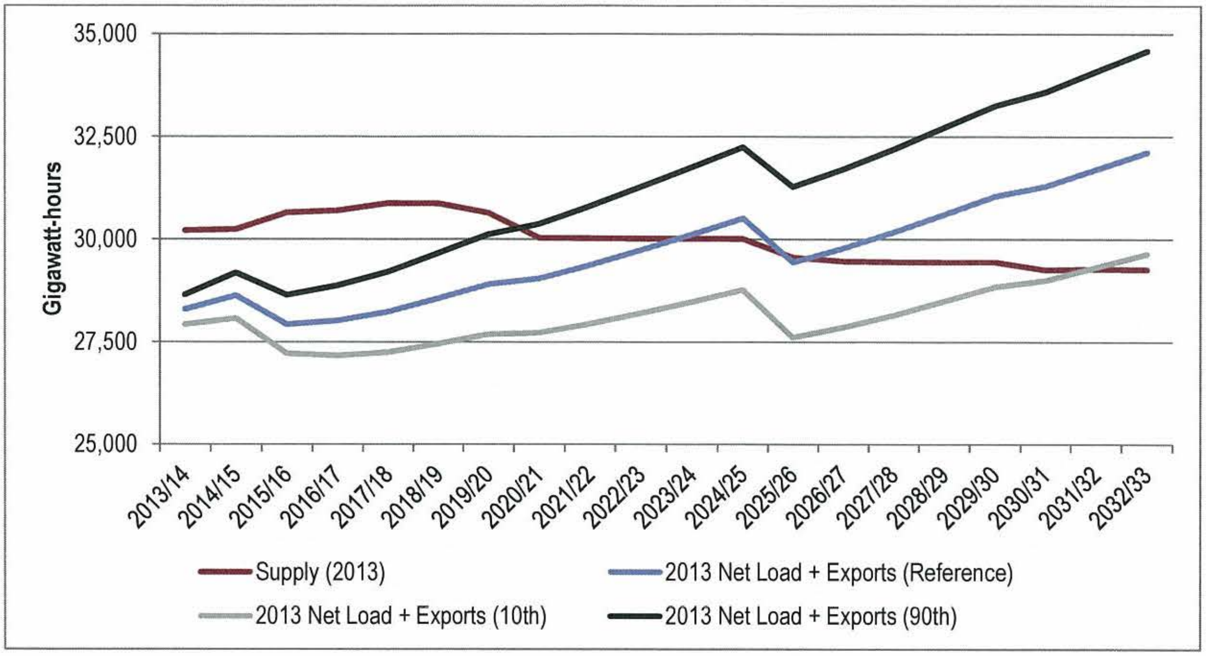

Figure 1-15: Existing Energy supply vs. demand sensitivities[86]

Keeping other assumptions constant, the lower 90th percentile forecast advances the year of energy need from 2023/24 up three years, to 2020/21. The 10th percentile forecast delays the year of need by nine years, to 2032/33.

Contracted Exports, Adverse Water

The second main component of the total energy demand is the energy required by export contracts. Figure 1-8 (see page 22) provides the details of existing or executed export contracts included in the 2012 planning assumptions.[87] The energy required by

[86] NFAT Submission, Appendix 4.2.

[87] The 2012 planning assumptions reviewed here do not include any potential export contracts that are contingent on the construction of Keeyask or additional interconnection that is the subject of the NFAT.

these contracts adds to the dependable energy requirement - approximately 11% in 2013/14, declining to approximately 6% in 2024/25, when most contracts expire.[88]

Some of MH's export energy obligations can be reduced under "adverse water conditions." If MH was experiencing drought and limited production from its hydro units, it could settle some or all of its export obligations financially, rather than actually export energy.[89]

Demand-Side Management

Similar to the discussion of DSM in the capacity need analysis, MH assumes a certain portion of dependable energy requirements will be reduced by new DSM initiatives.

The prior discussion of DSM in the context of capacity planning (see page 23) discussed MH's decline in forecast between 2012 and 2013, as well as the independent contracted DSM potential study which found that significant additional potential exists in Manitoba. The same conclusions apply here to the discussion of DSM as an energy resource.

Figure 1-16 below provides a comparison of potential energy savings from DSM under various assumptions, similar to Figure 1-10 above.

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88 NFAT Appendix 4.2, pp. 18-19, 122-123.

89 *Id.*, p. 13. For more on individual contracts treatment of adverse water conditions, see Technical Appendix 7: Export Contracts.

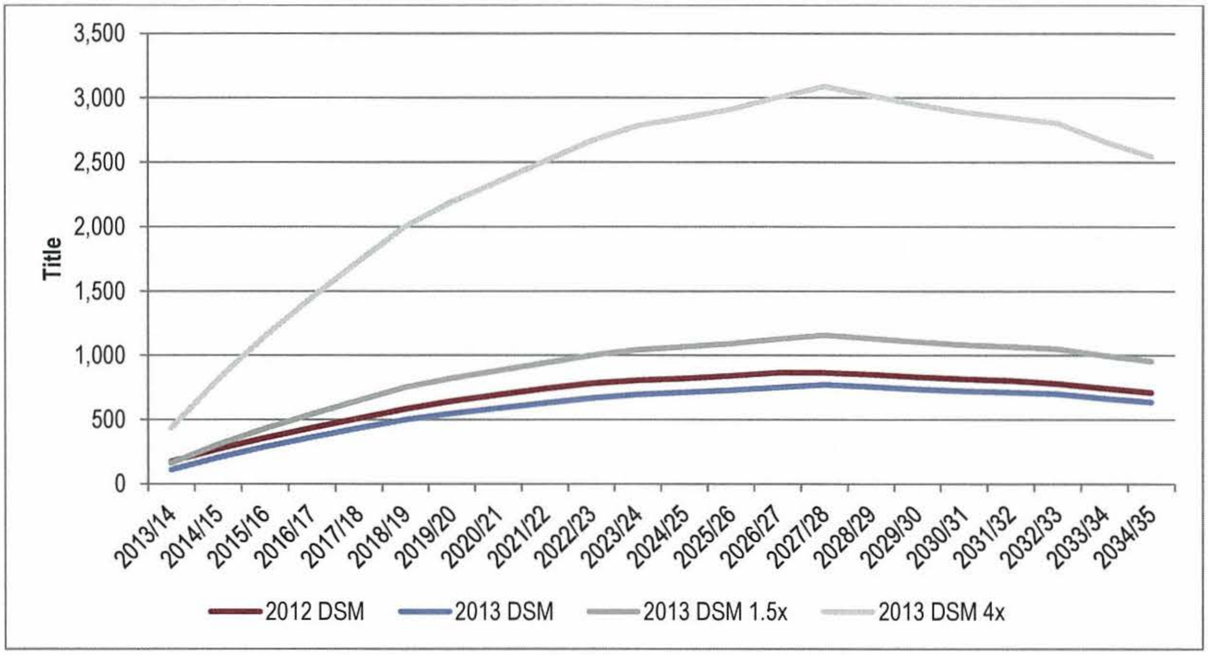

Figure 1-16: Manitoba Hydro DSM potential (GWh)[90]

Incorporating these levels into the supply demand balance for energy (Figure 1-17 below) demonstrates a similar effect as the impact on capacity in Figure 1-11 above.

[90] NFAT Submission, Appendix 4.2.

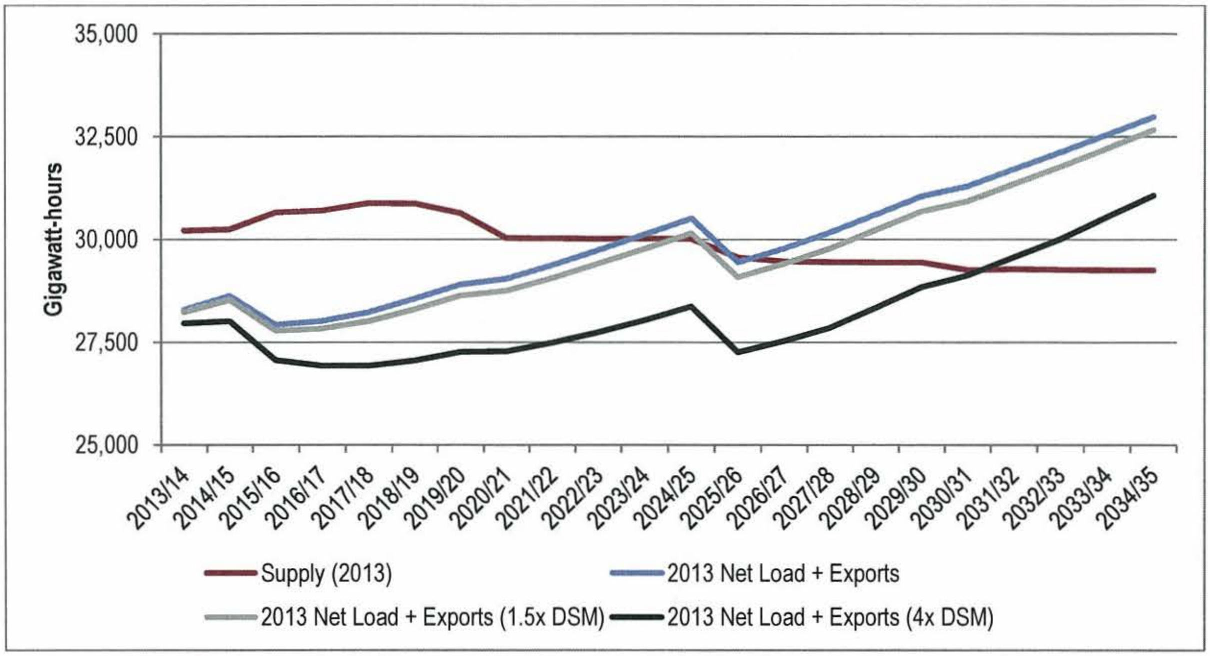

Figure 1-17: Existing energy supply-demand balance with 2013 DSM sensitivities[91]

The additional DSM extends the year of energy need from 2023/24 to 2024/25 in the 1.5x case, and by eight years to 2031/32 in the 4x DSM case.

While MH includes DSM as a resource in the supply-demand analysis, elsewhere in the NFAT material it expresses uncertainty in DSM as a resource. MH notes that "without regulation or legislation, achieving energy reduction targets is strongly dependent upon market acceptance and voluntary action… expected energy savings from DSM do not have the same future certainty of supply as would the development of a physical resource."[92]

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[91] *Id.*

[92] NFAT Submission, Chapter 7, p. 13.

Available energy resources

MH has various resources available to meet its energy load. For planning purposes, MH evaluates the capability of each resource to provide dependable energy. In some cases the contribution of these resources to the system's dependable energy requirements differs significantly from the average generation from those units.

Hydro

The primary source of energy needed to fulfill the system's dependable energy requirements is from the existing hydro generators. Dependable energy from hydro units is defined as energy that can be generated under the historically lowest flow conditions.[93]

The dependable energy provided by the hydro generators is significantly lower than the energy generated in an average year. This was discussed previously and Figure 1-5 (page 16) demonstrates that the dependable energy from the hydro units that is factored into the planning process is only two-thirds of the generation in an average year.

For planning purposes, MH assumes that available dependable energy will gradually decline due to upstream water uses in Saskatchewan and Alberta.[94]

Thermal

Another main source of dependable energy is MH's thermal generators. In determining the available dependable energy resources to fulfill need, MH assumes that the thermal units generate energy up to their full capability (as they would during critical flow conditions). This quantity represents much more energy than these thermal units typically generate in an average year.

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[93] A full explanation of how dependable energy from hydro assets is modeled by Manitoba Hydro can be found in: Kubursi, Dr. Atif and Dr. Lonnie McGee. Manitoba Hydro Risks: An Independent Review, pp. 88-93. (SP-076 MH Risks Report Independent Review Redacted.pdf)

[94] NFAT Submission, Appendix 4.2, p. 9.

Unit	Winter Peak Capacity (MW)	Dependable Flow Condition		Average Flow Condition	
		Generation (GWh)	Capacity Factor	Generation (GWh)	Capacity Factor
Brandon Unit 5	105	811	88%	125	14%
Brandon Unit 6&7	280	2,354	96%	23	1%
Selkirk	132	953	82%	18	2%

Figure 1-18: Comparison of dependable and average generation from thermal units[95]

MH's planning assumptions include the retirement of the Brandon Unit #5 after 2019. The corresponding reduction in 811 GWh of dependable energy can be seen in the supply component of Figure 1-14 above. Figure 1-19 below depicts the supply-demand balance keeping the Brandon coal unit as a dependable energy resource. This revision extends the energy year of need by five years under 2013 assumptions, from 2023/24 to 2028/29. As previously discussed, MH has not provided any evidence to support the necessity of this assumed retirement.[96]

[95] Calculated from data available in NFAT Appendix 4.2.

[96] See, e.g. LCA/MH I-422.

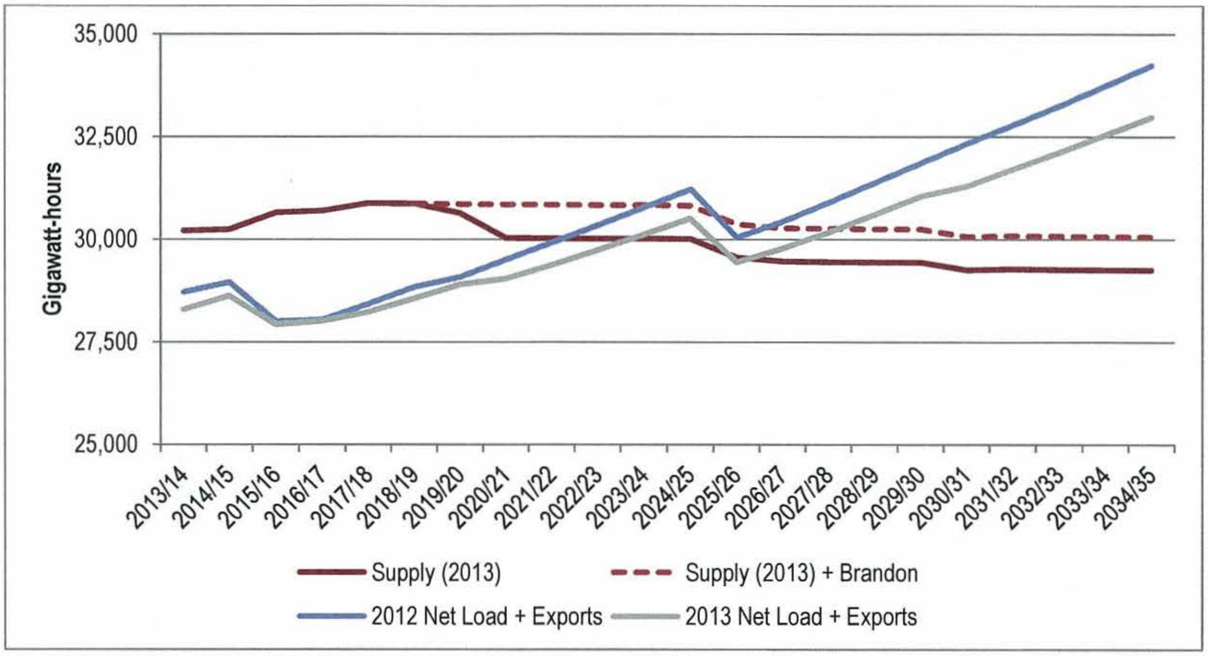

Figure 1-19: Existing supply vs. demand (plus Brandon #5 continued service)[97]

Imports, market purchases

Energy from import contracts contributes to the supply available to meet MH's dependable energy requirements. As with capacity from these contracts, MH only incorporates energy from executed contracts and does not assume renewal of the contracts for planning purposes.

MH currently receives dependable import energy from the diversity exchange agreements (see Figure 1-8, page 22). After determining the energy that will be provided to the system by these contracts, MH assumes market purchase energy is available to fulfill demand, up to the energy import criterion limit. Therefore, on an annual basis, the sum of imports and market purchases is equal to 3,068 GWh.[98] According to MH's analysis, this is equivalent to the amount of energy that can be

[97] NFAT Submission, Appendix 4.2.

[98] *Id.*

imported during the off-peak period and is the binding import criterion for dependable energy.[99]

Since MH already assumes, for planning purposes, that it will import the full 3,068 GWh either by import contract or by market purchase, the import limitation criterion is binding and an assumption on renewal of the import contract would not change the energy planning need calculation.

There would be a significant impact, however, if MH permitted dependable energy from imports at all hours, rather than just the off-peak period. Figure 1-20 demonstrates how the supply-demand balance changes if MH were to permit dependable import energy at all hours. Note that this calculation does not consider the planning criterion limitation related to the 10% of Manitoba load.

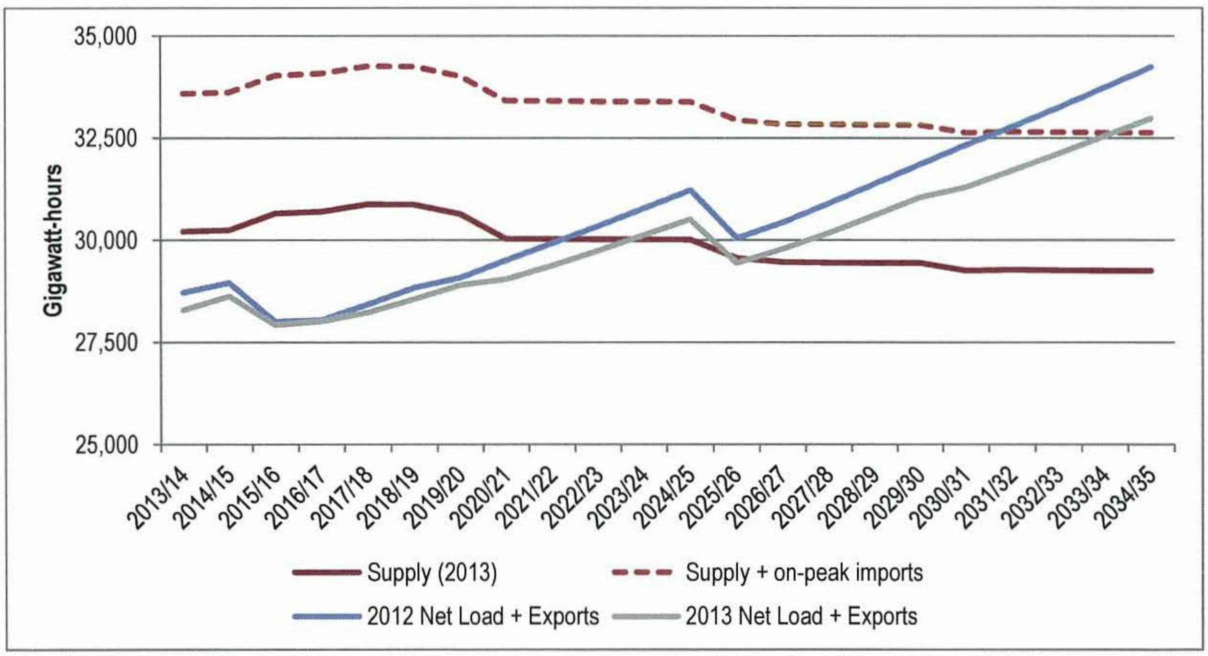

Figure 1-20: Existing energy supply vs. demand (plus additional import energy)

[99] The calculation of this figure is provided in Footnote 32.

With this revised import limitation, the year of need for energy is delayed until 2034/35 using 2013 assumptions.

Hydro adjustment

MH assumes an additional energy supply resource related to the existing seasonal diversity contracts. MH terms this energy the "hydro adjustment" and explains it as follows:[100]

> *Diversity Contracts provide the benefit of reducing energy requirements from the MH system during the months when there is less operational flexibility due to ice restrictions and ice cover. A quantifiable amount of dependable energy, shown as the Hydro Adjustment, can be identified which represents the efficiency of using MH generation in the summer months when there are no ice cover restrictions.*

This hydro adjustment energy is eliminated once the diversity contracts expire. If MH assumed the renewal of these contracts there would be a small amount of additional energy added to the assumed supply for planning purposes.

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[100] NFAT Submission, Appendix 4.2, p. 10.

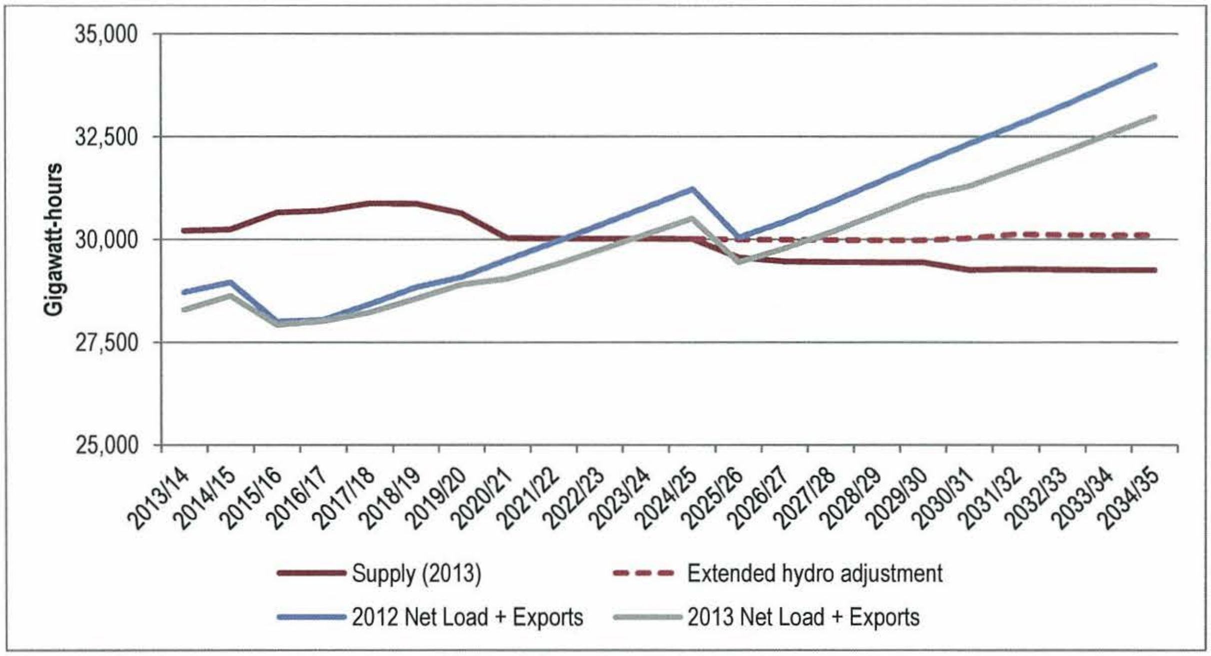

Figure 1-21: Energy supply vs. demand with extended hydro adjustment

Wind

MH has contracts to purchase the entire output of the St. Joseph and St. Leon wind farms. MH estimates the annual generation from the projects through "statistical wind resource assessments and operating history."[101] This equates to a 40% assumed capacity factor.

For dependable energy purposes, MH relies on 85% of the expected wind generation.[102]

Other energy resources

There are two additional energy resources assumed in the NFAT needs analysis. These resources derive from the capacity increases discussed above. Based on the 2013 assumptions, from the planned rebuild of the Pointe du Bois powerhouse MH anticipates an additional 150 GWh and the reduced losses from the construction of Bipole III will yield 190 GWh of annual dependable energy.

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101 NFAT Submission, Chapter 5, p. 6.

102 NFAT Submission, Chapter 5, p. 6

C. Critique of needs analysis

MH provided substantial data in support of the needs analysis included in the NFAT. Our review of these data shows that MH's conclusion regarding the year of energy need in 2022/23 and capacity in 2025/26 are very conservative. Using MH's forecasts and assumptions, there is low probability that the year of need is earlier than those dates, there is a material probability that the year of need is several years later, and there are near-term options that could mitigate that need for several years.

Load forecast variability, sensitivity

It is the nature of long-term resource planning that the years of need for both energy and capacity are clearly very sensitive to the load forecast. MH completes a new load forecast each year. The load forecasts often show substantial changes from year to year, particularly in the near term forecast.[103] Between the 2012 and 2013 forecasts, demand projections decreased enough to move the year of need for energy and capacity by a year each (see Figure 1-6 and Figure 1-14 above). In addition, the review of the 90th and 10th percentile sensitivities (Figure 1-7 and Figure 1-15 above) demonstrated the impact on year of need for both capacity and energy.

Given the sensitivity of resource planning to load forecasts, it is essential to conduct planning such that changes in the forecasts are incorporated, particularly when evaluating large generation projects.

Manitoba Hydro uses overly conservative assumptions

MH's needs analysis uses the most conservative assumptions on resource availability, a strategy which advances the year of need for energy and capacity. These assumptions include retiring the Brandon Unit #5 before necessary, failing to assume the renewal of diversity contracts, minimal DSM assumptions, and low reliance on imports.

[103] For a multi-year review of Manitoba Hydro's load forecasts, see the 2012/2013 Power Resource Plan, pp. 4-5.

The low reliance on imports has a very strong impact on year of need. While MH's assumptions are consistent with their planning energy criterion, as previously discussed, the foundation for this criterion has not been supported.

The low DSM assumptions similarly impact the year of need. The consultant report which provided the market and achievable forecasts was not completed until after the NFAT analysis was performed. The fact that MH did not contract this study before developing the NFAT analysis in part demonstrates a shortcoming to its approach to resource planning.

<u>Summary: Needs analysis shows ample opportunities to delay build</u>

Given the uncertainty a long-term load forecast, as well as MH's conservative assumptions, our analysis of the resource need concludes that the actual year of need for new capacity and dependable energy will very likely be later than MH has stated.

Additionally, there are many options for smaller investments with shorter lead times that could delay the year of need. Based on these conclusions, MH has options to delay investment in the large hydro units until a more confident year of need is determined.

LCA has worked with MH to develop an alternative development plan which incorporates expanded import criterion. The alternative plan permits imports up to 20% of Manitoba load with additional transmission capacity. This plan, along with the impact on year of need and economic analysis, are discussed in Technical Appendix 3: Alternative Resource Plans.

IV. Exports Created from Planning Criteria

MH's system is characterized by large amounts of export energy. This section discusses how MH's planning criteria contribute to the creation of surplus energy.

As explained by MH, there are two aspects of a hydro-dependent system that create surplus energy for export given MH's planning criteria.[104] First, to address the variability of water flows from year to year, the hydro generation additions to the system must be built to provide sufficient energy generated in the lowest flow years to meet all provincial load and firm exports if the criterion is to be met. This results in surplus energy in every year with more water available than the lowest flow year, even when the system is just meeting its energy and capacity requirements criteria. This issue was discussed in preceding sections. Secondly, large-scale hydro development that MH has done and proposes to do typically results in additional surplus energy and capacity in the years immediately following project completion. In other words, the scale of the hydro projects are very large compared to annual load growth which means that there are several years of surplus following the in-service date of those investments.

MH currently exports a significant amount of its total generation, but the actual amount sold year-to-year varies significantly with water availability. The figures below illustrate this graphically in different ways.

Figure 1-22 below shows the history of export sales volumes over time. Sales volumes have increased as new hydro generation and transmission interconnection assets have been added to the system. In between the years in which new generating assets come online the total exports still remain variable, and this variability is largely explained by the availability of hydro generation due to water flows. CONFIDENTIAL Figure 1-23 below shows the historical water record. Comparison of the two figures shows that high water years correlate to high exports and vice versa.

[104] NFAT Submission, Chapter 5, pp. 31-32.

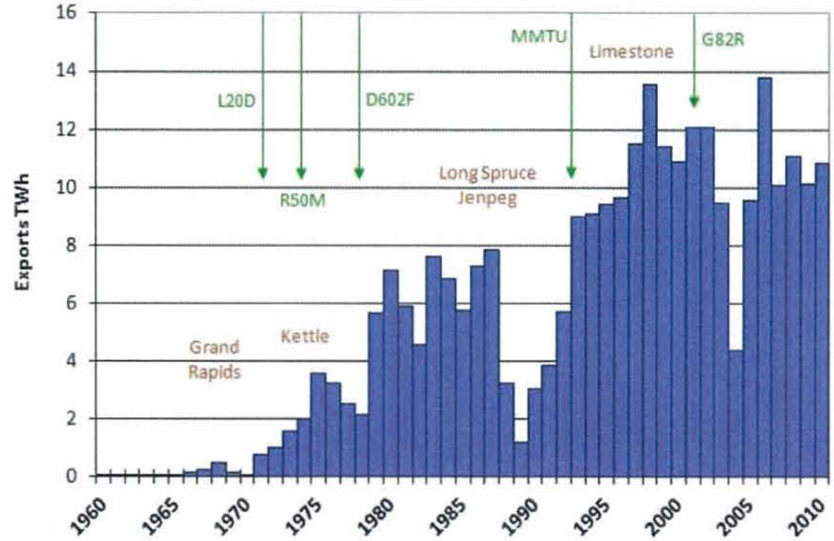
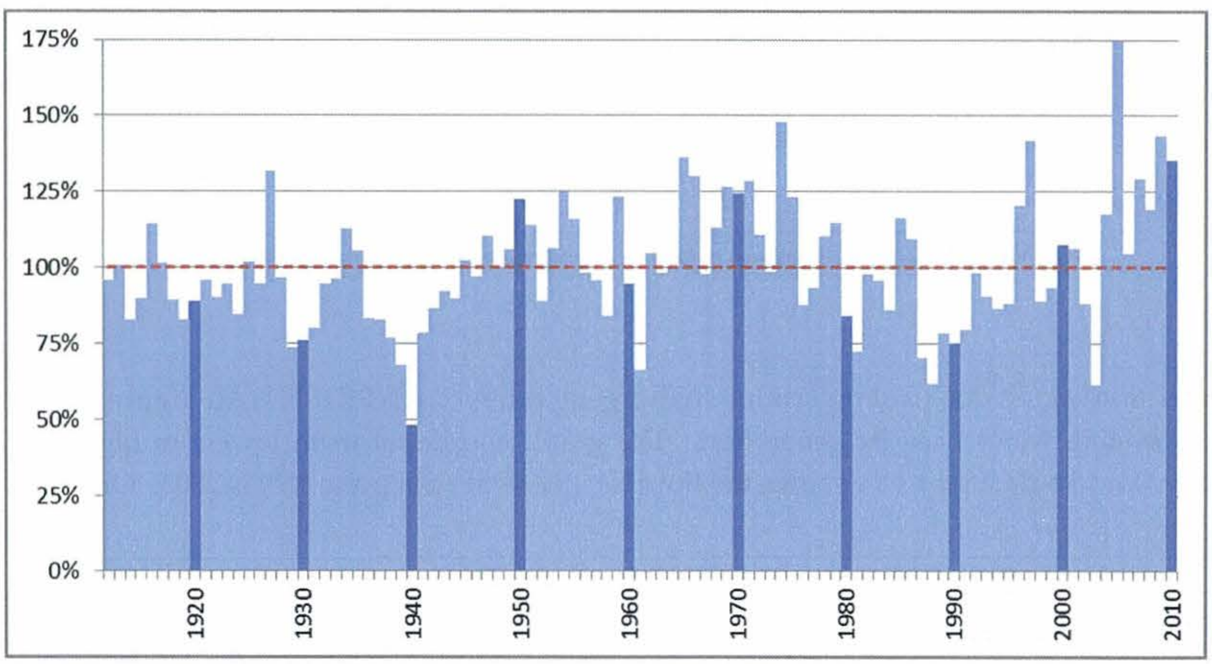


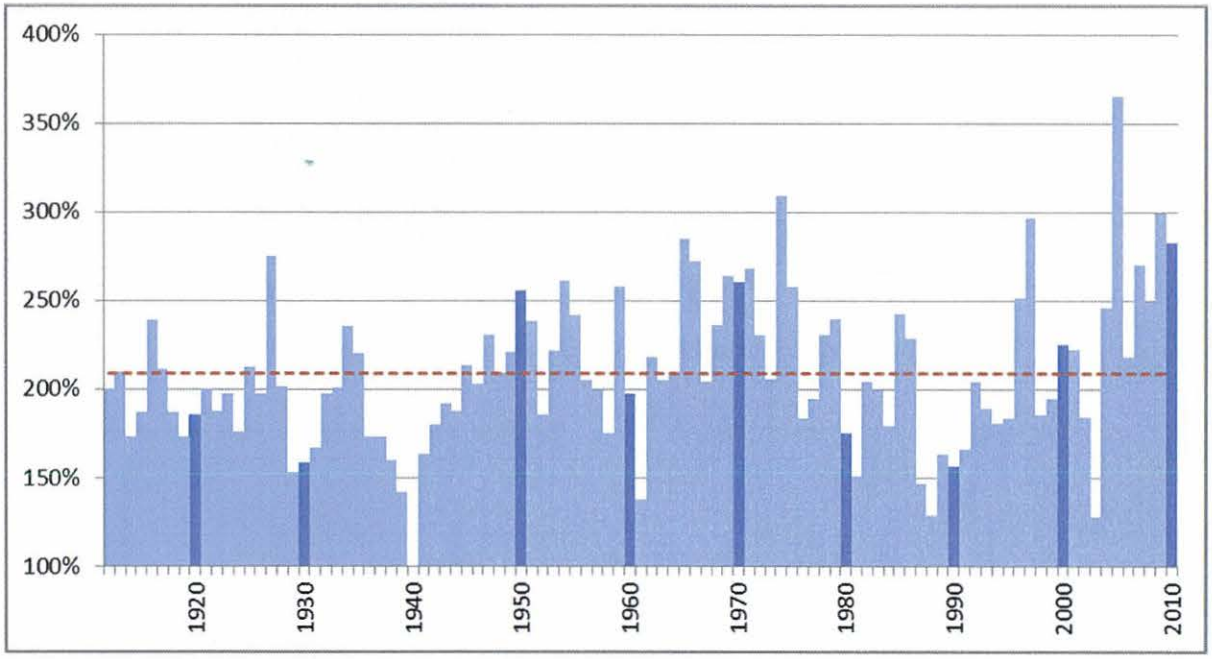
Figure 1-22: Manitoba Hydro history of export sales.[105]



CONFIDENTIAL Figure 1-23: Manitoba Hydro historical water record.[106]

[105] NFAT Submission, Chapter 5, Figure 5.4, p. 23.

CONFIDENTIAL Figure 1-24 below contains similar data, normalized to the minimum flow year, 1940. This demonstrates that there is a wide range in annual flow values. In fact, in an average year the flow is 209% of the flow in 1940, and in the highest year the flow was more than 350% of the lowest year.



CONFIDENTIAL Figure 1-24: Water flow normalized to 1940[107]

Water flow alone does not determine hydro generation. CONFIDENTIAL Figure 1-25 plots system water flow by generation. The graph is ordered from lowest to highest water flow, so data point #1 shows the flow for 1940 and data point #99 is 2005. On the

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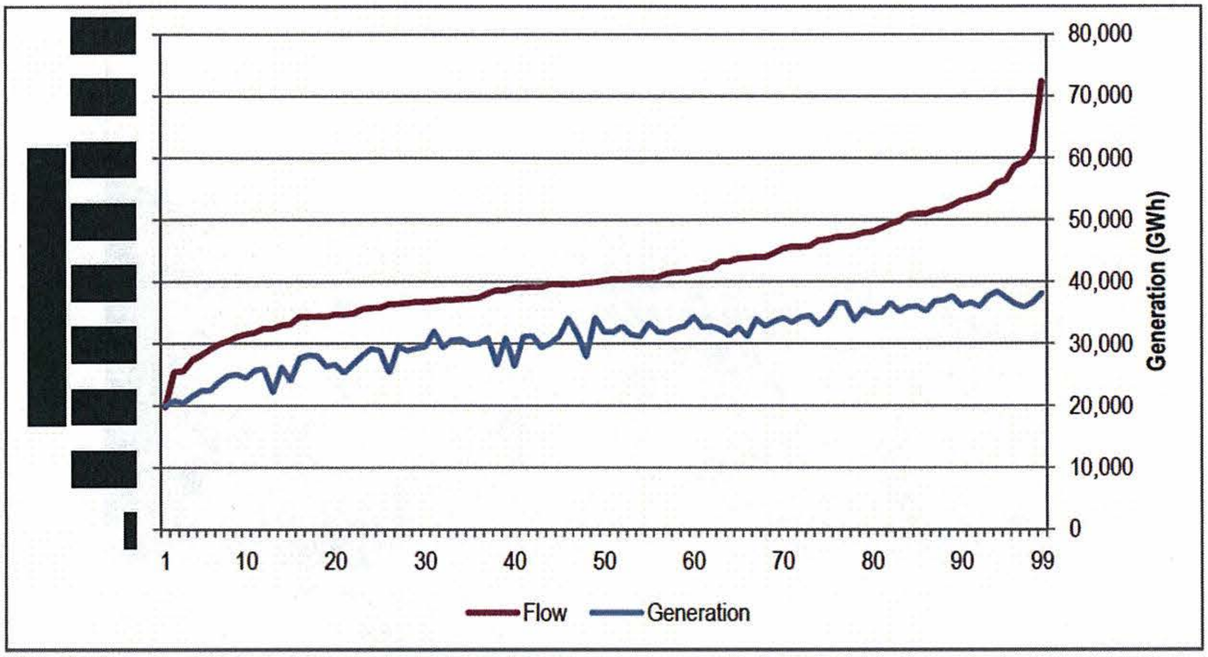
[106] Data derived from Manitoba Hydro inflow data. (SP-121 NFAT Confidential - LTFD_DATA_1912-2010(CONFIDENTIAL).xlsx)

This figure is similar to Figure 5.8, NFAT Chapter 5, p. 30, difference is in available data range and impact on average flow.

[107] Data derived from Manitoba Hydro inflow data. (SP-121 NFAT Confidential - LTFD_DATA_1912-2010(CONFIDENTIAL).xlsx)

generation side, values represent the average generation from the SPLASH output for the corresponding flow year. Point #1, for example, represents the average generation for all years using the 1940 flow data. SPLASH data from the All Gas Scenario (Scenario #1) was used to eliminate any impact of new hydro build.



CONFIDENTIAL Figure 1-25: Comparison of system flow and generation[108]

CONFIDENTIAL Figure 1-25 demonstrates that while there is a correlation between flow and generation, it is not a perfect correlation. And particularly in the high flow years, generation does not increase proportionally.

Because the system is planned for the lowest flow years, the high variability in annual generation yields a wide range in export sales. Figure 1-26 illustrates the relationship between water supply and exports. The black line represents Manitoba load projected for 2014/2015. The red line labeled total commitments also includes MH's firm export obligation. The chart shows in about 10% of water years, thermal generation is needed

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108 Data derived from Manitoba Hydro inflow data. (SP-121 NFAT Confidential - LTFD_DATA_1912-2010(CONFIDENTIAL).xlsx)

to meet some fraction of Manitoba's total commitments. In the best water years, imports and thermal generation are close to zero, and MH exports about 10 TWh or 30% of total generation.

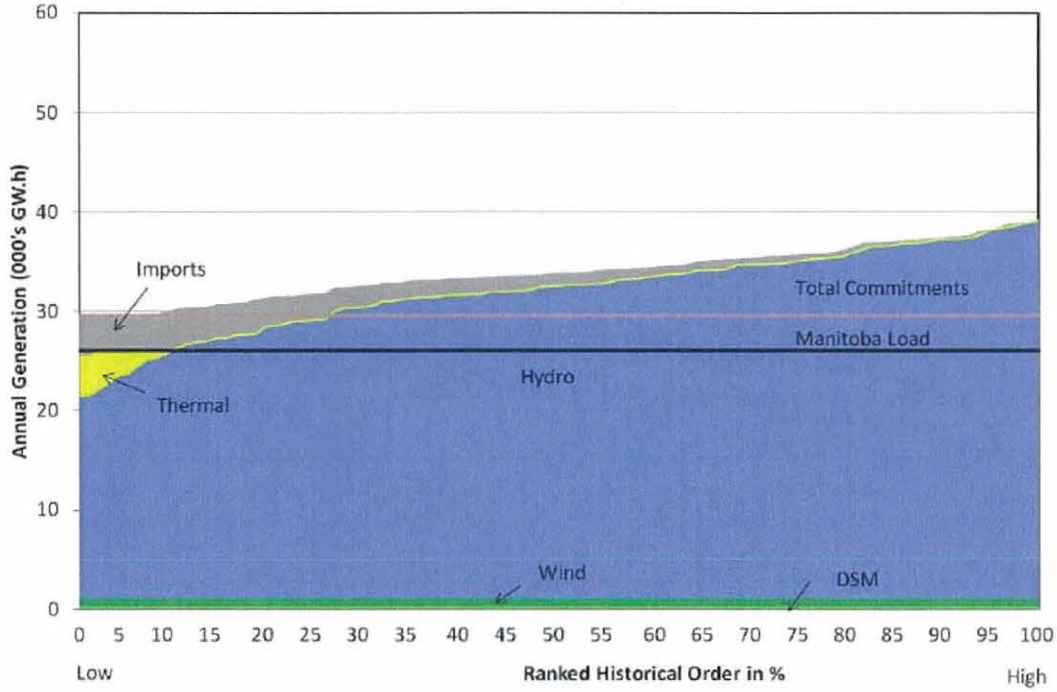

Figure 1-26: Manitoba Hydro generation supply sources over a range of water conditions in 2014/2015.[109]

This high variability means that even with additional hydro capacity, there still could be low water years with low generation. Therefore, MH must limit its firm export obligations during the planning process even though there it typically abundant surplus energy.

MH employs system modeling to determine this firm export limit. Using its SPLASH model, MH estimates available dependable energy.[110] The model uses the worst

[109] NFAT Submission, Chapter 5, Figure 5.10, p. 34.

[110] Kubursi, Dr. Atif, and Dr. Lonnie McGee, "Manitoba Hydro Risks: An Independent Review," pp. 88-93. (SP-076 MH Risks Report Independent Review Redacted.pdf)

drought on record, beginning in the late 1930s to calculate the dependable energy requirement.[111] SPLASH either increases load or exports iteratively until a system constraint is on the verge of being violated.[112] The critical period begins in the last month Lake Winnipeg is at its maximum storage potential, and the dependable energy is calculated from the last twelve months of the critical period.[113]

As part of its planning, MH always owns or has under contract enough dependable energy to meet its total commitments, i.e. domestic load and firm exports.[114] This means MH does not export on a firm basis more hydro generation than is available during the critical flow year. Firm exports must also be accompanied by firm transmission service.

Due the limitations on the amount of power MH will export on a firm basis, in any year with more water than the worst drought on record, there will be surplus water available for additional exports as opportunity sales.[115] Similarly, MH will have surplus hydro capacity when not needed to meet system peak demand.[116]

Exports are also driven by the size of the hydro investments in MH's current portfolio and those proposed as part of the preferred development plan. These investments are large enough to meet many years of MH load growth. While load grows, the surplus dependable energy is available for export on a firm basis.[117]

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111 *Id.*, Figure 3.15, p. 89.

112 *Id.*, p. 89.

113 *Id.*, Figure 3.17, p. 91.

114 NFAT Submission, Appendix 4.1, p. 4.

115 NFAT Submission, Chapter 5, p. 31.

116 *Id.*

117 *Id.*

V. Preferred Plan Exceeds Resource Needs and Creates Surplus Power

A. Surplus Created by the Preferred Development Plan

MH's resource planning process is designed to forecast resource demand and ensure that sufficient supply exists to fulfill that load. As previously discussed, MH has determined as part of the NFAT process that the year of need for energy is 2022/23 and for capacity is 2025/26. The preferred plan presented in the NFAT would create significant excess energy in three ways.

First, the plan intentionally brings new resources online in advance of the year of need for energy and capacity, as the Keeyask unit is targeted to be in service in 2019. All surplus dependable energy between 2019 and the actual year of need is driven by the decision to put Keeyask into service in advance of need. This is discussed by MH in the NFAT as related to the "window of opportunity"[118] and discussed in more detail below.

The second and third ways in which surplus power is created is related to the previous discussion and is a natural consequence of hydro-based generation. The figure below shows the exportable surplus energy for the Preferred Development Plan under the NFAT 2012 reference assumptions. The amount of energy between the blue line and the grey area representing Manitoba net load is the amount of dependable surplus that can be exported as a firm sale. For years after the year of need, this corresponds to the surplus created by building new large hydro assets for which the assets are naturally larger than the need in the first few years they are in service.[119] The amount above the blue line shows the surplus energy above the dependable energy available in an average water year. This light blue area corresponds to the surplus created by the planning criterion that MH always owns or has under contract enough dependable energy to meet its total domestic load and firm exports.

[118] NFAT Submission, Chapter 6.

[119] The final two increases in dependable energy after 2039/2040 are due to natural gas fired generation additions. This is relatively small compared to the exportable dependable surplus created by the new hydro development.

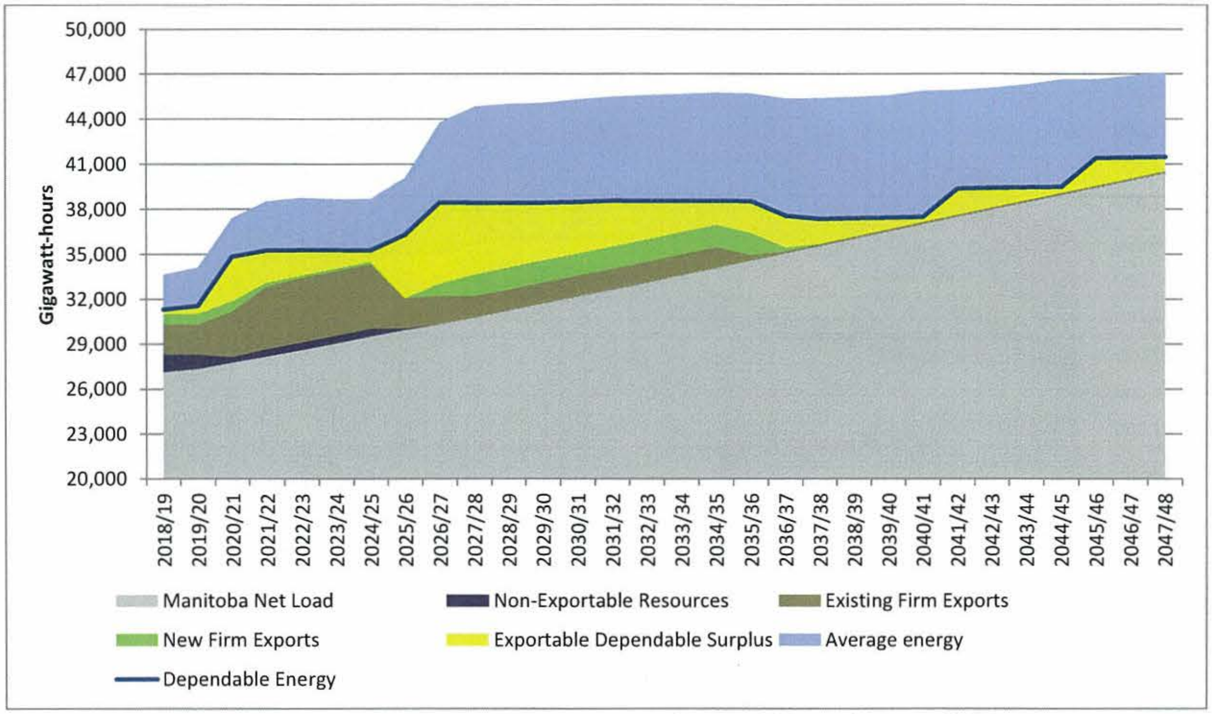

Figure 1-27: System energy supply and firm demand.[120]

The pink area depicted in Figure 1-28 below includes the additional energy generated in a maximum flow year. This demonstrates the range of surplus energy values above the dependable flow condition.

[120] PUB/MH I-031c

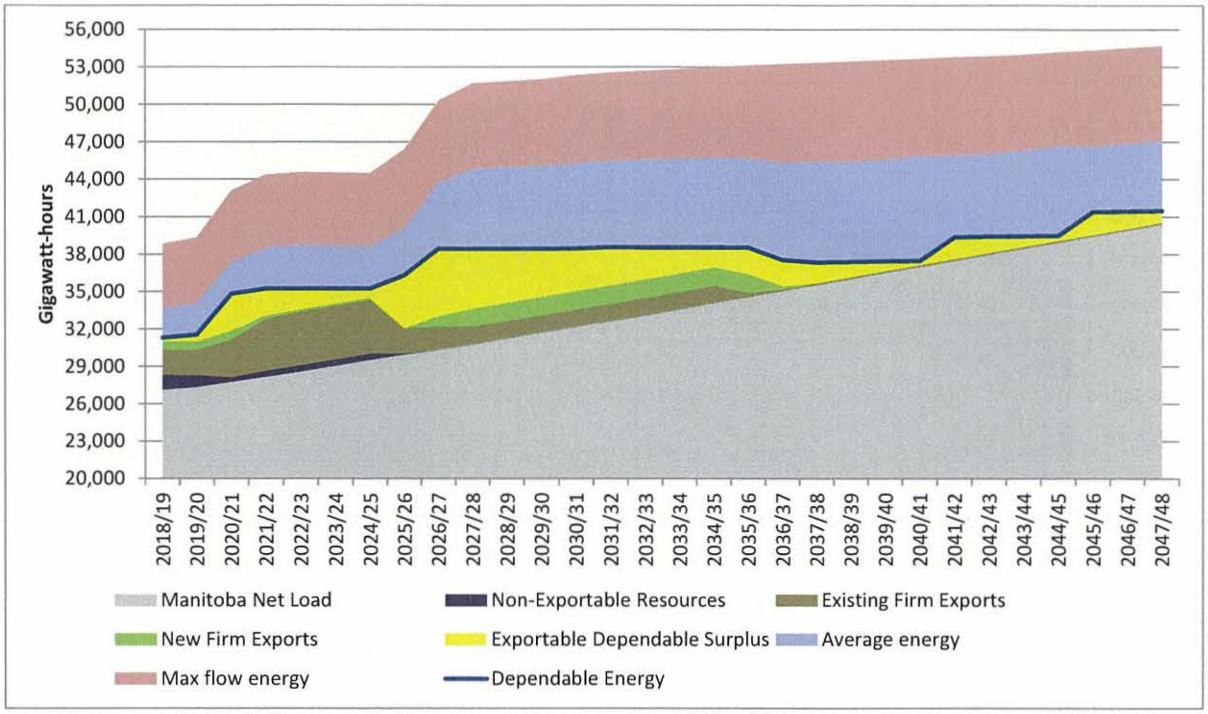

Figure 1-28: System energy supply and firm demand, with max flow energy

The preceding figures demonstrate that the Preferred Development Plan creates substantial surplus power, derived both from MH's planning criteria and the nature of large hydro investments. The surplus power created has important implications for the decisions surrounding when to put large hydro investments into service. This is discussed in more detail in the next section.

B. Resource Timing and the Importance of the "Window of Opportunity"

As discussed above, MH's resource needs assessment determined that, based on the 2012 analysis, MH will have an energy need in 2022/23 and a capacity need in 2025/26. The timing of need was delayed by one year each pursuant to the updated 2013 analysis. Regardless of these conclusions on timing, the Preferred Development Plan calls for Keeyask to be in service in 2019.

The reasons for advancing the timing of Keeyask relate to the export opportunities such new large hydro development creates under MH's planning criteria, as explained in

Section IV. Along with the exports comes the question of when best to place the assets in service to make full advantage of export opportunities and, therefore, the needs of potential purchasers of these exports must be taken into account.

In Chapter 6 of the NFAT Submission MH discusses the concept of a "Window of Opportunity" for new exports in detail. While not a component of its official planning criteria, MH's assessment of this opportunity is an important consideration in its recommendation of the Preferred Development Plan, so will be briefly addressed here.

Overall, MH perceives demand in the US for its hydro power.[121] This is based primarily on near-term US resource need due to load growth and (primarily coal-based) resource retirement.[122] Additionally, MH claims that there is export demand for renewable hydro power due to renewable portfolio standards and potential carbon pricing legislation.[123]

MH's position is that by constructing Keeyask in advance of need with additional transmission capacity, MH can take advantage of this demand for exports and further develop a market for the surplus energy that is naturally characteristic of hydro-dependent systems. MH believes that timing of this development is critical because this demand for hydro power, as well as US federal incentives for transmission development, may not continue to persist.[124]

Due to MH's conservative assumptions and the other factors discussed above, it is likely that the actual year of energy and capacity resource need will be later than MH has presented. Therefore, it will likely not coincide as closely with the timing of new generation and transmission involved in the Preferred Development Plan.

Since the timing of resource development may not be contingent on Manitoba resource need, the merits of the plan as presented by MH depend more on the benefits derived

[121] NFAT Submission, Chapter 6, pp. 1-5.

[122] *Id.*, pp. 7-10, 17-20.

[123] *Id.*, pp. 10-16.

[124] *Id.*, pp. 5-6.

from export sales and the perceived "window of opportunity" to take advantage of these opportunities.

LCA's Technical Appendix 9: Economic Analysis addresses the economics related to the export opportunities, Technical Appendix 8: Transmission Economics addresses the "window of opportunity" in the context of transmission economics, and Technical Appendix 4: Environmental Issues and Policy addresses the issue as it relates to demand for renewable energy in potential export markets.

VI. Summary and Conclusions

Based on the foregoing review and analysis, we provide the following conclusions and commentary.

A. Resource planning criteria

MH has recently reviewed and revised its planning criteria.

Its capacity criterion is reasonable and within the range of industry criteria for similar systems. As MH noted itself, it should be incorporating more probabilistic studies in assessing the criterion in the future.

MH's energy criterion, conversely, has some unique and limiting features which restrict the resource planning options. There is a lack of analytical support for the limitations the criterion places on dependable energy from imports, and overall the criterion does not fully consider the modern system with high transfer capability with MH's neighbors, particularly the MISO market.

B. Resource needs analysis

The determination of resource supply and demand performed by MH is very conservative. Combined with the restrictive planning criteria, MH has identified a resource need that is likely well in advance of the year that it will actually face an energy or capacity supply deficiency.

Certain supply options (particularly imports and DSM) have not been appropriately treated and have the potential to significantly delay need.

By modifying the planning criteria to allow more imports, MH could allow flexibility to have dependable resources available in the early years after the forecasted year of need, as an alternative to the Preferred Development Plan. More on this potential will be discussed in Technical Appendix 3: Alternative Resource Plans.

C. System Exports and Resource Timing

The combination of a hydro-dependent system with MH's specific planning criteria creates significant exports depending on flow conditions, which offers both opportunity and risk. The exports created by the Preferred Development Plan exceed even the amount created by planning only to meet load.

Despite the significant analysis completed by MH to determine the timing of resource need, the Preferred Development Plan is structured to build resources in advance of this need. This is MH's strategy to maximize the potential benefits from exports by taking advantage of the perceived "Window of Opportunity." It is important context for review of the NFAT to recognize that this viewpoint is driving the timing of the resource plan presented in the NFAT Submission, rather than need identified by MH's resource planning criteria.