INDEPENDENT EXPERT CONSULTANT REPORT: EXPORT REVENUES AND DROUGHT OPERATIONS

APRIL 13, 2023

PREPARED FOR
Manitoba Public Utilities Board

PREPARED BY
Daymark Energy Advisors

DAYMARK ENERGY ADVISORS
370 MAIN STREET, SUITE 325 | WORCESTER, MA 01608
TEL: (617) 778-5515 | DAYMARKEA.COM

TABLE OF CONTENTS

Executive Summary 8

I. Introduction 11

A. Scope overview 11

B. Daymark approach 12

II. Inflow Forecasting and Dependable Energy Modeling 14

A. MH watershed and hydraulic system 14

B. Inflow forecasting and flow case development 16

C. Dependable energy modeling 18

D. Other changes since 2017/18 GRA 20

E. Transition to 40-year flow record for budget year analysis 20

F. Daymark findings 21

III. MISO Market Overview and Outlook 22

A. Scope of investigation 22

B. Manitoba Hydro's outlook on MISO market 23

C. State and federal policies on electricity generation and emissions 24

D. Existing generation mix 25

E. Expected new generation to be installed in the next 20 years 27

F. Forecasted generation retirements in the next 20 years 30

G. Supply and demand balance in the northern MISO region 31

H. Factors that may affect Manitoba Hydro's ability to export energy and capacity into the MISO market 35

IV. Export Price Forecast 39

A. Scope of investigation 40

B. Near-term energy price forecast 40

C. Long-term energy price forecast 42

D. Daymark findings 46

V. Export Contract Review 48

A. Scope of investigation 48

B. Review of contract revenue forecast 48

C. Daymark findings 51

VI. Export Energy Volume Forecast 52
A. Scope of investigation 52
B. MH analysis results 52
C. Daymark findings 54
VII. Export Capacity Volume Forecast 55
A. Scope of investigation 55
B. MH assumptions and analysis 55
C. Daymark findings 57
VIII. Export Revenue Forecast 59
A. Scope of investigation 59
B. Export revenue methodology 59
C. Export revenue forecast results 60
D. Fuel and power purchases 61
E. Manitoba Hydro assumptions regarding future contracts 63
F. Daymark findings 63
IX. Keeyask Scenarios 64
A. Scope of investigation 64
B. Manitoba Hydro analysis 65
C. Daymark findings 69
X. Operations During 2021/22 Drought 71
A. Scope of investigation 71
B. Overview of the 2021/22 drought conditions 72
C. Summary of Manitoba Hydro's policies and processes 77
D. Manitoba Hydro hydrology modeling implications 80
E. 2021/22 drought operations 81
F. Manitoba Hydro price hedging activity 87
Appendix A: Independent Expert Consultant scope of work 94

TABLE OF FIGURES

Figure 1. Manitoba Hydro watershed and major sub-basins 15
Figure 2. OPBIFF Phases – Forecast Locations 16
Figure 3. Inflow forecasting and blending timeframes 17
Figure 4. MISO UCAP percentage by fuel, 2017 and 2021 26
Figure 5. MISO energy percentage by fuel, 2017 and 2021 27
Figure 6. MISO 2022 RRA results, energy mix 28
Figure 7. MISO 2022 RRA results, capacity additions and retirements 29
Figure 8. MISO Futures Report, age-based retirement assumptions 30
Figure 9. MISO Futures Report, total retirements 31
Figure 10. MISO LRZ map 32
Figure 11. MISO subregions 32
Figure 12. 2022 MISO RRA, LRZ 1 load growth assumptions 33
Figure 13. 2022 MISO RRA, LRZ 1 accredited capacity and required reserves 34
Figure 14. 2022 NERC LTRA, MISO reserve margin 35
Figure 15. Extraprovincial revenue, firm and opportunity sales 39
Figure 16. Near-term MHEB price forecasts 41
Figure 17. Range of consultant forecasts of long-term MHEB energy prices 43
Figure 18. On-peak energy price forecasts at MHEB ($2022/MWh) 45
Figure 19. Off-peak energy price forecasts at MHEB ($2022/MWh) 45
Figure 20. Firm and opportunity energy sales 49
Figure 21. MH energy supply by source 53
Figure 22. MH energy demand by source 54
Figure 23. MH winter capacity balance 56
Figure 24. MH summer capacity balance 56
Figure 25. Extraprovincial revenue, firm and opportunity sales 60
Figure 26. U.S. opportunity sales revenue, on-peak & off-peak 61
Figure 27. Fuel and purchased power expenses by subcategory 62
Figure 28. Keeyask scenarios, annual total revenue 68
Figure 29. Keeyask scenarios, cumulative total revenue 69
Figure 30. Total system inflows, September 2020 – November 2021 74
Figure 31. Potential Hydraulic Energy From Inflows – All Basins 74
Figure 32. Total potential energy in storage 75
Figure 33. Jenpeg total outflow as of January 2022 85
Figure 34. Potential energy in storage, January 2022 86
Figure 35. Henry Hub natural gas price, July 1, 2021, to December 31, 2021 89
Figure 36. Financial performance of Winter 2021/22 hedging activities 91
Figure 37. Henry Hub natural gas price, January 3, 2022, to March 31, 2022 91
Figure 38. MINN HUB day-ahead energy price, January 1, 2022, to March 31, 2022 92

TABLE OF TABLES

Table 1. Map of Scope of Work items to report sections....................12
Table 2. State and utility renewable and carbon goals....................25
Table 3. Manitoba Hydro export contract portfolio....................50
Table 4. Precipitation Basins Report for April 24, 2021, to June 22, 2021....................76

LIST OF ACRONYMS

CAGR	compound annual growth rate
CO_2	carbon dioxide
DRS	Drought Reserve Storage
ECCC	Environment and Climate Change Canada
EIA	Energy Information Administration
EIS	energy in storage
EOP	Energy Operations Planning
ERM	Enterprise Risk Management
ESP	Energy Supply Planning
FERC	Federal Energy Regulatory Commission
FEWS	Flood Early Warning System
FVR	Forward Volumes Report
GES	Generation Environmental Services
GRA	General Rate Application
GSPRO	Generation System Simulation, Planning and Resource Optimization
GW	gigawatt
GWh	gigawatt hour
HEFI	hydraulic energy from inflow
ICR	Indigenous and Community Relations
IEC	Independent Expert Consultant
IR	information request
IRA	Inflation Reduction Act
KHLP	Keeyask Hydropower Limited Partnership
kW	kilowatt
kWh	kilowatt hour
LRZ	Local Resource Zone
LTRA	Long-Term Reliability Assessment
MFR	Minimum Filing Requirement
MH	Manitoba Hydro
MISO	Midcontinent Independent System Operator
MW	megawatt
MWh	megawatt-hour
NERC	North American Electric Reliability Council
NFAT	Needs For and Alternatives To
OPBIFF	Operational Physically Based Inflow Forecasting Framework
PBIF	physically-based inflow forecasting

LIST OF ACRONYMS (CONTINUED)

PRA	MISO Planning Resource Auction
PUB	Public Utilities Board of Manitoba
RPPS	Resource Planning and Production Scheduling
RPS	renewable portfolio standard
RRA	Regional Resource Assessment
SCD	System Control Department
SPLASH	Simulation Program for Long-term Analysis of System Hydraulics
UCAP	unforced capacity
USGPIPD	U.S. Gross Domestic Product Implicit Price Deflator
WAM	Waterway Approvals and Monitoring
WPT	Wholesale Power Trading

EXECUTIVE SUMMARY

On November 15, 2022, Manitoba Hydro (MH) filed its 2023/24 and 2024/25 General Rate Application (GRA) with the Public Utilities Board of Manitoba (PUB or the "Board") seeking an Order to finalize an interim Board order increasing rates effective January 1, 2022, and approving proposed rate increases to support increases in General Consumers Revenue of 3.5% effective September 1, 2023, and 3.5% effective April 1, 2024. This application was amended on December 9, 2022, to incorporate a reduction in the Provincial Debt Guarantee and water rental fees; the amended application reduced the requested revenue increases to 2.0% in each GRA year.

The PUB retained Daymark Energy Advisors as its Independent Expert Consultant (IEC) to review and assess specific components of MH's GRA Filing. The Daymark Scope of Work (attached as Appendix A to this report) contained twelve individual scope items focused around answering two central thematic questions:

1. Is the forecast of export energy and capacity included in the net extraprovincial revenues in GRA application reasonable, based on accurate modeling and hydrology analysis, and consistent with plausible market futures?
2. During the 2021/22 drought, did MH effectively operate its system to balance reliability with cost, with the objective of minimizing the economic impact of the drought, and did MH's recently-modified modeling and hydrology practices improve the ability to respond to water conditions?

Daymark reviewed the GRA filing in detail, along with MH responses to information requests (IRs) from the Board and multiple intervenors. Daymark also engaged in multiple virtual and in-person discussions with MH personnel to obtain detail and clarity on various policies, procedures, analytical tools, and forecasting elements to assist in our evaluation of the items in the Daymark Scope of Work.

Based on our review of the evidence in this matter and the supplemental information received from the Corporation, we offer the following findings.

Question #1: Export revenues

Daymark finds that, overall, MH's forecast of export revenue is reasonable, and reflects sound analysis of future system inflows, energy generation, export prices, and contract revenues. MH has implemented several upgrades to its hydrology and inflow forecasting methods, as well as its energy modeling tools. The result is a revenue forecast based on more granular data and more detailed analysis. While we conclude the revenue forecast is reasonable, it is a conservative forecast, and MH should actively monitor export markets for opportunities to see premiums for its energy and capacity sales.

In support of this general finding, we offer the following observations:

1. The short-term and long-term export price forecasts are reasonable, and the low and high sensitivities reflect a reasonable range of future market conditions.
2. The export contract terms are appropriately reflected in the modeling and export revenue forecast.
3. The inflow forecasting changes align with near-term and long-term energy modeling improvements, which have increased the ability to model system conditions and constraints.
4. MH is projecting lower export volumes due to higher domestic demand, and lower export energy prices due in part to increase renewable development in the MISO market. In addition, the possible transition of MISO to a winter-peaking system lowers potential seasonal diversity exchanges. In combination, these suggest that maximizing net extraprovincial revenue may be more challenging than in the past.
5. Despite those challenges, there is significant change occurring in MISO and significant need for clean firm energy (for capacity and for balancing) projected over time, potentially driving an increase in the market value of MH's products. This suggests that MH should remain active with MISO and other US stakeholders to seek opportunities and to help shape future market changes to allow MH to maximize the value of its hydro energy.

Question #2: Drought operations and risk management

Overall, MH managed its hydrology and energy forecasting, operations, and hedging effectively to adjust priorities as drought unfolded in 2021. MH followed its policies appropriately. We do not find any fundamental issues of note related to Scope items #10, #11 or #12. We do find that some policies and supporting documentation enhancements could be beneficial.

In support of this general finding, we offer the following observations:

1. MH does not operate its system in a fundamentally different manner during drought.
2. MH did execute additional oversight and risk management consistent with its policies to ensure they maintained a safe and reliable system while accounting for competing operational and stakeholder priorities.

3. MH's move to a 40 year hydrology (and their use of their hydrology and forecasting tools in general) was effective and produced a measured but increasingly strong response to the risk of further drought conditions.
4. MH policies are reasonable and provide appropriate oversight and approval authority guidance. There could be ways for MH to better articulate trading risk in a manner that distinguishes risks from purchasing power from risks from selling power, which are likely different and may not be symmetrical.
5. MH operations are extremely complex and much of the knowledge necessary to make appropriate trade-offs during adverse water conditions appears to reside in the minds of its many experts.
6. While MH does a good job of bringing those experts together to ensure collaboration around mid-year adjustments to reflect the varied and competing priorities that guide system operations, MH might benefit from an effort to capture more of that expert knowledge into documentation.
7. After the conclusion of drought conditions, MH implemented multiple internal process changes to improve its ability to respond to future drought conditions.

I. INTRODUCTION

The Manitoba PUB retained Daymark as its IEC to review multiple technical issues contained within Manitoba Hydro's 2023/24 & 2024/25 GRA filing. Daymark has supported the PUB on multiple occasions over the past 10 years, providing expertise in diverse technical areas, including resource planning, economic cost-benefit analysis, market analysis and pricing, contract review, load forecasting, energy efficiency program evaluation, and policy expertise.

The GRA Filing comes during a time of significant change and uncertainty in energy conditions in Manitoba and its neighboring markets in the U.S. and Canada. Energy systems are undergoing significant transition driven by decarbonization policy, economic drivers, and customer preferences. The MH system is expecting increasing load growth that will put pressure on energy and capacity margins, and major long-term contracts are set to expire over the next several years. Against this backdrop, MH has faced back-to-back years with extreme water conditions. In 2021/22 MH experienced a prolonged drought, followed by a rapid transition to extreme rainfall and flood conditions. These conditions – both broader market trends and province specific physical conditions – all impact the GRA filing and are addressed by elements of the Daymark Scope of Work.

This section describes Daymark's scope for this proceeding and details our approach in performing our duties as IEC.

A. Scope overview

The Daymark Scope of Work is attached as Appendix A to this report and contains twelve individual scope items collected under two categories: *Export Pricing and Revenues Review*, and *Reservoir and System Operations During the Drought of 2021/22*. The primary topics under each of these topics are summarized below.

<u>Export Pricing and Revenues Review</u>

- Reasonableness of energy price forecasts
- Review of export revenue forecasts, including the dependable energy modeling tools and methods
- Hydrology and inflow forecasting methodology
- MH's scenarios and calculated revenues from the Keeyask Generating Station
- Status of MISO market conditions and commentary on future outlook, including future availability of export contracts

Reservoir and System Operations During the Drought of 2021/22

- Review MH's operations during the drought and assess whether costs and risks were appropriately managed
- Assess how inflow forecasting methods and the change to a 40-year record impacted drought response
- Reasonableness of price risk management policy

The table below maps the individual scope items to the sections of this report.[1]

Table 1. Map of Scope of Work items to report sections

REPORT SECTION	SCOPE ITEM(S)
II. Inflow forecasting and dependable energy modeling	3, 4
III. MISO market overview and outlook	8, 9
IV. Export price forecast	1
V. Export contract review	6
VI. Export energy volume forecast	2
VII. Export capacity volume forecast	2
VIII. Export revenue forecast	5
IX. Keeyask scenarios	7
X. Operations during 2021/22 drought	10, 11, 12

B. Daymark approach

We structured our investigation to develop a thorough understanding of the pertinent areas of MH's planning, operations, and forecasting that relate to our scope areas. Our primary source of initial information was the materials filed on the record in this proceeding and provided in response to information requests.

1 The version of the scope of work posted on the PUB website inadvertently combined scope items #2 and #3 in the numbering scheme. For the purposes of this report, Daymark corrected this issue and uses the numbering noted in Appendix A. http://www.pubmanitoba.ca/v1/proceedings-decisions/appl-current/pubs/2022-mh-gra/dea-scope.pdf

Since some of our scope items were not directly addressed in the GRA Filing, we supplemented this review with multiple conversations with MH personnel. We had multiple virtual meetings with MH, including five extensive virtual meetings with subject matter experts from both Daymark and MH. These meetings covered specific aspects of the GRA Filing and Daymark's scope as IEC. In addition, personnel from Daymark traveled to Winnipeg for full-day on-site meetings with MH personnel from February 21-23.

During the in-person meetings, Daymark requested specific information and files supporting various elements of MH's GRA Filing, and other documents relevant to our scope. MH was very responsive to those requests, providing nearly 1,500 individual electronic files.

In addition to these materials, Daymark reviewed the Interim Rate Application materials and IRs submitted in that proceeding. We also reviewed materials from the 2017/18 & 2018/19 GRA proceeding, including our report and summary presentation. We also conducted independent research and analysis of MISO market conditions and energy and natural gas market prices.

Lastly, we relied on our prior experience serving as expert consultants in Manitoba PUB proceedings and our general expertise in U.S. and Canadian energy markets and policy.

II. INFLOW FORECASTING AND ENERGY MODELING

The outlook on MH's exportable surplus energy and related extraprovincial revenue is primarily influenced by two key analytical processes. The *inflow forecasting* determines the expected short- to medium-term water supply, and the *energy modeling* converts water supply into an energy quantity that is used to meet firm load and exported as opportunity sales.

MH has made notable changes to both processes in recent years. Changes to the inflow forecasting were primarily driven by the Operational Physically Based Inflow Forecasting Framework (OPBIFF) project. The use of physically-based inflow forecasting (PBIF) represents a significant change in forecasting capabilities. MH has started the implementation of the OPBIFF project, and as a result, the inflow forecasting and energy modeling has changed to include a combination of physical and statistical forecasting. The PBIF process requires a specific type and granularity of data that is only available for the past 30 years. Those 30 years do not sufficiently reflect the variability of flow conditions, so MH has developed a methodology that uses 30 years of PBIF and 10 years of statistical-only flow years.

The major change to the long-term energy modeling process is the transition from the SPLASH model to a new platform, GSPRO.

MH's application, MFRs, and responses to IRs contains extensive detail about the transition and the methodology. The remainder of this section provides a discussion of the key elements of these changes as they relate to Daymark's scope of work. The elements include MH watershed and hydraulic system, inflow forecasting and flow case development, and energy modeling.

A. MH watershed and hydraulic system

Manitoba Hydro's energy production is the result of reservoirs and flows within the watershed of which Manitoba is a significant part. The Nelson-Churchill watershed is a vast area encompassing over 1.4 million square kilometers. It features diverse land areas and physical conditions and includes portions of multiple Canadian provinces and U.S. states.

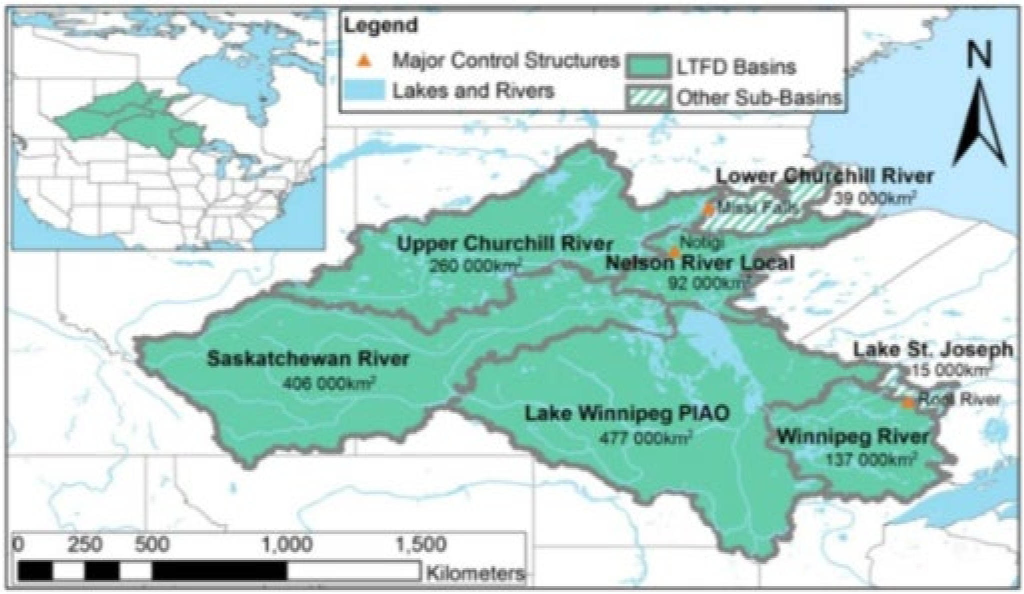

Figure 1. Manitoba Hydro watershed and major sub-basins[2]

MH represents individual forecast locations, or "nodes", around the watershed in its inflow forecasting, and the OPBIFF project will eventually develop PBIF models for most of these nodes. MH is transitioning the forecasting in three phases, prioritizing the nodes that represent the greatest portions of system inflow. Phase 1 locations were deployed in Spring of 2021; Phase 2 is presently underway and Phase 3 will begin in the next few years. Figure 2 identifies the nodes that will be converted to PBIF locations through the three phases. The phases were designed to ensure greatest impact, in terms of increased forecasting potential of hydraulic energy from inflow (HEFI), by starting with flows that more directly impact the production of hydro energy. Because such a large percentage of MH energy production is centered on the Nelson River and a large portion of storage relates to the Winnipeg River and Lake Winnipeg, those areas were prioritized in Phase 1.

2 GRA Filing, Appendix 5.4 – Flow Forecasting and Hydrology, Figure 4, p. 10.

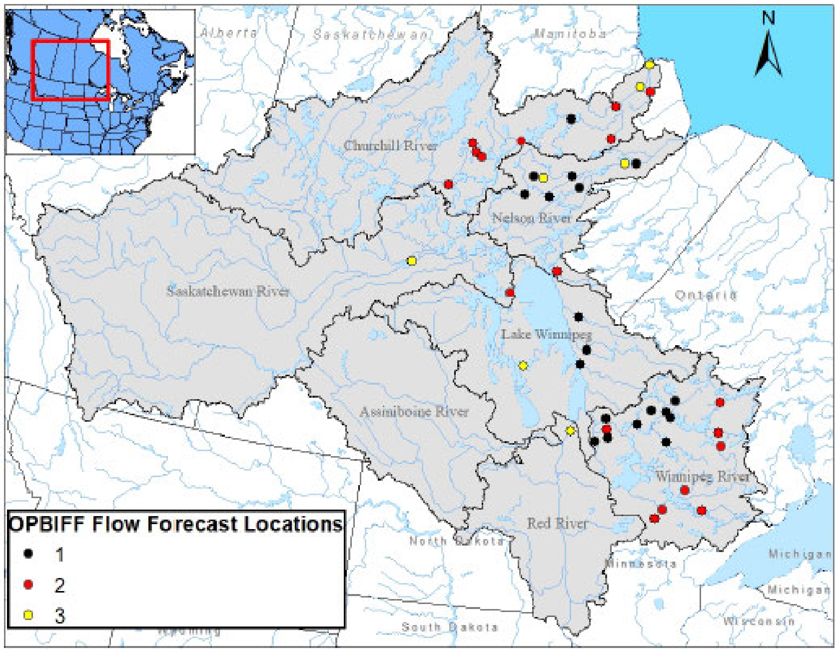

Figure 2. OPBIFF Phases – Forecast Locations[3]

The PBIF method requires specific data types, and these data are only available on an historical basis for the past 30 years. Since the 30-year record does not sufficiently cover the range of potential flow conditions, MH uses a combination of datasets to develop flow cases: a PBIF process for the last 30 years of data combined with a statistically-based process for the 10 years prior to that. The 40-year period "captures 95% of the hydrologic variability within the full [LTFD]."[4]

B. Inflow forecasting and flow case development

Forecasting system inflows and developing the flow cases used in system modeling are key pieces of MH's system operations and revenue forecasting. The OPBIFF project is introducing significant changes in the methodology and data sources used for the near-term and medium-term forecasting. Figure 3 below depicts flow case development using the near-term single trace forecast, the medium-term forecast using a combination of PBIF and statistically-based forecasts, and the long-term flow cases using the historical LTFD record. The methods used for each time frame are briefly discussed below. The figure demonstrates the data sources and blending for a forecast for a single node; the

[3] Source: Manitoba Hydro.

[4] GRA Filing, Appendix 5.4 – Flow Forecasting and Hydrology, p. 7.

blue lines represent the process for PBIF nodes for a year with suitable data availability (i.e., the past 30 years), and the red lines represent the process for years using statistically-based forecast methods.

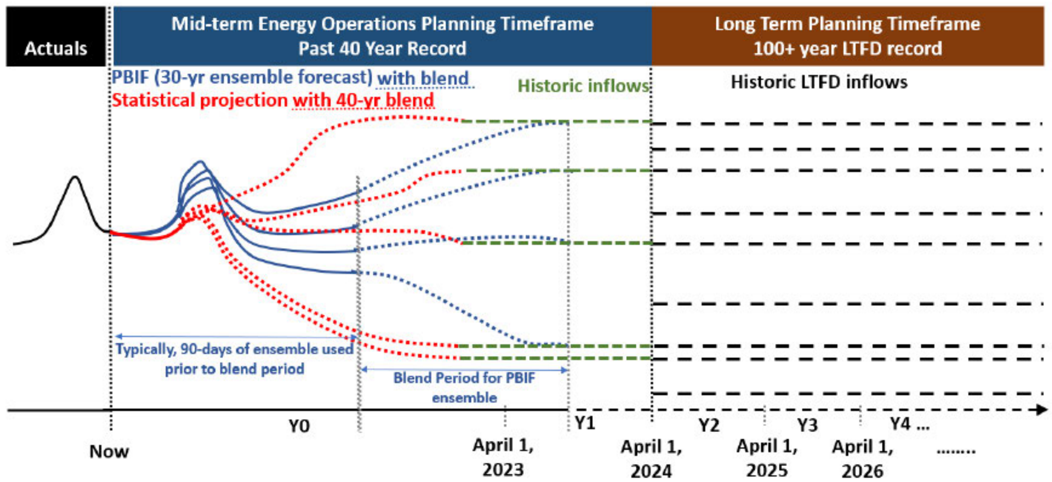

Figure 3. Inflow forecasting and blending timeframes[5]

Near-term

As described by MH, in the near-term, "inflow forecasts use meteorological forecast and hindcast data from Environment and Climate Change Canada (ECCC) to produce a deterministic ('single trace') inflow forecast for the first 16 days."[6] This relies on multiple meteorological data sets covering different time periods, with varying levels of granularity.

In Figure 3 above, this near-term single trace forecast is the beginning of the single solid blue or red line, where there is no variation between the flow cases.

Medium-term

The medium term starts with day 17 and extends out until the end of Y1. This is the period during which MH transitions to and models hydrology based on their most recent 40 years of data. First, after the 16-day single-trace, the flow forecast transitions to a seasonal "Ensemble Streamflow Prediction forecast," typically for 90 days.[7] For a PBIF

[5] Id at p. 7, Figure 2.

[6] Id. at pp. 3-4.

[7] Id at p. 4.

location, this uses the historical precipitation and temperature data over the past 30 years as inputs to the model to produce an inflow forecast for each weather year. As discussed above, to build out the full 40-year record needed to capture 95% of the variability, MH uses the statistically-based method for the first 10 years of the record when the data needed for the PBIF method is unavailable. This produces 30 forecast cases using the PBIF process and 10 using the statistical process. Each of these forecasts is then blended into the actual historic inflows for each of the years. This is reflected in Figure 3 above by the dotted blue and red lines that blend into the green dotted lines, which represent the historic inflows. After the blend period, the remainder of the medium-term forecasting period is the 40 most recent historic flows until the start of Y2, which is the transition to long-term forecasting.

Long-term

The long-term planning timeframe uses the full 100+ year LTFD record. The historic inflows for each year are used as direct inputs to the model, rather than as inputs to the PBIF or statistically-based process.

C. Energy modeling

The flow case development described in the preceding section provides key inputs to the energy modeling, which in turn forms the foundation of the export revenue forecast. Energy modeling is conducted using two different software platforms, one for short/mid-term and one for long-term. Both platforms contain detailed representations of the MH system, including loads, generation, internal transmission and external tie-lines, external markets, and a representation of a variety of operational constraints. Other key inputs include the characteristics of the firm export contracts and market prices, especially natural gas prices and MISO energy market prices.

Short/mid-term energy modeling

Within the GRA filing, the short/mid-term modeling covers the 22/23 and 23/24 years. For these periods, flow cases are inputs to HERMES, which has a detailed representation of the MH system. The model economically optimizes the system to meet load and maximize export revenue subject to physical constraints. MH has used this tool for many years to model current year and budget year (Y1) operations. One change since the 2017/18 GRA is that MH has expanded the use of HERMES to also model Y2 using the 100+ year flow data set, rather than using the Simulation Program for Long-term Analysis of System Hydraulics (SPLASH) for Y2.

Long-term energy modeling

As discussed above, long-term modeling technically starts with 100+ HERMES runs for Y2. For long-term modeling starting in Y3, MH uses a different simulation model. Since the 2017/18 GRA, MH implemented changes to the methodology used to forecast the amount of dependable and opportunity energy available and related extra-provincial revenues.[8] Historically, MH used the SPLASH model as its in-house long term production cost model for all long-term model runs starting in Y2. Recently, MH transitioned to a commercially-available model through PSR called the Generation System Simulation, Planning and Resource Optimization (GSPRO) system.[9]

MH has identified several advantages of the GSPRO model. According to MH, the SPLASH model was built on old IT infrastructure and was reaching the limits of its capabilities when modeling new system conditions. For example, SPLASH did not have the ability to model solar resources. Maintaining and improving the SPLASH model would have involved a significant investment, and the use of a commercial product puts those development costs and responsibilities on the vendor development team.

But beyond the technical drivers for the change, there are clear functionality improvements that MH is taking advantage of with its new modeling tool and approach. First, GSPRO includes consideration of uncertainty in future water conditions, solving one month of system operations at a time without foresight of future flow conditions. SPLASH, on the other hand, had “perfect foresight” of future water conditions. When a model has perfect foresight of a variable that is highly uncertain in reality (such as flow conditions), the model results may not be as reasonable. The GSPRO model has more uncertainty built in, and this new functionality allows for a more realistic system simulation over time. In addition, GSPRO has a much higher degree of granularity, categorizing load periods into 21 unique monthly blocks, while SPLASH only modeled two blocks (on-peak and off-peak). This additional granularity lowers the error range for modeling load conditions and provides more realistic results. Lastly, GSPRO includes a much more detailed representation of the transmission system, which allows for better modeling of losses and constraints on the system.

8 GRA Filing Tab 05 – Energy & Supply Assumptions pg. 40.

9 Id. at pp. 40-41.

D. Other changes since 2017/18 GRA

In addition to the key changes in energy modeling described in the preceding section, MH has made some smaller changes to its forecasting processes:[10]

- Increased allowance of imports as dependable energy due to new transmission interconnections
- Included SPC 215 MW export contract in the analysis
- Reduced thermal dependable energy due to disconnection of Selkirk Generating Station
- Improved modeling of transmission losses under dependable flow conditions

E. Transition to 40-year flow record for budget year analysis

One of the key changes to MH's methodology in this GRA is the transition to the physically-based inflow forecast and the related change to using a 40-year flow record for the budget year in place of the 100+ year record used previously. MH provided substantial documentation in this proceeding concerning the different considerations related to length of flow record. MH conducted an internal analysis (*A Review of Hydrologic Variability as Represented by Streamflow Time Series of Varied Lengths*) to describe and analyze the potential advantages and disadvantages of the different flow records.[11] MH also provided analysis of the impact of the change in flow record length in MFR 41, and provided additional discussion of the differences in response to IRs.[12] This is in addition to materials explaining the differences in flow records provided in the Interim Rate Application.[13]

One key point to this discussion is the connection of the change in flow record duration to the change to the PBIF process. The PBIF process caused a change in the needs for data resolution and using a 40-year flow record allows MH to leverage the forecasting improvements related to the PBIF.

In addition to the relationship to PBIF, MH notes that the higher spatial and temporal resolution of the data in the 40-year data improves modeling of specific key components of the system, adding specificity to the mid-term revenue forecasting when compared to the prior LTFD-based method. For example, the updated method allows for modeling of

10 GRA Filing Tab 5 – Energy Demand & Supply Assumptions, pp. 41-42. See also PUB/MH I-49.

11 GRA Filing, Appendix 5.4 – Flow Forecasting and Hydrology, Section 5.

12 See, e.g., PUB/MH I-59.

13 See, e.g., Interim Rate Application, Coalition/MH I-1a-d, PUB/MH I-3.

upstream storage reservoirs. MH indicates that this allows it to reflect changes in reservoir operating rules (e.g. drawdown limits) when using historical inflow data to model revenues under current rules.

Lastly, the shorter flow record recognizes that there may be long-term hydrology trends that would make using a shorter, more recent flow record more statistically appropriate for forecasting purposes. This is known as "non-stationarity."[14]

F. Daymark findings

Hydrology, inflow forecasting, and energy modeling are key analytical elements of the GRA and form the foundation of several other areas of the Daymark Scope of Work related to export revenue analysis and drought operations. Daymark reviewed the detailed information provided by MH in the GRA materials. In addition, these items were key topics of discussion during multiple meetings between Daymark and MH subject matter experts.

Based on our review, we find that the MH has made significant advances in its inflow forecasting methodologies to improve the near-term forecasting using the PBIF process. MH is continuing to phase in more PBIF locations, and the Corporation's experience so far indicates that the continued work on the hydrological models will improve forecasting outcomes in the future.

Similarly, we find that MH has made significant improvements to its long-term dependable and opportunity energy modeling processes, incorporating advancements in data and availability, and transitioning to more advanced models to better reflect load shapes, transmission topology, inflow data, and operational constraints.

Regarding the specific question concerning the transition to the 40-year flow record from the 100-year record for the budget year, we find that MH's justification for this change is satisfactory. There are significant benefits to the spatial and temporal data granularity in the 40-year record, as discussed above. MH recognizes the tradeoffs between the two approaches and appears committed to continuous revaluation of its approaches and methods to determine the most effective analytical methods.

[14] GRA Filing, Appendix 5.4 – Flow Forecasting and Hydrology, Section 5, p. 57.

III. MISO MARKET OVERVIEW AND OUTLOOK

Manitoba Hydro engages in significant trade with the Midcontinent Independent System Operator (MISO) region through both long-term bilateral contracts with U.S. utilities and market purchases and sales. The MISO region is the destination of most of MH exports, and thus the market developments in that region are key elements of MH's long-term revenue outlook and planning priorities.

This section reviews MH's outlook on the MISO market and how that outlook impacts the GRA analysis and includes a review of key information about the MISO region and notable changes since the 2017/18 GRA.

A. Scope of investigation

Daymark's Scope of Work includes the following Item #9:

> *Provide comments on the factors influencing the MISO market and trends that are affecting market prices, including but not limited to:*
>
> a. *state and federal policies on electricity generation and emissions;*
> b. *existing generation mix;*
> c. *expected new generation to be installed in the next 20 years;*
> d. *forecasted generation retirements in the next 20 years;*
> e. *supply and demand balance in the northern MISO region; and*
> f. *factors that may affect Manitoba Hydro's ability to export energy and capacity into the MISO market*

Related to item (f) in that list item, the Daymark Scope of Work also includes Item #8:

> *Assess the reasonableness of Manitoba Hydro's assumption that a minimum level of seasonal diversity contracts will no longer be available following the expiration of its existing seasonal diversity contracts.*

Daymark regularly conducts business with clients in MISO or who have interests in MISO and is engaged in monitoring, forecasting, and advising clients regarding MISO markets. To supplement our general expertise in the region, Daymark conducted research on the MISO market conditions and trends related to these items and we summarize the points most relevant to the GRA filing in the following sections.

In addition, we reviewed the GRA filing and MH responses to IRs related to its outlook on MISO market conditions and how that outlook impacts various assumptions used in the GRA analysis. Daymark also met with MH personnel to discuss the Corporation's view on future MISO market conditions and their involvement in MISO stakeholder activities.

B. Manitoba Hydro's outlook on MISO market

As the primary market for MH's energy and capacity exports, developments in the MISO market are of significant interest to the Corporation. MH noted that the energy sector in the MISO is evolving quickly, with increased renewable development and changes to pricing trends. This section summarizes MH's outlook on the expected trends in the MISO market.

The GRA filing includes Appendix 4.2 – Export Market Conditions, which provides MH's views on the evolution of the MISO market and the implications for MH's export revenue. The filing notes that MISO export price forecasts are now exhibiting a downward trend in real dollars, and surmises that the increase in renewable resources is a primary cause. MH notes that "low variable cost renewables displace higher variable cost thermal resources and are anticipated to result in lower average market prices."[15]

MH also notes that electrification of heating in the U.S. is causing some MISO utilities to become "winter peaking", meaning that the moment of highest regional energy consumption will occur in the winter, instead of in the summer when air conditioning load has typically driven the annual peak. As such, this might result in less interest in seasonal diversity arrangements, in which MH provides capacity to MISO counterparties in the summer in exchange for capacity in the winter during the Manitoba peak period.[16] MH notes that this trend led to a change in its assumptions about the minimum level of seasonal diversity contracts.[17]

At the same time, MH also acknowledges as part of Strategy 2040 that "[t]he increase in demand for renewable, dependable, green energy puts Manitoba Hydro in an advantageous position."[18]

The uncertainty regarding specific elements of the future of the MISO market, along with MH's expectation that energy prices will reduce over time, has reduced MH's outlook of potential export revenues from the MISO markets. In Section III.H, below, we

15 GRA Filing, Appendix 4.2 – Export Market Conditions, p. 1.

16 Id. at p. 4.

17 GRA Filing, Tab 5 – Energy Demand & Supply Assumptions, p. 39.

18 GRA Filing, Tab 2 – Manitoba Hydro is strategically adapting to the changing future, p. 11.

respond to these concerns and discuss Daymark's view of potential MISO market changes.

C. State and federal policies on electricity generation and emissions

Across the U.S., including within the MISO region, the electricity sector is in a period of rapid transition, driven primarily by state and federal policies. These policies include both mandates for development of renewable resources in the case of renewable portfolio standards (RPS), as well as incentives (most notably in the form of tax credits) that lower the cost of renewable resource additions and improve the economic justification for these resources.

At the federal level, the Inflation Reduction Act (IRA) was enacted in August 2022, providing a major long-term boost to policies designed to incentivize renewable development in the U.S. The IRA extended and increased tax credits for renewable resources and created new credits for storage, green hydrogen, and nuclear resources. The IRA is multifaceted and includes additional incentives for electrification of heating, transportation, and cooking, as well as additional spending on increased efficiency and building insulation. The policy will inject billions of dollars over the coming years to promote economy-wide decarbonization and is a major driver of the renewed expectations for renewable project development.

Other federal initiatives in the U.S. relate to transmission development. There are well-recognized challenges to interconnecting new renewable resources and building the largescale transmission needed to deliver this renewable generation to load. The Federal Energy Regulatory Commission (FERC) is considering multiple new rulemakings to reduce barriers to interconnection and new transmission development. Simultaneously, the U.S. Department of Energy is considering designating National Interest Electric Transmission Corridors, which could potentially encourage high-voltage interregional transmission to allow faster and more widescale grid decarbonization.

At the state level, RPS policies and carbon targets require the development of large amounts of new renewable resources. Many states have strengthened policies or in some cases state Governors have issued non-binding targets for carbon neutrality. In addition, many utilities in the U.S. have developed independent targets for renewable resources or net emissions reductions that are more stringent than statutory requirements. Table 2, below, provides a summary of state and utility goals included in the 2021 MISO Futures Report.

Table 2. State and utility renewable and carbon goals[19]

<table>
<tr><th>State Clean Energy Goals & RPS[6] (source linked)</th><th>State</th><th>Utility</th><th>Utility Carbon Reduction Goals (2005 Baseline)[7]</th><th>Utility Renewable Energy Goals</th></tr>
<tr><td>RPS: 15% RE by 2021 (IOUs)</td><td>Missouri</td><td rowspan="2">Ameren</td><td rowspan="2">Net Zero by 2050*</td><td rowspan="2">100% by 2050</td></tr>
<tr><td rowspan="2">100% Clean Energy by 2050 (Governor)
RPS: 25% by 2025-2026</td><td rowspan="2">Illinois</td></tr>
<tr><td rowspan="2">MidAmerican Energy</td><td rowspan="2">-</td><td rowspan="2">100% by 2021</td></tr>
<tr><td rowspan="3">RPS: 105 MW (completed 2007)</td><td rowspan="3">Iowa</td></tr>
<tr><td>Alliant Energy</td><td>Carbon Free by 2050</td><td>30% by 2030*</td></tr>
<tr><td rowspan="2">Dairyland Power</td><td rowspan="2">-</td><td rowspan="2">29% by 2029</td></tr>
<tr><td rowspan="3">Carbon Free by 2050 (Governor)
RPS: 10% by 2020</td><td rowspan="3">Wisconsin</td></tr>
<tr><td>WEC Energy Group</td><td>Carbon Neutral by 2050</td><td>-</td></tr>
<tr><td>Madison Gas & Electric</td><td>Net Zero by 2050*</td><td>30% by 2030</td></tr>
<tr><td rowspan="3">Carbon Neutral by 2050*
RPS: 15% by 2021 (standard), 35% by 2025 (goal, including EE & DR)</td><td rowspan="3">Michigan</td><td>Consumers Energy</td><td>Net Zero by 2040</td><td>56% by 2040</td></tr>
<tr><td>DTE Energy</td><td>Net Zero by 2050</td><td>25% by 2030</td></tr>
<tr><td>Upper Peninsula Power</td><td>-</td><td>50% by 2025</td></tr>
<tr><td rowspan="4">Voluntary clean energy PS,
10% RE by 2025</td><td rowspan="4">Indiana</td><td>Duke Energy</td><td>Net Zero by 2050</td><td>16,000 MW by 2025</td></tr>
<tr><td>Hoosier Energy</td><td>80% by 2040</td><td>10% by 2025</td></tr>
<tr><td>Vectren</td><td>75% by 2035*</td><td>62% by 2025</td></tr>
<tr><td>NIPSCO</td><td>90% by 2028</td><td>65% by 2028</td></tr>
<tr><td rowspan="4">Carbon Free by 2050 (Governor)
RPS: 26.5% by 2025 (IOUs),
25% by 2025 (other utilities)</td><td rowspan="4">Minnesota</td><td>Xcel Energy</td><td>Carbon Free by 2050</td><td>100% by 2050</td></tr>
<tr><td>SMMPA</td><td>90% by 2030</td><td>75% by 2030</td></tr>
<tr><td>Minnesota Power</td><td>100% Clean Energy by 2050*</td><td>50% by 2021</td></tr>
<tr><td>Great River Energy</td><td>95% by 2023</td><td>50% by 2030</td></tr>
<tr><td>Net Zero GHG by 2050 (Governor)</td><td>Louisiana</td><td>Entergy</td><td>Net Zero by 2050
(2000 baseline)</td><td>12% by 2030*</td></tr>
</table>

In general, states have continued to strengthen energy and climate policies, so it is likely that many of these targets will accelerate in the coming years.

D. Existing generation mix

The MISO generation portfolio consists of diverse generating resources, including coal, natural gas, nuclear, wind, solar, and various others. Natural gas and coal are the primary sources of capacity making up more than 80% of unforced capacity (UCAP) in MISO.[20] The remaining capacity is supplied by a combination of nuclear, renewables, and other sources. There have been moderate changes to this capacity mix since 2017. Figure 4, below, provides the proportion of total MISO UCAP provided by each resource type.

19 MISO Futures Report. MISO, Published April 2021, updated December 2021. Table 1, p. 12. Available at: https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf.

20 Unforced capacity values include downward adjustments to nameplate capacity values to account for intermittency of renewable resources and forced outages of thermal units.

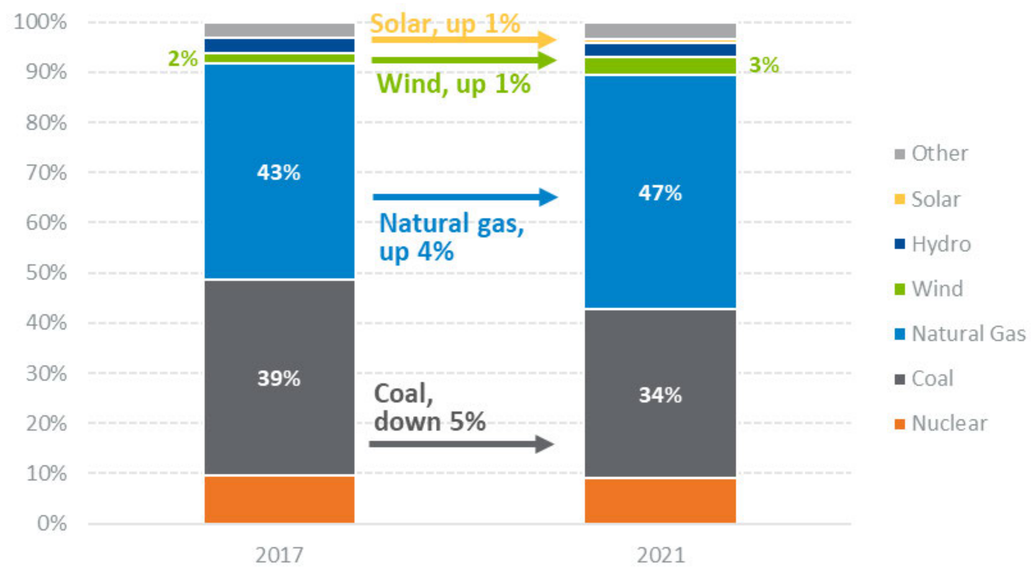

Figure 4. **MISO UCAP percentage by fuel, 2017 and 2021**[21]

Between 2017 and 2022 the share of capacity provided by coal units declined, replaced mostly by natural gas units. There was a small increase in capacity provided by wind and solar resources, but even though many new renewable projects have come online, those units are derated between the nameplate capacity value and the UCAP value, so the capacity contribution is not yet significant when compared to nuclear, coal, and natural gas.

On an energy basis, the portfolio transition has been more significant in the past several years as more wind resources have been added to the MISO system. Figure 5, below, shows the percentage of total system energy from each fuel in 2017 and 2021.

[21] Data sourced from:
2017 State of the Market Report for the MISO Electricity Markets. Potomac Economics, June 2018. Table 1, p. 4. Available at: https://www.potomaceconomics.com/wp-content/uploads/2018/07/2017-MISO-SOM_Report_6-26_Final.pdf
2021 State of the Market Report for the MISO Electricity Markets. Potomac Economics, June 2022. Table 1, p. 6. Available at: https://www.potomaceconomics.com/wp-content/uploads/2022/06/2021-MISO-SOM_Report_Body_Final.pdf

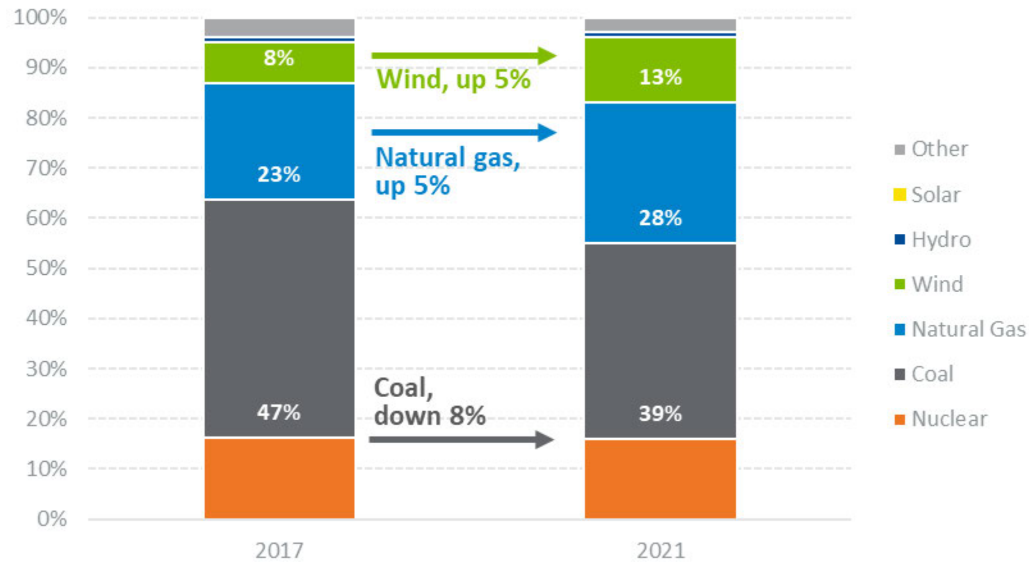

Figure 5. MISO energy percentage by fuel, 2017 and 2021[22]

These data show that wind has become a significant portion of the energy supply in MISO, providing 13% of the system energy in 2021. The portion of energy generated by natural gas also increased, and the increases in these fuels largely displaced coal units.

The changes in the supply portfolio are expected to accelerate in the coming years as state and federal policy continues to influence utility planning and independent generation developer investments. The following section discusses current expectations for supply evolution in the coming years.

E. Expected new generation to be installed in the next 20 years

Over the next 20 years, the MISO generation portfolio is expected to undergo a rapid transformation. This evolution will be driven by current policy objectives focused on decarbonization, resource retirements due to unit age, and the comparative economics of new renewable resources compared to existing conventional thermal units. The

[22] Data sourced from:
2017 State of the Market Report for the MISO Electricity Markets. Potomac Economics, June 2018. Table 1, p. 4. Available at: https://www.potomaceconomics.com/wp-content/uploads/2018/07/2017-MISO-SOM_Report_6-26_Final.pdf
2021 State of the Market Report for the MISO Electricity Markets. Potomac Economics, June 2022. Table 1, p. 6. Available at: https://www.potomaceconomics.com/wp-content/uploads/2022/06/2021-MISO-SOM_Report_Body_Final.pdf

change in resource portfolio will have implications for market pricing of energy, capacity, and ancillary services, as well as the relative value of different resource types.

In MISO, resource planning is not conducted in a centralized way for the whole region. Decisions to develop new generation resources and/or retire existing resources are made by individual utilities and independent project developers, influenced by various market conditions and state and federal policy signals. As such, it can be challenging to forecast the region's resource portfolio since the ultimate decisions are made by so many market actors and thus driven by many different factors and priorities. In addition, as described in Section III.C above, the pace of policy change is accelerating.

The most comprehensive outlook on future generation additions in the MISO region is the Regional Resource Assessment (RRA) prepared by MISO. The most recent version of this report was issued in November 2022 and it concludes that the renewable portion of the energy supply mix will increase rapidly over the next two decades. The RRA estimates that wind and solar will make up 28% of energy supply in 2026, 42% in 2031, 51% in 2036, and 60% in 2041 (Figure 6).

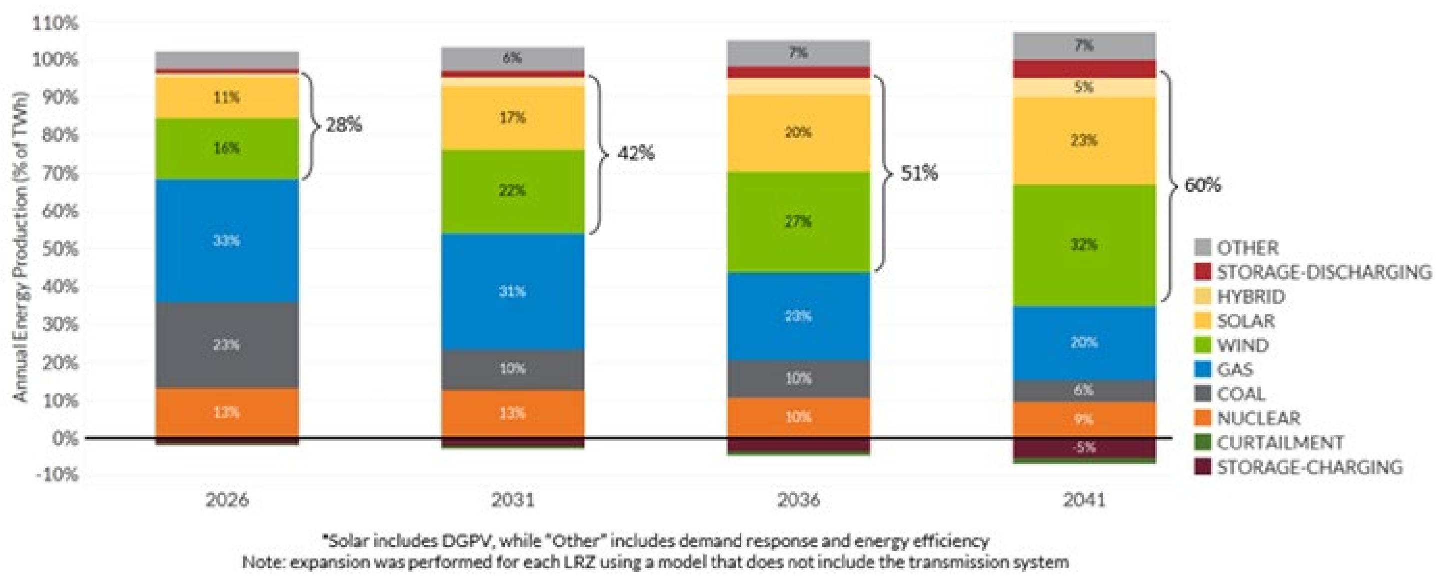

Figure 6. MISO 2022 RRA results, energy mix[23]

[23] 2022 Regional Resource Assessment. MISO, November 2022. Figure 3, p. 6. Available at: https://cdn.misoenergy.org/2022%20Regional%20Resource%20Assessment%20Report627163.pdf

In addition to the energy mix, the RRA included estimates of planned retirements and resource additions. Figure 7 provides the expected retirements and additions by Local Resource Zone (LRZ).

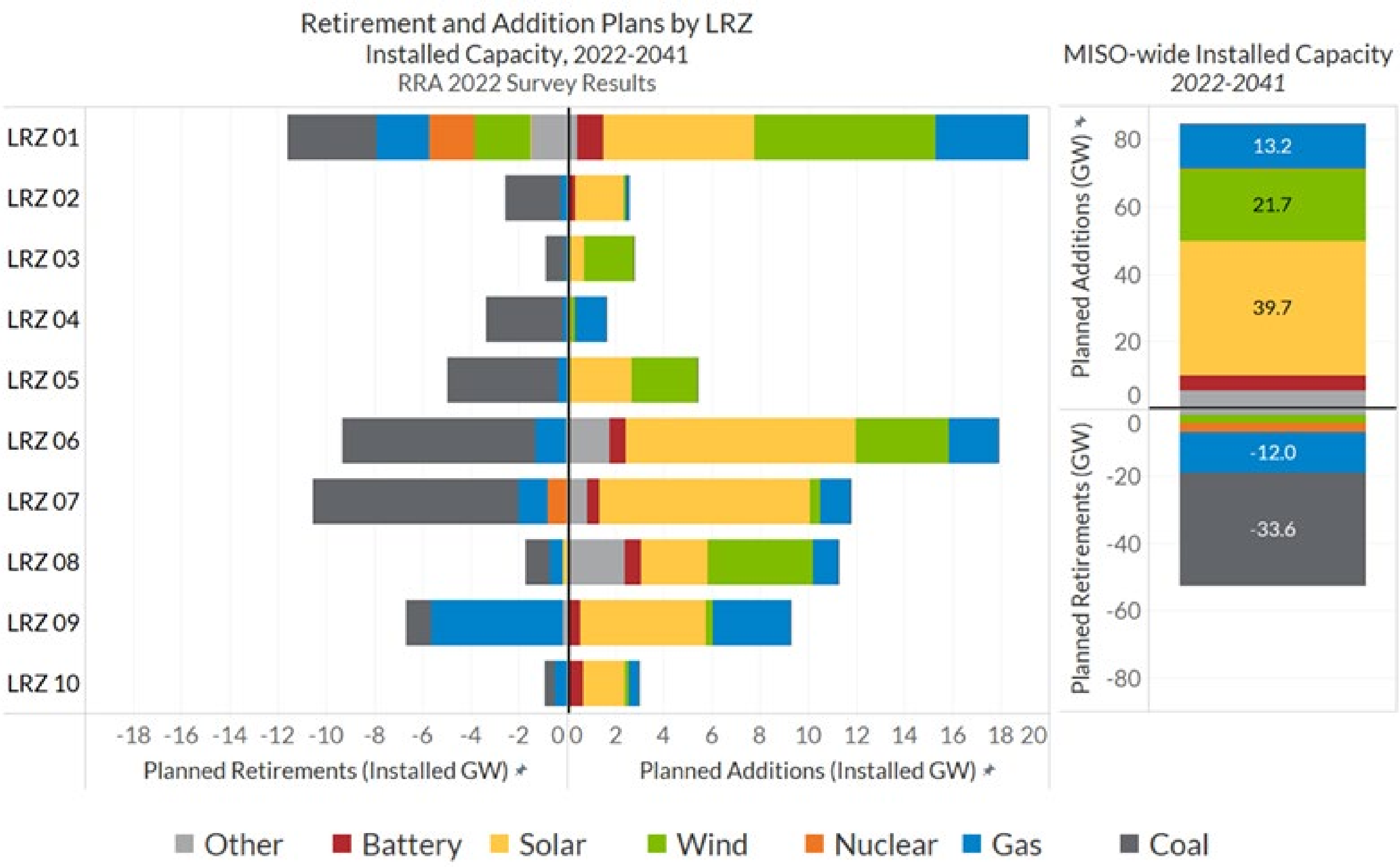

Figure 7. MISO 2022 RRA results, capacity additions and retirements[24]

The results show an expected MISO-wide addition of more than 60 GW of new wind and solar resources (nameplate) by 2041, and total retirements of more than 55 GW of coal and natural gas capacity. Of particular note, the LRZ with the highest expected MWs of retirements and additions is LRZ 1, which is the zone that borders Manitoba and includes Minnesota, North Dakota, and portions of Wisconsin, South Dakota, Illinois, and Montana. This indicates that the most important portion of the market for potential export of MH energy and capacity is the region expected to undergo the most change.

[24] 2022 Regional Resource Assessment. MISO, November 2022. Figure 10, p. 18. Available at: https://cdn.misoenergy.org/2022%20Regional%20Resource%20Assessment%20Report627163.pdf.

F. Forecasted generation retirements in the next 20 years

The previous section included results of the 2022 MISO RRA, which included an estimate of unit retirements totaling more than 55 GW of retirements MISO-wide, and more than 10 GW of retirements in LRZ 1 (Figure 7). Most of these retirements are coal and natural gas units, but there are some nuclear retirements as well, including several in LRZ 1. Because the RRA only includes *announced* retirements and does not project any retirements based on age or economics, it is likely to be a conservative analysis.[25]

In addition to the RRA, MISO also produces the MISO Futures Report, which does not use the same conservative assumptions. Instead, the MISO Futures Report includes age-based retirements in addition to announced retirements. The most recent report was produced in December 2021.[26] The analysis produces three future scenarios of capacity additions and retirements. Each of the three futures uses slightly different rules for the age threshold at which units retire (Figure 8).

	Future 1	Future 2	Future 3
Coal	46	36	30
Natural Gas – CC	50	45	35
Natural Gas – Other	46	36	30
Oil	45	40	35
Nuclear & Hydro	Retire if Publicly Announced	Retire if Publicly Announced	Retire if Publicly Announced
Solar – Utility-Scale	25	25	25
Wind – Utility-Scale	25	25	25

Figure 8. MISO Futures Report, age-based retirement assumptions[27]

With those assumed retirements added to the announced retirements, the MISO Futures Study projects total MISO-wide capacity retirements to range from approximately 80 GW to 110 GW by 2039 (Figure 9), significantly higher than the 50 GW of total announced retirements assumed in the 2022 RRA.

25 2022 Regional Resource Assessment. MISO, November 2022, p. 26. Available at: https://cdn.misoenergy.org/2022%20Regional%20Resource%20Assessment%20Report627163.pdf.

26 MISO Futures Report. MISO, Published April 2021, updated December 2021. Available at: https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf.

27 MISO Futures Report. MISO, Published April 2021, updated December 2021. P. 14. Available at: https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf.

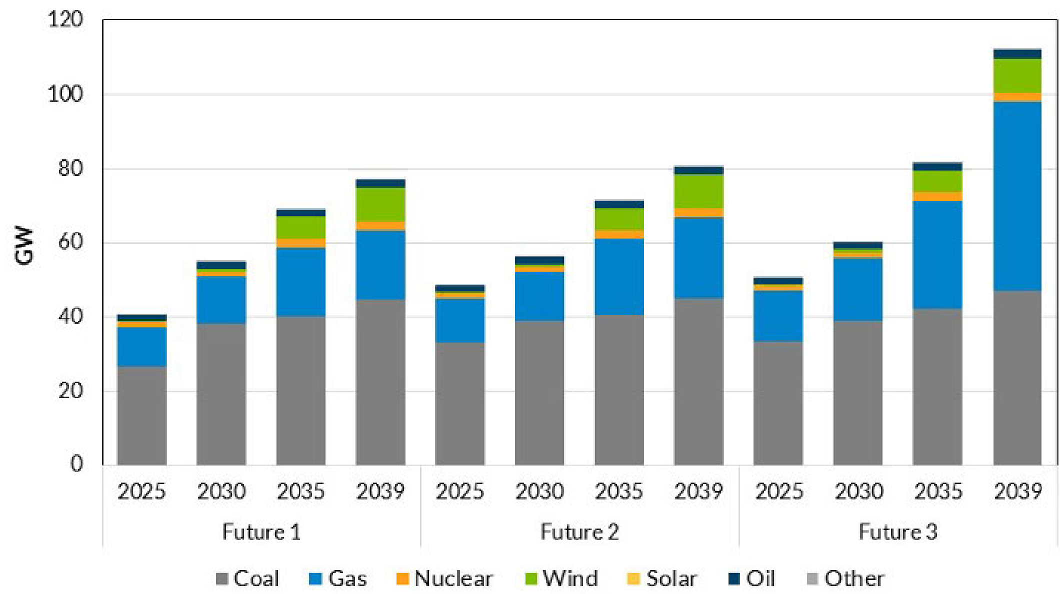

Figure 9. MISO Futures Report, total retirements[28]

A higher level of retirements as indicated by this analysis would suggest that the new resource additions could be even higher than the forecast in the RRA cited in the prior section.

G. Supply and demand balance in the northern MISO region

For the purposes of this report, Daymark defines the Northern MISO Region to be LRZ 1, which includes Minnesota, North Dakota, and portions of Wisconsin, South Dakota, Illinois, and Montana (see Figure 10).

[28] MISO Futures Report. MISO, Published April 2021, updated December 2021. P. 15. Available at: https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf

Figure 10. MISO LRZ map

This definition is slightly different than the "MISO North" subregion that is sometimes defined as Minnesota, Iowa, North Dakota, and portions of South Dakota and Montana (Figure 11).

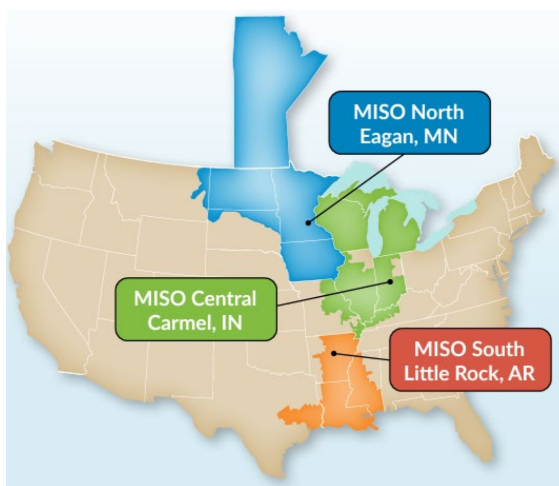

Figure 11. MISO subregions[29]

For this discussion of supply and demand balance, using the LRZ designation is more relevant because it aligns with how MISO considers capacity and resource adequacy.

29 MISO Fact Sheet, March 2023. Available at: https://cdn.misoenergy.org//Fact%20Sheet%20-%20March%202023627569.pdf

The 2022 MISO RRA report provides detailed LRZ-level analyses of load forecasts (energy and peak) and supply conditions (discussed in Section III.E above). The RRA includes assumptions of moderate growth in peak load and annual energy through 2024, with a compound annual growth rate (CAGR) of 1.23% for peak load and 1.22% for annual energy.

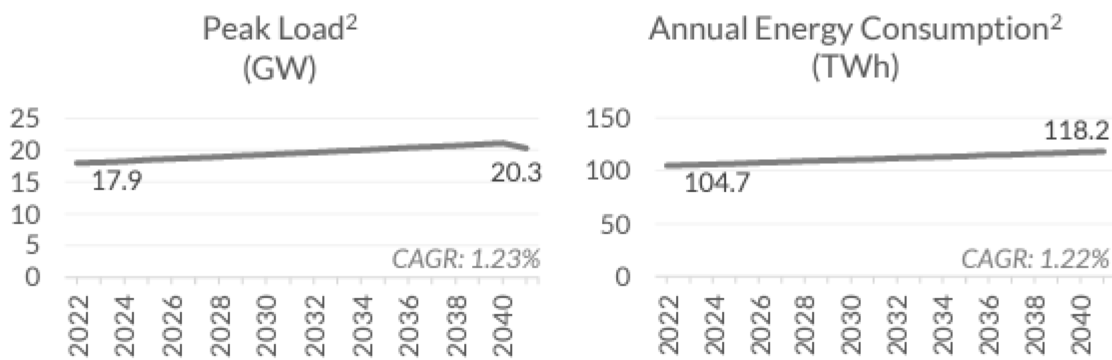

Figure 12. 2022 MISO RRA, LRZ 1 load growth assumptions[30]

The RRA concluded that after considering forecasted load growth, announced plans for generation retirements, and announced plans for new additions, the net effect is that LRZ 1 will have a capacity shortfall in just a few years. In Figure 13, below, the existing resources net of announced retirements is the dark blue bar, and the planned additions is represented by the light blue bar. The analysis assumes that the retirements and additions occur on schedule. To meet load plus reserve margin (the black line), the RRA model built additional new resources, represented by the light grey bar. These are theoretical projects, rather than specific projects actually in development. This indicates that northern MISO could have a capacity shortage in the near-term as the market responds to load growth and retirements.

30 2022 Regional Resource Assessment: LRZ-level Assumptions and Results. MISO, November 2022. P. 5. Available at: https://cdn.misoenergy.org/2022%20RRA%20LRZ-level%20Assumptions%20and%20Results626061.pdf

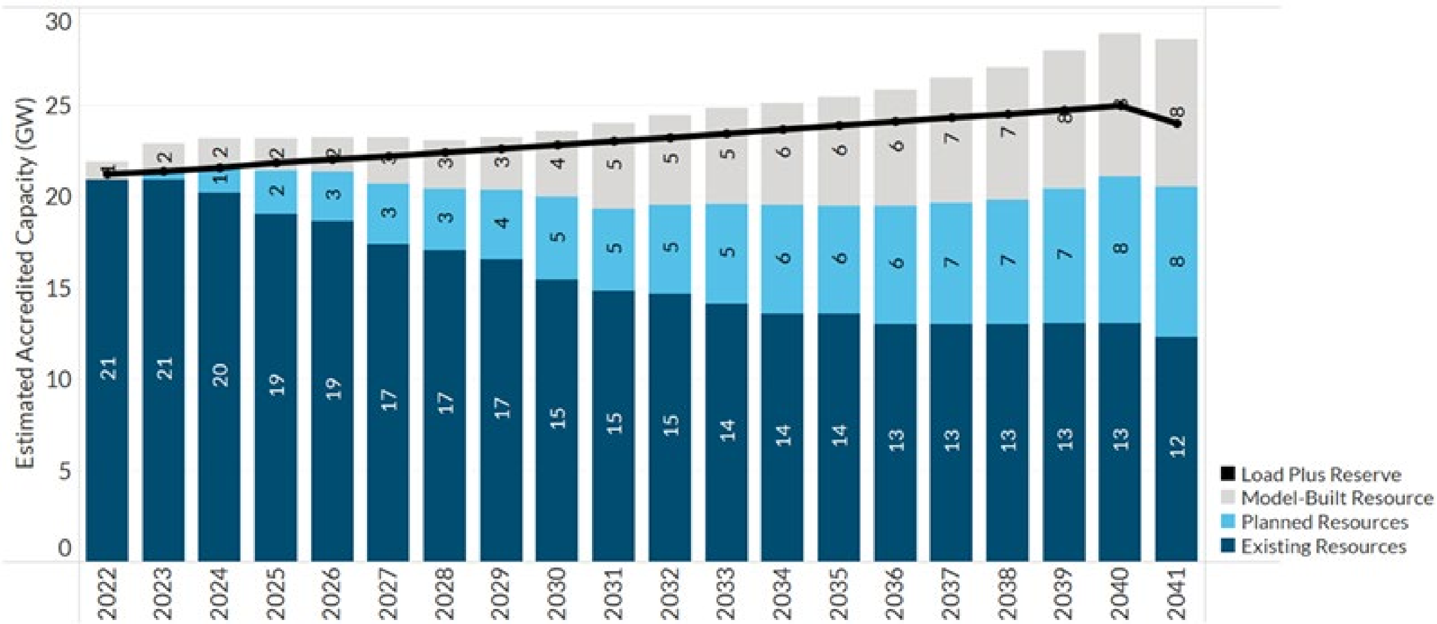

Figure 13. 2022 MISO RRA, LRZ 1 accredited capacity and required reserves[31]

This conclusion is reinforced by the most recent North American Electric Reliability Corporation (NERC) Long-Term Reliability Assessment (LTRA), which reviews capacity positions for multiple regions in North America. It analyzed MISO as a whole and found that MISO capacity could be below the reference reserve margin within the next couple of years (Figure 14). The "Anticipated Reserve Margin" includes new projects in the later stages of development and interconnection. The "Prospective Reserve Margin" includes resources in earlier stages that are less likely to be completed.

[31] 2022 Regional Resource Assessment: LRZ-level Assumptions and Results. MISO, November 2022. P. 8. Available at: https://cdn.misoenergy.org/2022%20RRA%20LRZ-level%20Assumptions%20and%20Results626061.pdf

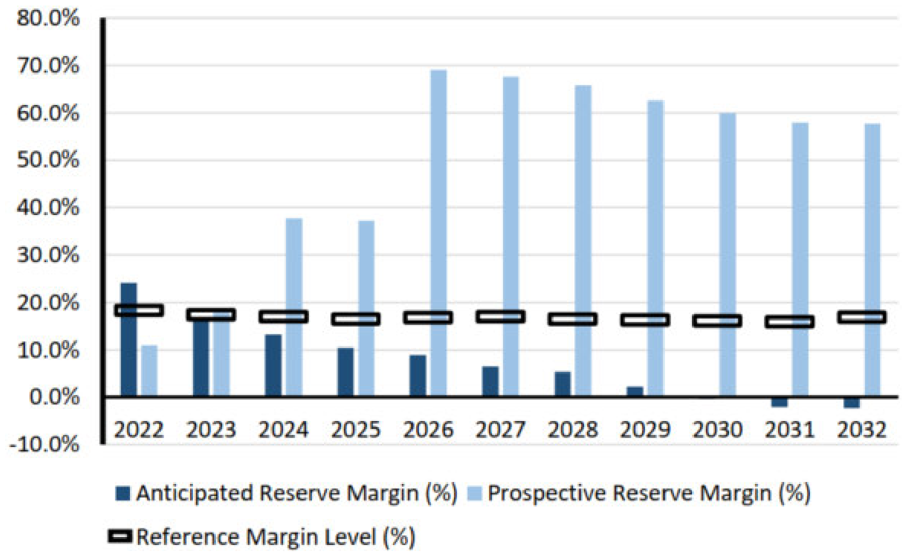

Figure 14. 2022 NERC LTRA, MISO reserve margin[32]

H. Factors that may affect Manitoba Hydro's ability to export energy and capacity into the MISO market

Daymark examined the conditions described above within the MISO region in the context of Manitoba Hydro's ability to continue to make firm and non-firm energy and capacity sales. In this section we will discuss key drivers of market evolution in the recent past as well as their outlook for the near future. The MH forecast for export sales is limited to sales of non-firm energy, firm energy, and capacity. In other words, the estimates are limited to Manitoba Hydro's ability to continue providing MISO participants with these same products. This section also discusses how the needs of the MISO participants are evolving as the capacity and transmission systems transition in support of a zero-carbon future, and the ability of the MH system to provide some of the products that are likely to arise out of those needs.

The MISO market conditions summarized in the prior sections demonstrate the level of grid transition being driven by policies, economics, customer behavior and preferences, and an aging infrastructure fleet:

- **Changing energy market dynamics.** As noted, the MISO market is undergoing significant change, which will accelerate in the coming years. While thermal resources are a significant component of the portfolio, the development of

[32] 2022 Long-Term Reliability Assessment. NERC, December 2022, p. 25. Available at: https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_2022.pdf

renewables will serve to provide an abundance of zero marginal cost energy in some hours and some seasons, depressing average market prices.

- **Resource adequacy and capacity market uncertainty.** The capacity situation has tightened dramatically in recent years, with an impending shortage expected MISO-wide, and in the subregion directly south of Manitoba (LRZ 1). Driven by increased resource adequacy concerns, MISO is moving to a seasonal capacity requirement which could result in some utilities experiencing capacity deficits in the near-term. At the same time, there are indications that northern MISO could become a winter peaking system due to heating electrification and the addition of solar resources that typically contribute only to meeting summer peak needs and not winter.

In addition to the uncertainty in the MISO market, there is some uncertainty in Manitoba that impacts the ability of MH to export products to MISO. Section VII discusses MH's current resource outlook, which includes a winter capacity shortfall in 2030/31 and a shortfall of dependable energy in 2033/34.[33] This gives MH several more years with some amount of surplus but not a level of surplus that would allow significant long-term firm energy sales. MH also has an obligation to serve all Manitoba load, including new load; if electrification of heat, transportation, and industrial processes occur more rapidly than expected, or if large new industrial customers seek service, MH will need to serve that load with existing capacity and energy resources or procure new resources.

The MISO system with its formalized energy market provides a customer for all the energy that Manitoba Hydro can deliver across its transmission interconnections. These energy sales would be delivered on a non-firm basis and be compensated at MISO market clearing prices. However, it is the additional characteristics of the MISO system, often driven by policies of the states within MISO and the strategies of its utility participants, that has increased the value of the zero-carbon hydroelectric energy and made sales of capacity possible for Manitoba Hydro. Historic drivers have been:

- Demand for renewable energy within the U.S to fulfill state policies and utility strategies,
- Periods of rising energy prices in the U.S. and the hedging value of a long-term contract,
- Seasonal diversity between peak periods in the MH system and the MISO system, and

[33] GRA Filing, Tab 5 – Energy Demand & Supply Assumptions, p. 37.

- Manitoba Hydro's expansion of its generation and transmission interconnections with MISO.

MH has expressed uncertainty that there will be a continued premium for its energy over and above MISO spot market prices, and has concern whether there will be a market for its capacity resources. In discussing the clean, fixed-price attributes of its export supply, MH noted that "at this time there is no apparent reason for customers to pay a premium above the energy price forecast to Manitoba Hydro for such attributes."[34] In general, the factors identified by MH include:

- On average, the increased development of renewable resources in MISO is lowering energy market prices;
- With increased development of renewable and storage projects backed by tax incentives, U.S. utilities have multiple options for long-term contracts and clean capacity;
- Shifting load patterns may make some areas in MISO winter-peaking, lowering the value of MH's surplus summer capacity and reducing the options for seasonal diversity contracts.

In isolation, these factors could lead to a reduction in the premium for MH's exports, and MH has noted that there is enough uncertainty about these factors that it has led to a more conservate outlook on potential MISO market revenue.

Despite these uncertainties, it is important to acknowledge the potential market changes that could lead to a continued, or even expanded, value of MH products. MISO participants are evolving as the capacity and transmission systems transition in support of a zero-carbon future. Customers are increasingly seeking more clean energy, with many large corporations seeking 24/7 emission-free supply arrangements. It is possible if not likely that the Manitoba Hydro system will be able to provide some of the products that arise out of those needs.

The U.S. electric power systems, including MISO are facing similar challenges as decarbonization drives changes to the grid:

- Renewable Integration, including the potential for congestion mitigation and transmission expansion.
- Replacement of significant coal generation retirements.

34 PUB/MH I-45d.

- Winter peak growth and resource adequacy concerns in traditionally summer peaking systems.
- The daily load shape after intermittent renewable generation requiring significant requirements for capacity with strong ramping capability.
- Battery energy storage integration.

To allow competition to lower the cost of meeting system needs, formal electric power markets generally respond to evolving needs with changes to existing market rules or the addition of new market rules or products. This is illustrated by the recent market change in MISO in moving to seasonal capacity resource requirements, increasing reserve margins and establishing procedures where renewable generation can be curtailed. Outside of MISO, other regions have made market changes in recent years to improve the integration of additional renewable resources, including the addition of flexible ramping products and other ancillary services to manage volatility in load and output from solar or wind resources. The challenge facing existing and new market participants is to develop the capability to provide products that respond to the new market rules profitably.

The MH system energy with attractive primary attributes of zero-carbon, large supply, available transmission, and flexibility in dispatch will likely be well positioned to engage the MISO market with new products and services that may provide additional export revenue beyond the outlook provided by MH outlook for its existing products. The key will be close participation in the MISO developments. At this stage it is impossible to form a monetary value for potential new products for any participants, including MH.

MH is actively engaged in MISO market activities and stakeholder groups. Through Daymark's multiple conversations with MH personnel, it was clear that maintaining a presence in MISO market development is a priority for MH, and these activities will continue to be an important element of a strategy to maximize the value of MH's energy resources.

IV. EXPORT PRICE FORECAST

Energy export price assumptions are key inputs to MH's short-term and long-term revenue forecasts presented in the GRA. Export price assumptions determine the value of MH's opportunity sales in Canadian and U.S. markets. These opportunity sales represent [redacted] of MH's flow-related extraprovincial revenue in 2022/23.[35] Over the 20-year forecast period, the total dollar value of opportunity sales is forecasted to decline, but proportional share of total extraprovincial revenue increases to [redacted] in 2041/42.[36] 3a & 5c 3a & 5c

[redacted]

3a & 3b

Figure 15. Extraprovincial revenue, firm and opportunity sales[37]

MH has two distinct export price forecasts that are used in its financial forecasting. The short-term forecast is used as an input to the near-term operations and financial forecast. The long-term forecast is used to estimate revenue in the GSPRO model (Y3 and later). For both forecasts, MH also produces high and low sensitivities, as described in the sections below.

35 Calculated from data provided in MFR 42 (CSI).

36 Calculated from data provided in MFR 42 (CSI).

37 Data source: MFR 42 (CSI).

A. Scope of investigation

Daymark reviewed MH's GRA filing and documentation supporting the energy export price forecasts used in its analysis. We also discussed the export price forecasts and various methodology issues on multiple occasions with MH personnel. Our analysis was structured to address the following item in the Daymark Scope of Work:

> *Review and comment on Manitoba Hydro's electricity export price forecast, including the low and high case forecasts, in the context of current MISO market conditions and factors influencing future MISO prices. Manitoba Hydro's price forecast, provided in PUB Minimum Filing Requirement (MFR) 84, is a consensus forecast comprised of third party consultant forecasts which may or may not be individually provided. Regardless, these forecasts are to be taken as a "given" and are to be assumed to be reasonable and accurate with respect to the other tasks in this Scope of Work. Notwithstanding that the third party consultant forecasts are to be accepted for the purposes of this review, if the IEC identifies significant issues or inconsistencies with the third party consultant forecasts in the course of its general review, those issues or inconsistencies are to be identified in the IEC's reports.*

As noted above, it was unknown at the time Daymark's scope was developed whether or not it would be possible for MH to provide the individual third-party consultant forecasts to Daymark. MH was ultimately unable to provide the individual forecasts without incurring significant expense and could not obtain approval on a timeline compatible with our review. However, we were able to review enough information through the filing and during our on-site discussions with MH to provide an assessment of MH's export price forecasts, as detailed below.

B. Near-term energy price forecast

To forecast export revenue in the near term, MH uses a regularly updated export price forecast. In this GRA, the "near-term" period is the 2022/23 and 2023/24 years. MH uses two sources to create the near-term base forecast: the [redacted] 3a & 3b
and a forecast purchased from a third-party consultant [redacted][38] The forecasts from both entities are provided as separate monthly strips for on-peak and off-peak prices at the MISO Minnesota Hub pricing location (MINN HUB).

38 Tab 4, p. 14. See also COALITION/MH I-29a (CSI).

[redacted] forward prices are updated on a continuous basis and the consultant prices are 3a & 3b
updated monthly.[39] To develop the inputs for modeling, MH uses [redacted] 3b
Lastly, the monthly values are converted to hourly values using an hourly price shape provided by [redacted] 3a & 3b

[redacted]

The results of this method are low and high near-term price forecasts that provide a range of uncertainty around the base forecast.

[redacted] 3a

Figure 16. Near-term MHEB price forecasts

39 COALITION/MH I-29a (CSI).

This method of developing low and high price forecasts is not considered "fundamentals-based." A fundamentals-based forecast would develop an internally consistent price forecast by modifying key pricing drivers that would plausibly lead to a lower or higher price forecast. MH's approach essentially modifies a base forecast by using low/high factors developed from forecasts for a different time period. The advantage of this approach is that it is often significantly less costly and still provides a reasonable range for the high and low uncertainty of resulting energy prices.

C. Long-term energy price forecast

For longer-term export revenue forecasting (starting in 2024/25 for this GRA), MH uses a different source for export price forecasting and a different method for developing the low and high price sensitivities. MH purchases long-term forecasts from five independent third-party forecasters and averages them together to develop the consensus base forecast.[40] [redacted] 3b To convert the forecast to the MHEB location, [redacted] 3a & [redacted][41]

The five forecasts were produced by leading firms in the industry, and the forecasts are generally contemporaneous, all produced between [redacted] 3b [redacted][42] Even with industry-leading firms producing contemporaneous forecasts, [redacted] The figures below were produced by MH and demonstrate the variability in the forecast values.

---

[40] MFR 84.

[41] MFR 84.

[42] PUB/MH I-52g (CSI).

[redacted]

3b

3b

Figure 17. Range of consultant forecasts of long-term MHEB energy prices[43]

Long-term fundamentals-based forecasts like these are the product of hundreds or thousands of individual system assumptions and rely on detailed simulation models to produce price strips. It can be difficult to assess the reasonableness of an individual forecast without a detailed review of all the assumptions and methods. While we did not

43 PUB/MH I-52(f) (CSI).

have access to all these data and details, MH provided Daymark with some information about the "implied heat rate" for the individual forecasts.

Implied heat rate is a metric that draws a connection between a forecaster's outlook on natural gas prices and electricity prices.[44] Since natural gas is currently a key driver in setting electricity prices in the MISO market, reviewing the implied heat rate for a forecast can provide an indication of how a forecaster is assuming the resource portfolio will change over time, and how a system might start to be less reliant on natural gas resources. It can also provide a quality check, as there are boundaries around what would be a reasonable implied heat rate for any market, even with the uncertainty regarding the many input variables.

From our review of the range of forecast prices provided in Figure 17 above, as well as the implied heat rate values of the five forecasts, our assessment is that while the forecasts are different, they are all plausible forecasts that likely rely on different assumptions regarding MISO system changes over time. None of the forecasts appeared unreasonable in any way, and the fact that there was a significant range supports MH's approach of using an average "consensus" value in its modeling.

From the consensus forecasts (on-peak and off-peak), MH developed low- and high-price forecasts for use in the sensitivity analysis. These forecasts are developed by first calculating the on-peak and off-peak implied heat rate of the consensus natural gas and electric price forecasts, and then using alternative natural gas price forecasts (low and high) to calculate the forecasted low and high energy prices. The low and high gas prices are calculated using the differential percentages from U.S. Energy Information Administration (EIA) base, low, and high gas prices.

[44] For more information on implied heat rate calculations, see PUB/MH I-52(e).

[redacted] 3b

Figure 18. On-peak energy price forecasts at MHEB ($2022/MWh)[45]

[redacted] 3b

Figure 19. Off-peak energy price forecasts at MHEB ($2022/MWh)[46]

45 PUB/MH I-52(a) (CSI).

46 PUB/MH I-52(a) (CSI).

There are some limitations to this approach of using the base case implied heat rate to develop the low and high price forecasts. First, similar to the short-term forecast, the low and high sensitivities are not "fundamentals-based" forecasts, and this methodology does not consider the impact that persistent high or low natural gas prices might have on the system implied heat rate. The calculated long-term implied heat rate is a function of the MISO resource portfolio being modeled, and it is reasonable to conclude that if the region faced persistent high natural gas prices, the total MISO regional resource portfolio would be likely to change over time to respond to those price signals. By assuming the implied heat rate does not change in those low and high price futures, MH's methodology assumes no market response.

Despite these limitations, MH's methodology results in a reasonable range of long-term MISO energy prices that allows for robust sensitivity analysis.

D. Daymark findings

As directed in the Daymark Scope of Work Item #1, we reviewed MH's near-term and long-term energy price forecasts, including the source of the forecasts and the methodology used by MH to make modifications prior to using the forecasts as inputs to the various modeling tools used in developing the export revenue forecast. We offer the following findings based on our review.

On the short-term forecast, we believe that MH's methodology produces reasonable base, low, and high forecasts for use in its analysis. Since the 2017/18 GRA, MH has started using two forecasts, rather than just the single forecast that was used previously. This reflects an improvement given that forecasters can sometimes have significantly different price outlooks, even in the near-term. MH's method of developing the high and low forecast reflect a simplified approach that is not the direct result of a fundamentals-based forecast, but in the case of this GRA, it produced a reasonable range of high and low forecasts ([redacted] that is sufficient to assess the 3b
impact of export prices on extraprovincial revenue.

For the long-term forecast, we similarly agree that MH's methodology produces reasonable base, low, and high forecasts. Long-term energy price forecasting poses many significant challenges, and the price volatility in the natural gas markets (which largely drive electricity prices) over the past two years have demonstrated that even near-term forecasting can be very difficult. MH's approach to forecasting creates a reasonable range of scenarios that allow for an assessment of how near-term and long-term price uncertainty impacts export revenues. From the information we were able to access, we do not have any specific concerns about the reasonableness of any of the five consultant forecasts, and we agree that developing the consensus forecast by averaging the five forecasts is a reasonable approach.

V. EXPORT CONTRACT REVIEW

Manitoba Hydro has multiple long-term energy and capacity export contracts that generate a significant portion of net extraprovincial revenue or otherwise provide value to MH and its customers. As part of the Daymark Scope of Work, we reviewed MH's treatment of these contracts to ensure that the contract terms are appropriately reflected in the revenue forecasts included in the GRA analysis.

A. Scope of investigation

Daymark reviewed MH's forecasts of energy and capacity volume and revenue related to the export contracts between MH and its various counterparties. We structured the analysis to address the Item #6 of the Daymark Scope of Work:

> *Review the forecast export revenues for each export contract provided as part of PUB Minimum Filing Requirements 85 and 86 and confirm whether these forecast revenues are reasonable and are underpinned by the export contracts.*

Daymark reviewed MFR 85 and MFR 86, which provide MH's forecast revenues and sales volumes. We also received a spreadsheet workpaper from MH supporting those MFRs, as well as copies of all export contracts. We reviewed the contracts to determine whether the contract terms (volumes, prices, duration) matched the assumptions used to prepare MFR 85 and 86. Lastly, we reviewed the workpapers supporting the export revenue forecast in MFR 42 to confirm that the contract revenue assumptions are consistent.

B. Review of contract revenue forecast

Contracted energy accounts for a large portion of MH's net extraprovincial sales and revenue. According to MH, long-term contracts are forecasted to make up 49% of total exports in 2024/25, and as contracts expire that proportion will decline to 19% by 2035/36.[47]

[47] GRA Filing, Tab 5 – Energy & Supply Assumptions. p. 17.

[redacted]

3a & 3b

Figure 20. Firm and opportunity energy sales[48]

MH currently has a portfolio of 15 export contracts with 8 different counterparties.[49] The table below provides MH's summary of contract characteristics.

[48] Data source: MFR 42 (CSI).

[49] GRA Filing, Tab 5 – Energy & Supply Assumptions. Figure 5.10, pp. 18-19.

Table 3. Manitoba Hydro export contract portfolio[50]

CUSTOMER	CONTRACT NAME	CAPACITY (MW)	TYPE	TERM
Basin Electric	Basin 50 – 80	50 – 80	Capacity Sale	Jun 1, 2023 to May 31, 2028
Dairyland Power	DPC 50 Div. Exchange	50	Diversity Exchange	Jun 1. 2022 to May 31, 2027
Great River Energy	GRE 200 Div. Exchange	200	Diversity Exchange	Nov 1, 2014 to Apr 30, 2030
Minnesota Municipal Power	MMPA 65 – 105	65 - 105	Capacity Sale	Jun 1, 2020 to May 31, 2030
Minnesota Power	MP 250	250	System Power Sale	Jun 1, 2020 to May 31, 2035
	MP 250 Energy Exchange	0	Energy Exchange	Jun 1, 2020 to May 31, 2035
	MP 133	0	Surplus Energy	Jun 1, 2020 to May 31, 2040
	MP 133 Energy Exchange	0	Energy Exchange	Jun 1, 2020 to May 31, 2040
Northern States Power	NSP 375/325	375(S) 325(W)	System Power Sale	May 1, 2015 to April 30, 2025
	NSP 125	125	System Power Sale	May 1, 2021 to April 30, 2025
	NSP 350 Div. Exchange	350	Diversity Exchange	May 1, 2015 to April 30, 2025
SaskPower	SaskPower 100	100	System Power Sale	Jun 1, 2020 to May 31, 2040
	SaskPower 215	215	System Power Sale	Jun 1, 2022 to May 31, 2052
Wisconsin Public Service	WPS 100 Product A	100	System Power Sale	Jun 1, 2021 to May 31, 2027
	WPS 100 Product B	0	Surplus Energy	Jun 1, 2027 to May 31, 2029

Several contracts are set to expire in the coming years, notably the NSP contracts in 2025, followed by the WPS contract in 2027. As previously noted, MH is not assuming

50 GRA Filing, Tab 5 – Energy Demand & Supply Assumptions, Figure 5.10, p. 18.

that any contracts are renewed, or that new long-term contracts are executed to replace those expiring contracts.

To evaluate the reasonableness of MH's contract revenue forecast, Daymark reviewed the workpaper used to develop MFRs 85 and 86 and reviewed each contract agreement to verify the terms. Several of the contracts contained explicit price schedules for energy and capacity, and Daymark was able to verify that the correct volumes and prices were used in developing MFRs 85 and 86. [redacted] 3a For these contracts with pricing terms that change over time, Daymark reviewed the pricing and concluded that MH use reasonable escalation rates when developing MFR 85 and 86.

As an added check to verify that MH's treatment of export contract revenues is consistent throughout the analysis, Daymark also reviewed the workpapers provided by MH to develop the export revenue forecast in MFR 42. We confirmed that the U.S. and Canadian firm export revenues are consistent between the workpaper used to develop MFRs 85 and 86 and the model output from HERMES and GSPRO used to develop MFR 42.

C. Daymark findings

Based on our review of the GRA filing, MH's export contracts, and the workpapers provided by MH, Daymark concludes that the export contract revenue forecasts developed by MH for MFRs 85 and 86 are supported by the contract terms. Furthermore, we conclude that the forecasts used in the export revenue forecast in MFR 42 are also consistent with the contract terms.

VI. EXPORT ENERGY VOLUME FORECAST

The analysis conducted by MH to support the GRA analysis includes a forecast of energy volumes available for export. The volumes are determined using the HERMES and GSPRO models described in Section II.C above.

A. Scope of investigation

Daymark reviewed MH's GRA filing and documentation supporting its forecasts of exportable surplus energy in the near-term and long-term, which underpin its export revenue forecasts. We also discussed the models, export price forecasts, and various methodology issues on multiple occasions with MH personnel. Our analysis was structured to address Item #2 in the Daymark Scope of Work:

> *Review and assess for reasonableness Manitoba Hydro's forecasts of exportable surplus energy and capacity by on-peak and off-peak period, taking into account expected inflow conditions, reservoir levels, and tie line capacities for both the test years as well as the next twenty years as provided in PUB Minimum Filing Requirement 42.*

Portions of this scope item are also addressed in Section VII below.

B. MH analysis results

The GRA filing contains annual energy balance data. The supply side includes volumes from hydroelectric generation, thermal generation, purchases from wind and solar units, and imports from the U.S. and Canada. The demand side includes domestic load, firm contracts to the U.S. and Canada, and opportunity exports to the U.S. and Canada. The data also include net energy losses.

These data are the direct outputs of the HERMES model in the short-term and the GSPRO model in the long-term.

[redacted]

3a & 3b

Figure 21. MH energy supply by source[51]

These results show a hydro output that is slightly higher in the first few years, and then remains relatively constant through most of the study period. The transition occurs at the same time that the water supply forecast transitions from the near-term analysis conducted with the HERMES model to the long-term analysis conducted with the GSPRO model. This is due to the fact that the HERMES model considers the reservoir levels at the time of the analysis, but the reservoir levels have only a minor impact on the GSPRO model.

The supply results also show a slight growth in imports from the U.S. over the study period, but a larger increase in new supply from purchases from wind and solar facilities. MH noted in the GRA filing that increased purchases are required to meet energy shortfalls, including 1,200 MW of new wind capacity by 2041/42.[52] Daymark did not conduct a detailed review of MH's long-term resource planning assumptions as part of this scope, but the future generation and purchase assumptions should be reviewed as part of the IRP.

[51] Data source: MFR 42 (CSI).

[52] GRA Filing, Tab 4 (Amended) – Financial Forecast Scenario, p. 20.

[redacted]

3a & 3b

Figure 22. MH energy demand by source[53]

On the demand side, MH's domestic sales are expected to grow over the study period.[54] The firm exports to the U.S. decline as contracts expire. Some of that energy is exported as opportunity sales, but the growth in domestic load leads to an overall decline in U.S. exports. In addition, the load growth leads to a deficit of winter capacity in 2030/31 and a shortfall of dependable energy in 2033/34.[55]

C. Daymark findings

Based on our review of the data provided by MH, and supported by our detailed review of the energy modeling methods and tools (discussed in Section II above), we find that the forecast of energy export volume filed in the GRA is a reasonable estimate upon which to base MH's revenue forecasts. The models perform detailed simulations of the MH reservoirs and generating units, considering operations during peak and off-peak periods to serve MH load, firm exports, and opportunity sales.

53 Data source: MFR 42 (CSI).

54 Daymark's Scope of Work did not include a detailed review of MH's long-term load forecast. However, Daymark did review the load forecast in Tab 5 and discussed certain elements of the forecast with MH personnel.

55 GRA Filing, Tab 5 – Energy Demand & Supply Assumptions, p. 37.

VII. EXPORT CAPACITY VOLUME FORECAST

Manitoba Hydro has multiple options to monetize capacity in excess of its firm domestic and export obligations, including through long-term or short-term bilateral capacity sales, seasonal diversity arrangements, or potentially through sales into the MISO Planning Resource Auction (PRA). This section provides our review of MH's assumptions regarding the forecast for capacity volume available for export.

A. Scope of investigation

Daymark has reviewed MH's GRA filing and documentation supporting its forecasts of exportable surplus capacity. We also discussed the Company's assumptions and analysis related to capacity sales with MH personnel. Our analysis was structured to address Item #2 in the Daymark Scope of Work:

> *Review and assess for reasonableness Manitoba Hydro's forecasts of exportable surplus energy and capacity by on-peak and off-peak period, taking into account expected inflow conditions, reservoir levels, and tie line capacities for both the test years as well as the next twenty years as provided in PUB Minimum Filing Requirement 42.*

Portions of this scope item are also addressed in Sections VI above and Section VIII below.

B. MH assumptions and analysis

As discussed previously in Section V, MH has multiple firm export contracts that include the sale of capacity. As we described in that section, Daymark has reviewed MH's analysis and agrees that those contracts are appropriately reflected in the GRA filing.

Beyond the firm contracts, MH's export forecast included in the GRA does not assume any revenue from future capacity sales.[56] MH provided several explanations for this approach.

First, the Company noted that the amount of surplus capacity is forecasted to decline over the next seven years, and that there will be a capacity deficit starting in the 2030/31 planning year. The figures below summarizes the capacity balance for the winter and summer periods if no new resources are added.

[56] PUB/MH II-19(a).

Because MH is heavily winter peaking, it shifts to capacity shortage in the near term:

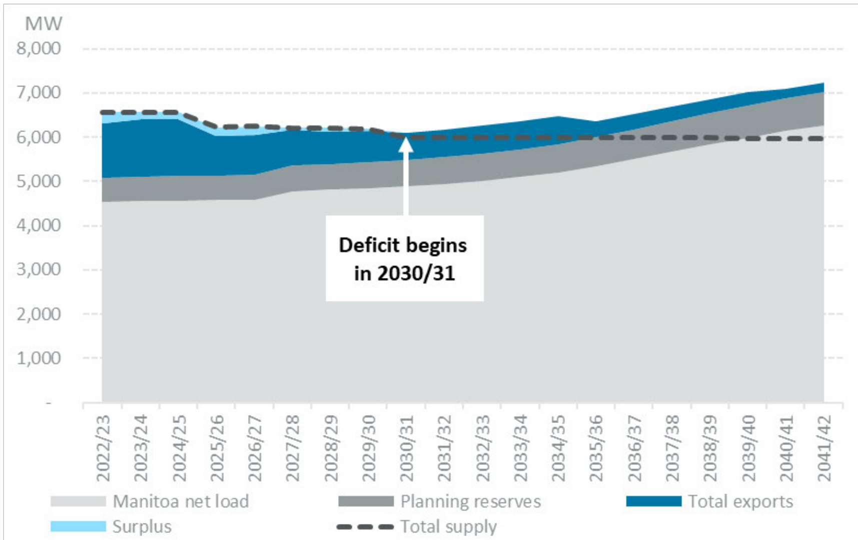

Figure 23. MH winter capacity balance[57]

In the summer, on the other hand, MH has surplus capacity throughout the study period:

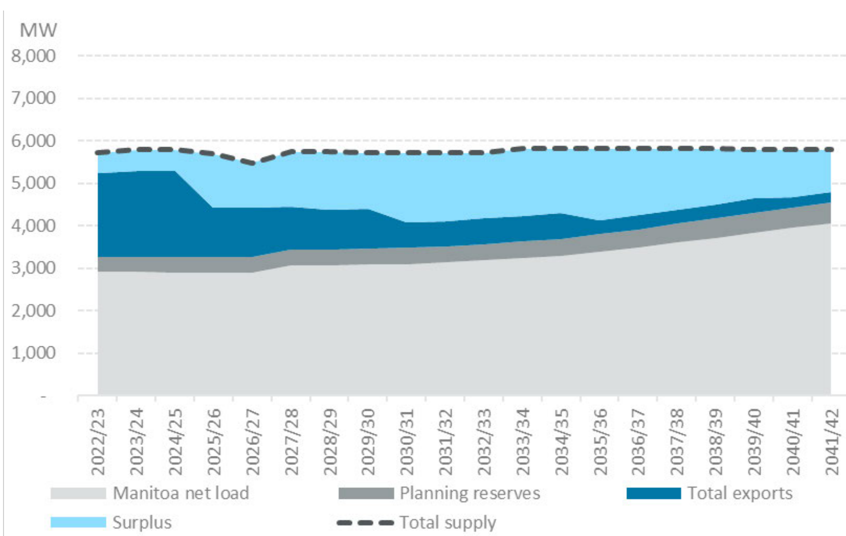

Figure 24. MH summer capacity balance[58]

57 Data source: MFR 43.

58 Data source: MFR 43.

The winter capacity balance in Figure 23 confirms that there is very limited surplus capacity at the beginning of the period, and that a capacity deficit begins in 2030/31. In the summer capacity balance (Figure 24), there is some summer capacity available at the beginning of the period, and this surplus grows as long-term contracts expire, with large commitments expiring in 2024/25 and 2029/30.

MH has stated that despite this summer surplus, there are numerous barriers and significant uncertainty related to selling this capacity. The MISO seasonal capacity construct is new as of August 2022 and there is uncertainty as to how the regional capacity balance will evolve and how capacity pricing will settle.[59] MISO has also determined that the winter planning reserve margin will be much greater than the summer reserve margin; MH interprets this change as reducing the likelihood of securing seasonal diversity contracts that provided value for its summer surplus.[60]

In addition, while MH could theoretically sell surplus capacity on a short-term basis through the MISO PRA, [redacted] 4a

C. Daymark findings

MH made updates to its capacity balance analysis since the 2017/18 GRA, and we find that the changes are reasonable. The most impactful changes are the addition of the SPC export contract and the change in the load forecast. As noted above, while we did not review the load forecast in detail, MH's description of the drivers of the increase in peak load appear reasonable.

The other major factor impacting the change in the timing of capacity need and the availability of surplus is the assumption that seasonal diversity contracts will not be renewed, and a related assumption is the uncertainty around the market for future summer capacity sales into MISO. As discussed in Section III above, we agree with MH that there is significant uncertainty related to the evolution of the MISO market and how the market will respond to new seasonal capacity requirements, increased penetration of variable energy resources, and other changes.

59 PUB/MH I-45(c).

60 PUB/MH I-48(a).

61 PUB/MH I-45(c).

Given these uncertainties, we agree with the Company's approach to assume no new sales of surplus export capacity in the revenue forecast. However, it should be recognized that this is a conservative assumption, and there is potential for incremental revenue if MH can monetize its excess summer capacity.

The MISO region is not yet a winter peaking system, and there is a shortage of capacity that led to high PRA clearing prices in 2022. Given that MH is forecasted to have a summer surplus of 492 MW in 2023/24, and that the surplus is forecasted to grow to 1,636 MW in 2030/31 without new capacity sales,[62] we would recommend that MH take steps to pursue monetization of that capacity. This summer surplus may be even higher if MH adds new resources to meet the winter capacity deficit.

At a minimum, MH should continue [redacted] this analysis will help MH make an informed decision if the PRA continues to clear at high prices. 4a

[62] MFR 43.

VIII. EXPORT REVENUE FORECAST

Manitoba Hydro's forecast of export revenue represents a major portion of the expected revenues that form the foundation for the GRA filing. The export revenue forecast, detailed in MFR 42, is a primary focus of the Daymark Scope of Work. This section reviews the export revenue forecast and details how several of the other elements of the GRA filing reviewed in other sections of this report relate to MH's projection of export revenue.

A. Scope of investigation

Daymark reviewed MH's GRA filing and supporting documentation to conduct a detailed evaluation of the forecast of export revenues included in the filing. This included the review of multiple topics already discussed in this report (energy modeling, export price forecasts, export contracts, energy and capacity sales). We also discussed the Company's assumptions and analysis related to the export revenue forecast with MH personnel. Our analysis was structured to address multiple items in the Daymark Scope of Work. The primary scope item for this section is Item #5:

> *Review Manitoba Hydro's forecasts for export revenues and fuel & power purchases for the next twenty years as provided in PUB Minimum Filing Requirement 42 and assess whether the forecasts of net extraprovincial revenues are reasonable. Confirm whether Manitoba Hydro has included uncontracted capacity and long-term firm sales revenue in its forecasts and whether such assumptions are supported.*

B. Export revenue methodology

The export revenues are primarily derived from direct outputs from the energy modeling processes described in Section II above. The near-term revenue values (2022/23, 2023/24, and 2024/25) are outputs from the HERMES model, and the GSPRO model provides the export revenue results for the remainder of the period. As previously discussed, both models are designed to operate the MH system under a specific set of input assumptions (e.g., inflow conditions, export prices) and optimize the system operations to meet load and maximize revenue. The HERMES models also include the parameters of the firm export contracts, such that the energy to serve those agreements is included in the output. The GSPRO model does not include the contract terms, so those revenues are separately added to the long-term revenue forecast. As these contracts expire, the energy that would have otherwise served those contracts is available to serve future growth in Manitoba load or for export as opportunity sales.

C. Export revenue forecast results

MH's export revenue forecast is provided in MFR 42, disaggregated into multiple categories including firm and opportunity exports to the U.S. and Canada. MH provided additional documentation to Daymark that further details the breakdown of certain elements of MFR 42 into subcomponents.

In the figure below, firm revenues include both fixed and variable components of contract sales. Opportunity revenues include non-contracted sales into the U.S. and Canadian markets.

[redacted] 3a & 3b

Figure 25. Extraprovincial revenue, firm and opportunity sales[63]

For the U.S. sales, Daymark reviewed the average value of on-peak and off-peak sales and determined that they are consistent with the input price forecast values developed by MH and discussed in Section IV above.

[63] Data source: MFR 42 (CSI).

[redacted]

3a & 3b

Figure 26. U.S. opportunity sales revenue, on-peak & off-peak[64]

D. Fuel and power purchases

The revenue forecast provided in MFR 42 includes a “Fuel and Power Purchased” category with four subcategories: MH Thermal Generation, Purchased Energy, Other Non-Energy Related Costs, and Transmission Charges.[65] Of these, the Purchased Energy category is the largest, representing two-thirds of the total in the first year, increasing to approximately 85% by the end of the study period.

64 Data source: MFR 42 (CSI).

65 MFR 42, p. 6.

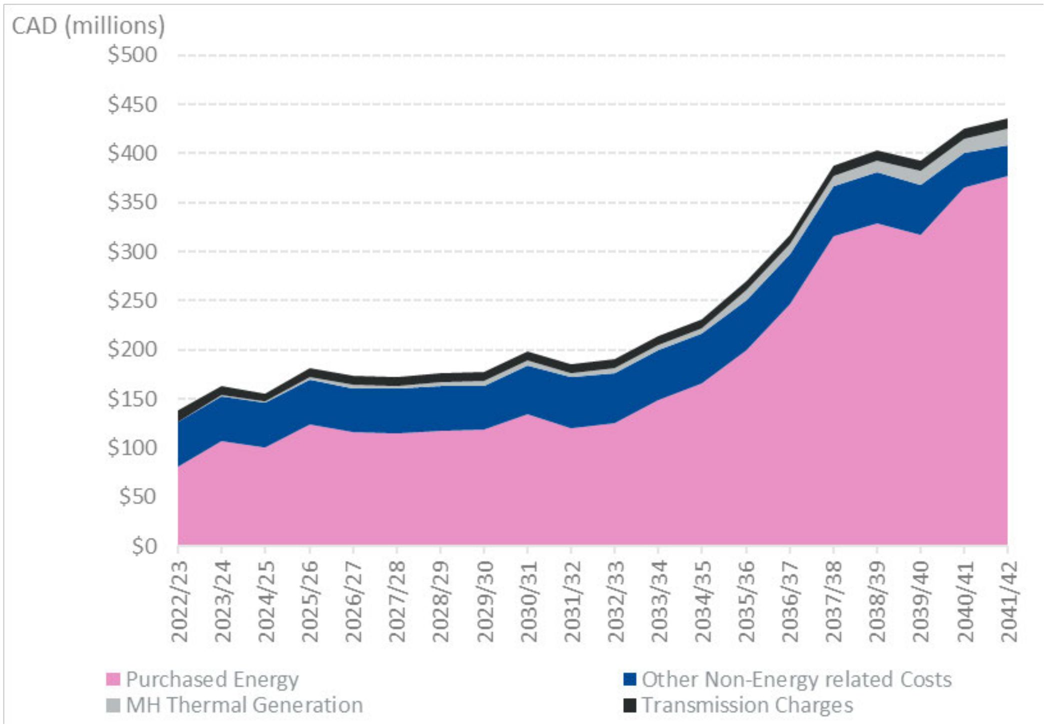

Figure 27. Fuel and purchased power expenses by subcategory[66]

Daymark reviewed the Corporation's workpapers supporting MFR 42 to assess these elements of the revenue forecast. Most of these categories are made up of multiple subcomponents. The Thermal Generation category includes both thermal purchases, as well as a forecast of carbon tax payments. The Purchased Energy category includes wind and solar power purchases, as well as Canadian and U.S. opportunity purchases. The opportunity purchases are determined as part of the HERMES and GSPRO model analysis. The Non-Energy Related costs include a variety of elements, but the majority of the expense is associated with the Great Northern Transmission Line. The Transmission Charges item does not include subcategories.

Of these categories, the thermal purchases and opportunity purchases are outputs of MH's energy modeling, and these values are consistent with our understanding of the system dynamics over the study period. Thermal purchases remain low through the study period, but opportunity sales increase as a component of an optimized supply portfolio in the later years as load growth reduces MH's surplus energy position.

[66] Data source: MFR 42.

E. Manitoba Hydro assumptions regarding future contracts

The Daymark Scope of Work includes the direction to "*Confirm whether Manitoba Hydro has included uncontracted capacity and long-term firm sales revenue in its forecasts and whether such assumptions are supported.*" As discussed in Section VII, MH has not included any assumptions regarding the renewal of existing contracts or the addition of any new or replacement contracts. All uncontracted energy is assumed to be valued at the market energy price and uncontracted capacity is assumed to produce no revenue. This issue was previously discussed in Section III.

It is likely that as the MISO market evolves, there will be some method for generating a premium price for MH's clean, dispatchable resources. However, at this time it is highly uncertain what those mechanisms will be, or what the monetary value will be. Additionally, as discussed in Section III, it is unclear whether the MISO market changes will produce opportunities that align with MH capabilities. Thus, for the purposes of the GRA, it is reasonable to assume that surplus energy is valued at the market price, rather than a premium price under a long-term contract.

F. Daymark findings

Based on Daymark's review of the filing and information requests, our conversations with MH personnel, and our review of supplemental materials provided by MH, we find that the Corporation's forecast of export revenues is reasonable. In our review of the export contracts, we found that MH's analysis properly reflected the contract terms and prices. Regarding the opportunity export revenue, we find that the Company's energy modeling methodology and tools are appropriate, and the Company's export price forecast is reasonable.

As described in this section, we conducted some additional analysis to confirm that the export revenue outputs from the HERMES and GSPRO models aligned with the market price forecasts used by MH.

Lastly, we reiterate the discussion presented in Section III above regarding the potential for additional revenues for MH's clean, dispatchable products. The export revenue as presented in the GRA assumes no renewal or replacement contracts and assumes that MH's future supply sales are valued only at the MISO market energy price. We believe this is a reasonable, but conservative, assumption, and that it is likely that there will be opportunities for premium pricing or additional revenues for MH's exports as the MISO market continues to evolve.

IX. KEEYASK SCENARIOS

The Keeyask Generating Station was fully placed in service in 2022 after being approved in the Needs For and Alternatives To (NFAT) proceeding in 2014. During that proceeding, in which Daymark[67] also participated as an independent expert consultant, a primary argument made by MH in support of the application was that export revenues enabled by the Keeyask project would help defray the cost of the project. This component of the Daymark Scope of Work includes the assessment of analysis conducted by MH to estimate Keeyask export revenue.

A. Scope of investigation

Item #7 of Daymark's Scope of Work requests a review of MH's analysis of Keeyask revenues:

> *Review PUB Minimum Filing Requirement 28 and confirm whether the scenarios and calculated revenues from the Keeyask generating station are reasonable. If Daymark concludes that the scenarios are not reasonable, provide Daymark's assessment of reasonable scenarios.*

Daymark's approach was an extensive review of the information and workpapers of MFR 28 as well as any related information requests. In addition, Daymark relied upon our experience with the operation and economics of the MH system that started a decade ago as part of the NFAT, the understanding of the export contract prices and revenue from our investigation as part of the 2017/18 GRA, and the information explored and developed in fulfilling the other tasks of this engagement.

As the Keeyask project is already in service, the analysis conducted for MFR 28 is not required for a decision to construct the facility. Rather, the analysis of Keeyask revenues requested by the PUB will produce metrics against which costs being recovered in rates can be compared. It will also provide some insight as to what the approximate impact Keeyask has on MH's revenue requirements in the early years of its operation. As stated in the Daymark Scope of Work item above, Daymark was not asked to perform a revenue requirement impact, but to merely review and comment on the scenarios and methodology used by MH to estimate the revenues that may be attributable to Keeyask.

[67] At the time of the NFAT proceeding, Daymark Energy Advisors was known as La Capra Associates.

B. Manitoba Hydro analysis

Keeyask Generating Station and related works are owned and operated by the Keeyask Hydropower Limited Partnership (KHLP). Each income statement line item reflects the complete partnership revenues and costs between KHLP's income statement and Manitoba Hydro's electric operations income statement.

MH discusses in MFR 28 that the determination of revenues attributable to Keeyask is not a simple task:

> *"There are many operational decisions made to manage reservoir levels and stream flow to maximize the overall value of energy generated by an integrated hydroelectric system. These decisions involve optimizing the collective generation output of the hydroelectric facilities on the system, thermal generation, and energy purchases. The output of individual facilities may appear to be suboptimal to benefit the system as a whole."*[68]

MH's response also notes the difficulty in attributing "generation of an individual facility to serving any of Manitoba's demand, the overall portfolio of firm sales, any one firm sale, or to non-firm sales (i.e., opportunity) in an integrated hydroelectric system."[69] MH recognizes that the presence of Keeyask Generating Station energy output enables export sales, which at a minimum produce a value equivalent to non-firm sales and more than likely Keeyask energy availability would create some additional firm sales.

MH approached the Keeyask revenue estimation by looking at three scenarios that are distinctive in their estimation of the amount and price of firm energy sales assigned to Keeyask. The revenue attributable to Keeyask energy in this methodology varied with the allocation of dependable energy used to serve firm sales. MH finds that "[t]hese three scenarios provide a range of revenue attributing Keeyask energy to various export sales… [h]owever, Keeyask is increasingly required as Manitoba load grows in the future and export contracts expire."[70]

MH calculated the total system average unit revenue at generation for firm export and non-firm export sales to apply each to their respective portion of Keeyask assumed in each specific scenario. The allocation of Keeyask energy between firm and non-firm has

68 MFR 28, p. 1.
69 Id.
70 Id. at p. 2.

been allocated between three different scenarios to yield a range of revenue allocations. The analysis of each scenario is discussed below.

These three scenarios are each calculated on a fiscal year basis, first determining the firm and non-firm energy export, and then multiplying by the average unit revenue to yield the total revenue for firm and non-firm revenues. The sum of the firm and non-firm energy and revenues equals the total energy and revenues for each scenario. Each of these scenarios is a unique way of estimating the portion of the same total export sales revenue that could be attributed to Keeyask. The scenarios do not change the export sales revenue total.

Scenario 1: All non-firm

This scenario assumes all Keeyask energy will be sold as non-firm, or opportunity, exports. This scenario is chosen to represent the minimum value of Keeyask energy, i.e., the value if Keeyask energy is only monetized through export sales to MISO at the MISO clearing price for energy.

The Keeyask energy non-firm energy export (in GWh) is multiplied by the respective average unit revenue (in $/GWh) for non-firm energy to determine the revenue attributable to Keeyask and summed to yield the total revenue for Scenario 1.

[redacted] 3b

Scenario 2: Keeyask generation serves MP 250 and other contracts first

Scenario 2 assumes that Keeyask is the first generating station to serve the contract sale with Minnesota Power, MP 250 MW, plus an amount of the remaining firm contracts based on the proportion of Keeyask generation to total hydraulic generation. The rest of the Keeyask output is valued at the average price for non-firm energy.

Keeyask firm energy export is calculated by determining the minimum between Keeyask dependable energy (2,760 GWh annually),[71] Keeyask modeled generation, and the contracted volume under the MP 250 MW agreement plus the remainder firm export based on a proportion of Keeyask generation to total hydraulic generation. This proportion is calculated by dividing the Keeyask generation by the total hydraulic generation multiplied by the difference of the total system firm export energy and the respective year MP 250 Keeyask export contract energy.

Keeyask non-firm revenue export subtracts the calculated firm revenue export from the total Keeyask generation for each respective year.

The respective firm and non-firm energy exports (in GWh) are multiplied by the respective average unit revenue (in $/GWh) to yield Keeyask firm and non-firm revenues (in millions), which are summed to yield total revenue for Scenario 2.

This scenario results in a nominal total revenue of $5,769 million over the 21-year period. Because a portion of the output is serving fixed price contract, the annual revenues are less impacted by the energy market price forecast. Since the firm contract rates are higher than MH's export price forecast, the revenue results are higher than Scenario 1. Annual revenues are shown in Figure 28 below.

Scenario 3: Keeyask generation first to serve all firm contracts

In this third scenario, MH assumes that Keeyask energy is the first resource assigned to serve all firm export sales. After meeting all firm export contracts, the remainder of Keeyask energy is then valued at the system average for non-firm energy.

For each fiscal year the minimum between the Keeyask dependable energy (2,760 GWh annually), Keeyask modeled generation, and the total system firm export energy. This is slightly different than Scenario 2 because in that scenario Keeyask only served its proportional share of firm export contracts other than MP 250.

In all years after 2021/22, Keeyask generation exceeds the total firm export contract obligations, so there are non-firm sales valued at the market price.

As expected, this scenario resulted in the highest annual revenue attributable to Keeyask because it assumes the highest proportion of Keeyask sales valued at the firm contract

71 MFR 39 Table 1

price. The nominal total revenue for this scenario is $6,899 million. Annual revenue totals are shown in Figure 28 below.

Figure 29 below compares the cumulative nominal revenue under each scenario under the study period.

[redacted] 3b

Figure 28. Keeyask scenarios, annual total revenue[72]

[72] Data source: MFR 28 (CSI).

[redacted] 3b

Figure 29. Keeyask scenarios, cumulative total revenue[73]

C. Daymark findings

The analysis conducted by MH provides a simplified view to quantify a range of potential values for the Keeyask generation. If the analysis presented here was used to support a go versus no-go decision the analysis would be best accomplished through a rigorous modeling of cases with and without Keeyask and then the difference in export sales revenue would provide the value of Keeyask energy. This would involve making assumptions for different contracting strategies by MH in the hypothetical scenario without Keeyask. The modeling would attempt to capture any MISO energy price changes that could result from eliminating large amounts of export energy from Manitoba. This scenario would also need to make assumptions for replacing Keeyask dependable energy and capacity as required for a reliable long term system plan.

Our experience tells us that this analysis would likely produce results within the band of the three scenarios chosen by MH. However, it is important for Daymark to make the following observations to fully communicate the areas and assumptions that make it important to characterize that these scenarios are estimates and not exact modeling determined results:

[73] Id.

- The use of average system revenue per kWh to provide prices that value the Keeyask energy does not capture the difference between the seasonality of the total exports supplied by the MH system and the relatively flat Keeyask energy production month to month through a given year.
- The three-scenario analysis ignores any changes in contracting that would occur between a "with and without" Keeyask analysis.
- The three-scenario analysis does not capture any potential MISO energy price differences between cases with and without Keeyask energy. Incremental low-cost energy can reduce market LMPs in some circumstances.
- In the introduction of its analysis – as noted earlier in this section – MH noted that the Keeyask energy and dependable energy is eventually necessary to serve domestic Manitoba load, as well as maintain reliability and resource adequacy. This value has not been captured in any of these scenarios, likely underestimating the value of Keeyask energy to MH. This impact can only be estimated by modeling the detailed cases of with and without Keeyask, requiring many assumptions in the hypothetical without Keeyask case.

Based on our directed scope of the investigation, the calculated revenues from Keeyask generating station were derived through a reasonable methodology to bound the value of Keeyask energy as it impacts export sales revenue. We believe the information provided by MH does provide valuable insight when incorporated into analyses of the estimated revenue requirement impact of Keeyask Generating Station.

X. OPERATIONS DURING 2021/22 DROUGHT

Manitoba Hydro experienced drought, to varying degrees in different areas, throughout much of 2021. As the adverse water conditions continued, Manitoba Hydro responded by adjusting ordinary operations to account for the increasingly challenging operations and financial conditions. As part of its Scope of Work, the PUB requested that Daymark review MH responses to the 2021 drought through three scope items, discussed below.

A. Scope of investigation

Daymark was charged with reviewing aspects of Manitoba Hydro's response to the drought, which occurred primarily throughout the 2021/22 water year. Full text of the Daymark Scope of Work can be found in Appendix A, including Items #10, #11 and #12, which have as their subject various questions regarding Manitoba Hydro's drought operations. These three scope items have multiple questions within them. Collectively, these questions cover three primary topics of inquiry. For ease of review and reporting, we have grouped those questions into the following themes:

Policies & procedures

- "*whether Manitoba Hydro followed its documented policies and procedures (including Appendix 5.3 Drought Management Planning document)*" [Item #10]
- "*whether the existing process and policies are the appropriate process and policies*" [Item #10]
- "*whether improvements could be made to enhance the response to future droughts*" [Item #10]

Hydrology for decision making

- "*effectively used hydrology forecasting tools*" [Item #10]
- "*Review and comment on whether and how the change to a 40-year flow record from the previous 100+ year flow record affected Manitoba Hydro's actions in responding to the drought, including reservoir operations, generator scheduling, and electricity imports*" [Item #11]

Risk & pricing

- "*whether these operations reasonably balanced the risks of a continuing drought and the need to ensure the reliable supply of electricity to domestic consumers with the economic operation of Manitoba Hydro's system in order to minimize the cost of the drought to ratepayers*" [Item #10]

- "*Review and comment on the appropriateness of Manitoba Hydro's price risk management policy*" [Item #12]
- "*Review and comment on the actions taken, or not taken, by Manitoba Hydro in 2021 and 2022 in response to the drought and whether these actions were in compliance with the price risk management policy*" [Item #12]

Reviewing and answering these questions required investigation into multiple aspects of MH forecasting, operations, trading, oversight, and decision making. Some of these topics are covered elsewhere in this report and will be referenced within this section. The goal of this review was to ensure understanding of MH's complex system and the policies, procedures, and operating rules that govern its decisions within the context of drought management. This effort was centered on determining if MH's actions were reasonable and in accordance with its procedures. This section will discuss each component of this review before addressing the PUB's specific questions.

The remainder of this section is divided into the following topics to clarify (1) the scope of the investigation, (2) the documents and other information relied upon to complete the full scope, and (3) the observations derived from that investigation:

- Overview of the 2021/22 drought conditions
- Summary of Manitoba Hydro's policies and processes
- Manitoba Hydro hydrology modeling implications
- 2021/22 drought operations
- Manitoba Hydro price hedging activity

B. Overview of the 2021/22 drought conditions

Manitoba Hydro discussed the 2021/22 water conditions, operating and financial decisions made, and outcomes of those decisions in both its 2021 Interim Rate Application and this General Rate Application. MH identified that one of the key characteristics of the 2021/22 financial year was that their system was in drought. Further, they discuss both the implications of drought and the general timeline of this particular drought in their Interim Rate Application. "Drought risk is the risk of low water inflows and storage, as well as energy market prices that can significantly impact Manitoba Hydro's financial position and operations."[74]

[74] MH Interim Rate Application, Tab 1, p. 5, lines 27-29.

Key elements of the 2021/22 water year drought include:[75]

1. Winter 2020/21 – Near normal storage; above average system inflows; below average Winnipeg River precipitation; increased Lake Winnipeg outflow to meet winter demand
2. Spring 2021 – Below average snowmelt runoff in the south; anticipated above average snowmelt runoff in the north; reduced Lake Winnipeg outflow; uncertain precipitation with potential for reversion to mean; projected reduced export opportunities and "economic conservation" (financial impact)
3. Early summer 2021 – Continued dry conditions in the south and extending into the Nelson River Basin; increased oversight and reduced outflows; drought reservoir constraint concerns; need for imports increasing; potential energy reliability (operating) concerns
4. Summer & Fall 2021 – Continued low precipitation; significantly lower Energy in Storage (EIS); significant operational constraints; significant hedging activity to mitigate financial exposure

MH's system[76] experienced low precipitation and by extension, low system energy volumes throughout much of the water year spanning April 2021 to April 2022. Three summary graphical representations of the system energy situation, all taken from the Interim Rate Application, are shown below. These figures were developed by MH and were frequently updated and shared within internal meetings held throughout the drought.

[75] Summarized from the Interim Rate Application, Tab 1 and discussions with MH staff.

[76] For a detailed description of the watershed and hydrological forecasting, see Section II.

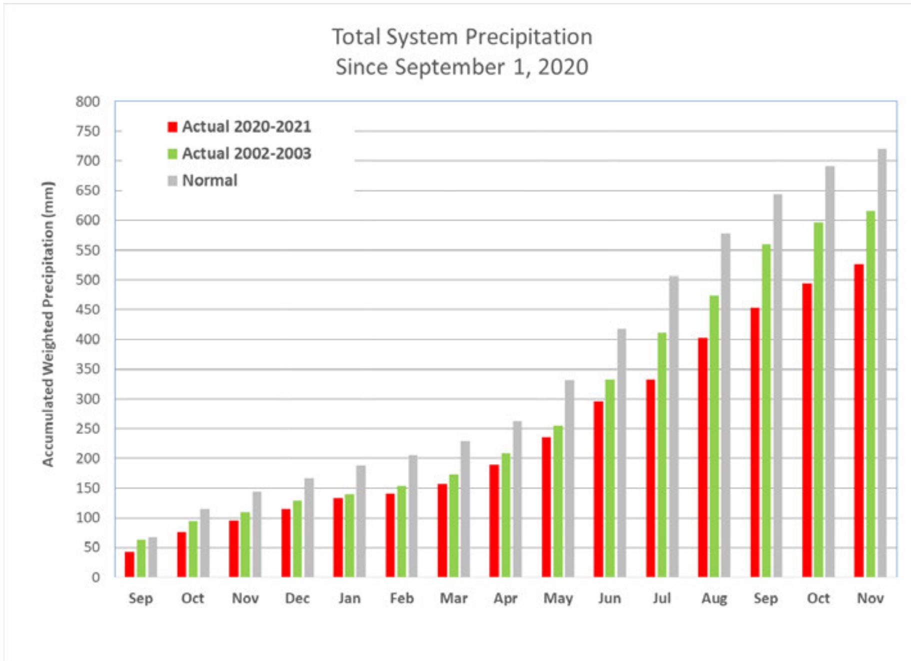

Figure 30. Total system inflows, September 2020 – November 2021[77]

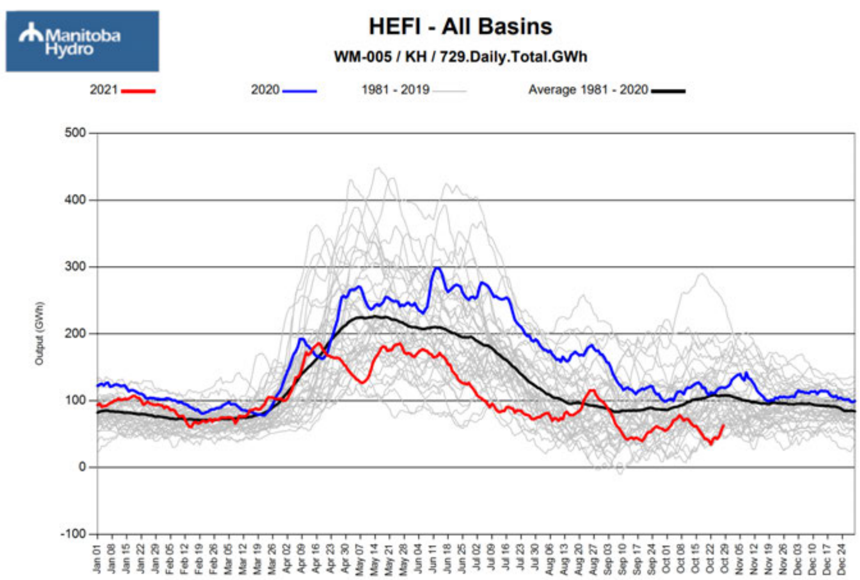

Figure 31. Potential Hydraulic Energy From Inflows – All Basins[78]

[77] 2021/22 Interim Rate Application, November 15, 2021, p. 11.

[78] Id. at p. 12.

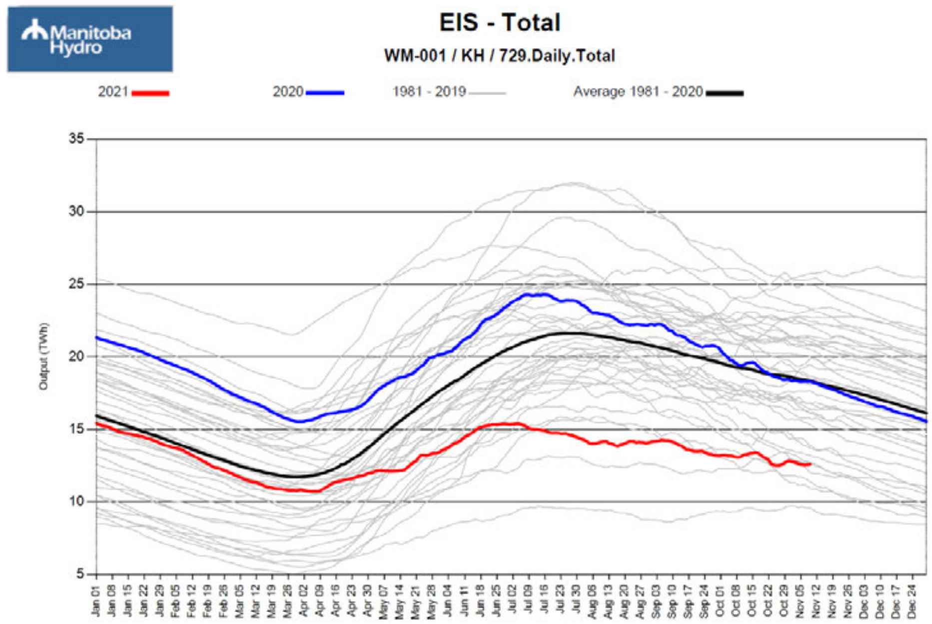

Figure 32. Total potential energy in storage[79]

These graphs show several important points. First, from January through mid-April of 2021, HEFI remained similar to both 2020 and the 40-year average. This is despite total system precipitation being far below normal levels (and even below the last major drought of 2003/04). Second, we can see the uncertainty, at a system level, of just how the continued drier weather in the south would impact MH as illustrated by the variability of HEFI beginning in mid-April. Not all dry weather has the same impact from an energy perspective. This is because MH energy production is centralized around a few key outflow conditions due to the amount of energy production along the Nelson River.

What this shows is that while the figures above provided useful context throughout the evolution of the drought, and useful illustrations in this GRA, the system-level nature of these metrics do not fully articulate the more granular, location-specific data which is of greater use in driving operational decisions.

Precipitation, and therefore inflows to reservoirs, vary greatly across the hydrological basins that converge in the province. The Nelson-Churchill watershed is a vast area covering multiple Canadian provinces and U.S. states. As can be seen in the table below, during the sixty days between April 24, 2021, and June 22, 2021, the Churchill River

79 Id.

Basin experienced 82nd percentile precipitation while the Winnipeg River Basin experienced 14th percentile precipitation.[80]

Table 4. Precipitation Basins Report for April 24, 2021, to June 22, 2021[81]

Precipitation Basins Report - Last 60 Days

Precipitation Report for 2021/04/24 - 2021/06/22
Historic data for 1991/04/24 - 2020/06/22

	Basin area sq. Km (% of Total)	Basin Weighting Factor (%)	Precip (mm)	Average	% of Average	Percentile
Churchill River Basin	**257,900**	**20.6%**				
Lower Churchill	(0)	0.0%	96.4	81.4	118.4	72.6
Reindeer Lake	(23)	34.3%	134.6	71.7	187.8	98.4
South Indian L. Local	(22)	32.1%	109.7	89.0	123.2	69.4
Upper Churchill	(55)	33.5%	109.4	104.7	104.5	50.0
Average			118.0	88.2	133.8	82.3
Nelson River Basin	**563,300**	**21.1%**				
Assiniboine U/S Bdn.	(15)	4.6%	95.5	116.1	82.3	33.9
Dauphin River	(14)	9.2%	86.7	115.3	75.2	21.0
Lake Winnipeg Local	(23)	32.4%	67.2	116.4	57.8	4.8
Nelson River Local	(12)	27.6%	227.6	97.6	233.2	98.4
Red River Basin (U/S Lockport)	(36)	26.2%	95.7	146.6	65.3	8.1
Average			122.1	119.0	102.6	59.7
Saskatchewan River Basin	**347,000**	**17.9%**				
North Sask. Mountain	(8)	35.5%	97.5	128.9	75.7	17.7
North Sask. Prairie	(28)	6.3%	102.0	113.2	90.2	33.9
Sask. River Local	(22)	20.2%	85.3	101.7	83.9	33.9
South Sask. Mountain	(12)	38.0%	102.9	150.5	68.4	17.7
South Sask. Prairie	(30)	0.0%	75.1	121.9	61.6	14.5
Average			97.4	130.6	74.6	11.3
Winnipeg River Basin	**139,000**	**40.4%**				
L. Seul/L. St. Joseph	(28)	28.3%	111.7	158.6	70.5	24.2
Lake of the Woods	(23)	19.9%	97.0	166.4	58.3	8.1
Winnipeg R. Upper Bdry	(28)	28.1%	125.1	160.8	77.8	24.2
Winnipeg River Local	(21)	23.6%	94.2	156.7	60.1	8.1
Average			108.3	160.2	67.6	14.5
Overall Weighted Average			**111.3**	**131.4**	**84.7**	**17.7**

Report Executed 2021/06/24

This variability across basins within its own watershed continued throughout the drought, leading to a complex picture that MH personnel needed to monitor, assess, and address through operational and financial decision making. To make the necessary operational decisions throughout the drought, MH's teams[82] used these indicators of

80 Manitoba Hydro tracks and reports on precipitation totals and their statistical percentiles for four key basins as part of its weekly Energy Supply Planning meetings: the Churchill River Basin, the Nelson River Basin, the Saskatchewan River Basin, and the Winnipeg River Basin. This table is an example of a precipitation report that is prepared weekly as part of Manitoba Hydro's RPPS meetings.

81 Source: Manitoba Hydro.

82 Energy Supply Planning, Wholesale Power Trading, and System Control Department, for example.

system conditions in conjunction with the numerous constraints[83] that are present in the operation of their generating stations.

C. Summary of Manitoba Hydro's policies and processes

In general, MH does not transition to any sort of alternative operations process upon water conditions deteriorating beyond a certain point. Rather, the Corporation's operational response to droughts should be thought of as an extension of normal operations wherein it pursues the objective of economic maximization within a set of constraints that are documented in their procedures and used daily. The challenges of operating the system change as system hydrology does, but the framework, which outlines the operational priorities and constraints under which the teams operate, does not change, regardless of whether the system is flush, is in drought, or is anywhere in between.

Priorities and constraints

Because drought operations are, in fact, ordinary operations under adverse water conditions, the first step in reviewing MH's performance during the most recent drought is to understand the general principles – the priorities and constraints – that govern MH operations. As outlined in their "Drought Management Planning" document,[84] MH manages its system according to a set of priorities. These are, in order:

1. Safety
2. Energy Supply
3. Energy Reserves
4. Short Term Reliability
5. Citizenship/Environment
6. Economics[85]

[83] For example, Manitoba Hydro operates its hydroelectric stations under licenses that impose limits on flow rates, flow rates of change, lake elevations, etc., which limit dispatch options that might otherwise be economic. Manitoba Hydro also plans and operates its system such that load (native plus firm exports) can be supplied reliably, which acts as a significant constraint particularly when the corporation must plan to have water available at Lower Nelson generating stations for cold snap contingencies.

[84] This document can be found in Appendix 5.3 of the GRA Filing.

[85] GRA Filing, Appendix 5.3, Section 4.

While all of these are important and MH strives to meet all of them fully, the order is important as it provides guidance to MH staff when they have to make difficult decisions regarding potential tradeoffs, such as can occur during drought conditions.

From a systems perspective, these priorities are part of a constrained optimization problem: items (1) – (5) are the constraints while item (6) is the reward function, which MH seeks to maximize within the existing constraints. This operational imperative – to maximize the value of its water while properly accounting for each constraint – is the goal of the weekly Resource Planning and Production Scheduling meeting, which is attended by a diverse set of employees representing either the various priorities or other expertise needed to operationalize the optimization problem. The following section provides details about this weekly meeting and its critical role in system operations, including during drought conditions.

Resource Planning and Production Scheduling (RPPS)

Manitoba Hydro's operations planning process occurs continuously and relies on several disciplines within the organization analyzing and handing off information in a rapid and coordinated fashion. To support this coordination, MH has a weekly operations planning meeting called the RPPS meeting. Information to which MH must respond to manage its system most effectively is communicated and discussed every week at this meeting, irrespective of whether the watershed is in drought, normal, or flush conditions. The information used at this meeting is updated over various time frames; for example, precipitation and other hydrometric data is updated daily while transmission availability which impacts the corporation's import and export activities may be updated monthly. The meeting includes representation from multiple teams and groups: Energy Supply Planning (ESP),[86] System Control Department (SCD), Wholesale Power Trading (WPT), Waterway Approvals and Monitoring (WAM), Enterprise Risk Management (ERM), Indigenous and Community Relations (ICR), and Generation Environmental Services (GES).

The Water Resources Department synthesizes real-time system hydrometric data with forecasts within its Delft Flood Early Warning System (FEWS) to calculate physically-based inflow forecasts. These forecasts are handed off to Energy Operations Planning at a weekly meeting. The physically-based forecasts depend on the system data for which the flow data are available; MH has prioritized the points within its system that are most

[86] Energy Supply Planning has been reorganized into Energy Resource Planning and Energy Operations Planning.

impactful to operations to implement physically-based forecasts. The transition to a 40-year flow is discussed in Section II above. The potential impact of this transition on drought operations is discussed below.

Energy Operations Planning uses the HERMES model to synthesize the physically-based forecasts with statistical forecasts, load forecasts, and other parameters and determine a weekly resource plan, operating instructions, and blended forecasts. Energy Operations Planning hands off these plans to internal stakeholders in the weekly RPPS meetings. These plans are detailed and provide significant data to the RPPS team to assist in weekly decision making regarding the actual operations of all MH facilities. Specific to Daymark's scope, however, one output of this data is the Forward Volumes Report (FVR). The FVR provides summary data on the expected opportunity sales and purchases forecast for the next twelve months in the most recent HERMES runs.

The guiding document for this meeting is a weekly presentation slide deck that the entire RPPS team reviews and then discusses in the weekly planning meeting. This slide deck, combined with that weekly meeting, forms the basis for the following week's operating and trading decisions.

Corporate policies

Manitoba Hydro references three corporate policies within its Drought Management Planning document:

1. P195 – Generation Planning Policy
2. P190 – Approval Authority Table for Wholesale Power Transactions and Related Agreements
3. P197 – Wholesale Export Power Policy

A summary of each policy and the way it was implicated in the drought conditions can be found below.

P195

The *Generation Planning Policy* dictates that "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."[87] The policy further discusses the conditions under which imports can be considered dependable energy. Additionally, it sets the planning reserve margin for the purposes of procuring capacity.

87 Policy P195, p. 1.

P190

The *Approval Authority Table for Wholesale Power Transactions and Related Agreements* sets out volume limits and their approval and execution authorities required for various wholesale power transactions and related agreements. During the drought, MH executed several types of transactions[88] for which the approval authority, allowed volumes, terms, and time frames were governed by this policy.

P197

The *Wholesale Export Power Policy* describes the Corporation's participation in wholesale electricity markets, and specifically states that, [redacted] 4a
"[89] The policy disallows manipulation but provides latitude to MH in executing wholesale power transactions, requiring only that they have an expected net benefit to MH. Finally, the policy establishes the risk management practices that ensure compliance with the Corporation's risk management policy.

D. Manitoba Hydro hydrology modeling implications

As discussed in Section II above, Manitoba Hydro's updated hydrology forecasting and modeling processes are reasonable improvements to their systems, tools and processes for forecasting hydrological conditions and resulting energy production. Separate from the general investigation discussed in Section II above, Daymark was tasked with reviewing the implications of the changes in hydrology modeling on MH's ability to respond to drought effectively. In addition to the general question of effectiveness within Scope of Work Item #10, Daymark was also tasked with specifically looking at the "change to a 40-year flow record from the previous 100+ year flow record." This section investigates both questions.

Three significant improvements in MH hydrology forecasting warrant discussion. First, MH now uses physically-based inflow forecasting (PBIF) to forecast short-term hydrology. Second, MH now utilizes the Drought Reserve Storage (DRS) concept for ensuring sufficient water supplies into the future. And finally, MH now performs a "cold snap" analysis to stress test DRS to ensure the resulting water supply target can withstand a

[88] For example, Financial Transmission Rights purchases, swaps, and gas commodity transactions.

[89] Policy P197, p. 2.

[redacted][90] 4a & 4b

PBIF produces higher quality forecasts versus the old statistical basis. Because each drought in MH's history has been different, utilizing the 40 year ensemble modeling with PBIF based on actual reservoir starting points provides an improved picture of the range of outcomes that represent energy production uncertainty. Any historic drought within the PBIF timeframe could be the most constrained hydrological case depending on starting reservoir conditions and near-term precipitation expectations. This is an improvement over the pure statistical forecast used for previous short-term modeling needs.

With respect to drought reservoir management, MH now tests for sufficient energy supply over time by constraining the modeling using the DRS value rather than a simpler volume target. According to MH documentation, "The DRS is the minimum potential energy in Manitoba Hydro's major reservoir storage that is needed at the start of the next water year (i.e., Y2), 2023/24 & 2024/25 General Rate Application such that firm demand can be met assuming the most severe single year drought of record is repeated."[91]

Finally, the inclusion of a "cold snap" test provides for a conservative plan for meeting domestic and firm export energy under a reasonable "worst case scenario." This test provides a check on the economic optimization model that might lead to energy being sold due to high short term value when that energy is needed for other policy purposes.

E. 2021/22 drought operations

As discussed in sub-section C, above, drought operations are not fundamentally different from operations during non-drought conditions. The Drought Management Planning document makes this clear in the summary, where it states that:

> "In the operating timeframe, Manitoba Hydro operates its power system consistent with the intent of the generation planning criteria. Manitoba Hydro plans reservoir releases, generation, and interchange with neighbouring markets on an ongoing and continuous basis in a manner that maximizes net revenue while maintaining a reliable and dependable supply for Manitobans. This practice is used under all water conditions,

[90] GRA Filing Appendix 5.3 – Manitoba Hydro's Drought Management Planning Document, p. 25.

[91] Id. at p. 17-18.

> including during droughts. To the extent that the cost of drought can be mitigated in the operating horizon, Manitoba Hydro will achieve this as a matter of course utilizing all resources available at the time as long as reliability of supply for Manitobans is maintained."[92]

Nonetheless, drought does cause some changes in behavior to occur within the organization. As water conditions[93] deteriorate, a shift occurs with respect to the priorities and activities of the RPPS and associated oversight committees. Operationally, ensuring energy supplies and protecting energy reserves become much more constraining in terms of the corporation's operational decisions. Financially, more imports and less exports necessarily mean that the actual net export revenue is going to be short relative to the budget, which brings extra attention and oversight. Decisions regarding opportunity purchases or sales are still dictated by the approval authority tables from P190, but beginning in July 2021 an oversight committee was formed and began meeting bi-weekly to ensure closer review throughout the drought.

Importantly, these changes are an outcome of MH processes, which operationalize the constraints discussed in sub-section C, above.

A prime example of MH operationalizing the constraints embedded in its policies is its cold snap planning process, which evaluates whether enough dependable energy will be available[94] to meet firm demand in the scenario where historically cold weather is experienced. To ensure that MH can definitively meet potentially high load in the winter, this planning process looks at the worst waterflow potential going forward from the current period. This analysis ensures current operations will provide sufficient energy supply (priority 2) without depleting reserves (priority 3) to the point where a cold snap would not be able to be met reliably (priority 4). In real time, this process is performed while also attempting to meet all known citizenship and/or environmental constraints, while optimizing available energy for export or needed imports. This analysis is always a part of MH operational planning. However, in most non-drought conditions it is not a binding constraint, and therefore does not change decision-making. As water conditions deteriorate, however, this constraint begins to alter operational decision making, to

---

92 Manitoba Hydro Drought Management Planning, p. 2.

93 "Water conditions" as used here refers to the instantaneous synthesis of antecedent conditions (precipitation amounts, lake levels, flows) and the limited time horizon forecasts which are available for decision making.

94 Due to the characteristics of the Manitoba Hydro system, this largely depends on water availability at the Lower Nelson River, where a majority of the corporation's generating capacity is situated.

ensure that the stated priorities are met in a manner that protects MH and its customers from potential issues in peak winter conditions.

MH also builds many other constraints into its decision-making process. For example, the corporation must abide by the licenses for its hydroelectric facilities, which dictate certain flow levels and elevations for points in its system; license compliance is reviewed at the weekly RRPS meetings, and any violations are reported. MH must also operate to limit adverse impacts, such as avoiding slushing as discussed in PUB/MH I-60d. Finally, MH has a long lead time relative to the gap from a decision to release water to when that water produces power. Typically, the water takes three weeks to get from the large storage facilities in southern Manitoba to the generating stations in the Lower Nelson. This physical constraint makes “fine adjustments” difficult to accomplish.

While the scope of all activities undertaken by MH, both ordinary and extraordinary, to manage its system during the drought period is far too large to capture in this report, the next subsection details some notable activities undertaken by MH to respond to the persistent drought conditions.

2021/22 specific activities

Manitoba Hydro’s operations planning processes are designed to respond to all possible water conditions, drought and flood alike, continually, to achieve the Corporation’s priorities. There were, however, some specific activities that occurred because conditions deteriorated over the 2021/2022 water year; some of these are defined in the Drought Management Planning document while others occurred on an ad hoc basis as conditions warranted. This section includes discussion of some key activities undertaken by MH during the drought that were reviewed in detail by Daymark. These include (1) the establishment of an oversight committee to review and guide decisions made by the RPPS meeting team, (2) increased hedging activity to mitigate perceived risk to MH net export revenue results, (3) communications with MISO to inform the market operator regarding risks, MH actions, and outlook during the drought, and (4) increasing energy conservation actions to ensure reliable delivery of firm energy needs. Collectively, these activities were designed to manage the potential conflicts between operational and financial priorities and to avoid or limit trade-offs where possible.

Executive Oversight

Section 5.8.1 of the Drought Management Planning document defines the executive risk oversight which provides that the executive team will be updated regularly and in greater detail and review and approve risk tolerance and risk mitigation strategies. Specifically, the document states that "The Corporation's response to drought will depend upon its current financial position, water storage conditions, market conditions, and other factors. Senior management are informed of operating conditions and review and approve decisions related to drought management outside of established controls and approval authority of line management."[95] To adhere to this, bi-weekly meetings were established starting in early August.[96]

At the first meetings of this oversight committee, a set of "drought management fundamentals" was established. The principles were articulated in a slide presented to the team and are clearly consistent with the policies and requirements of the Drought Management Planning document. The principles articulated are as follows:

- Economic decisions 'on average' until energy security is binding
- Energy security second only to safety
- Defer costly actions until required
- Plan to supply firm load with firm resources
- Plan for continued drought

The content of presentations to this committee varied by meeting, but typically included key hydrological data, insights on current MISO market conditions, the state of currently approved hedge volumes and outstanding hedges, and important operational considerations.

MISO communications

During the drought, MH both monitored MISO markets closely to review potential portfolio risk (risk of material variability in net export revenue) but also communicated with MISO personnel with respect to what MH operations were seeing and what actions MH was taking in response to drought.

Energy conservation activity

Per Section 6.2.1.4 of the Drought Management Planning document, under drought, special consideration is given to short term energy availability to meet requirements under extreme conditions; the prime example of this is cold snap analyses. In the course

95 Manitoba Hydro Drought Management Planning, p. 12.

96 The committee met roughly every two weeks throughout the fall and winter 2021/22. It is Daymark's understanding that, while initially stood up specifically for the adverse conditions experienced in 2021, this committee or a subsequent version of it is now a standing committee for MH.

of interviews with MH personnel, we established that the cold snap analysis was updated and reviewed with senior leadership, Wholesale Power Trading, and System Control as part of MH's drought response.

Hedges of different varieties were characteristic of MH's drought response: acquisition of Financial Transmission Rights, forward power purchases, and forward purchasing of gas. Per Section 7.1 of the Drought Management Planning document, the implementation of these hedges is to be gradual and mechanistic. Sub-section F below discusses MH's hedging activity in detail.

During low flow conditions, the corporation may be forced into making tradeoffs between energy supply and energy reserves; per its operating priorities MH may take actions to ensure energy supply which draws on energy reserves. The charting of Jenpeg outflow, which is a point which reflects flows from MH's major reservoirs into the Nelson River, demonstrates this tradeoff: in November, flows were increased to ensure energy sufficiency despite system energy in storage being at low levels.

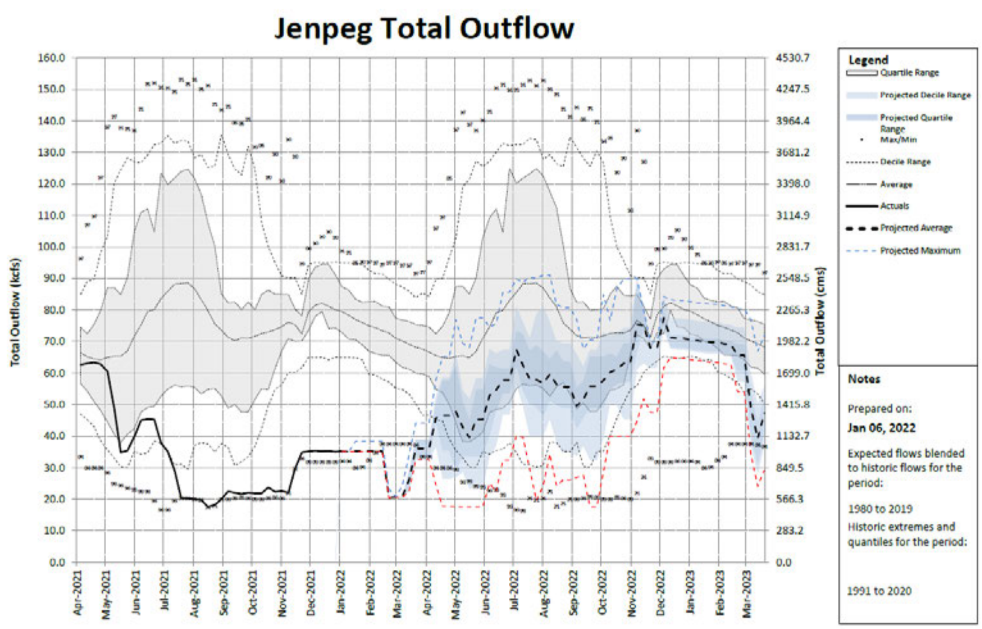

Figure 33. Jenpeg total outflow as of January 2022[97]

97 Source: Manitoba Hydro

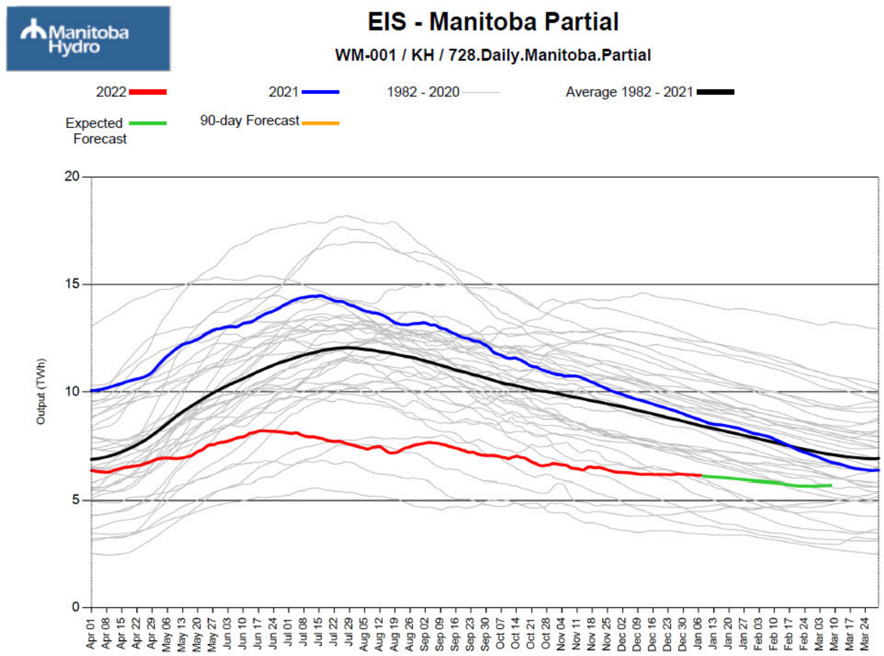

Figure 34. Potential energy in storage, January 2022[98]

Other observations

In addition to the items discussed above, MH performed various activities beyond the formally documented actions. These activities included: news releases, responding to media inquiries, meeting with MISO to discuss MH's plans for imports, correspondence with the Minnesota Public Utilities Commission, advocating for Winnipeg River critical flow requirements through the Lake of the Woods Control Board, and giving advanced notice of potential curtailment of industrial load under curtailable rates.

Compliance with Policies and Procedures

In addition to the documented areas of investigation, Daymark reviewed the RPPS presentations from 2021 and early 2022, as well as presentations to the oversight committee and to MISO. We also held meetings with the personnel responsible for guiding the drought responses. There will always be uncertainty as to the value of any particular action taken or avoided, especially from a position of hindsight. Nonetheless, we find that MH did comply with their written policies and procedures and took extraordinary care to continuously balance the often competing priorities that are part

98 Source: Manitoba Hydro.

of operating such a large hydrological system. We further find that the RPPS and oversight meetings (and associated presentations) were critical to ensuring that all priorities were met. The team of executive and senior leadership was formed to provide executive oversight during the drought. Through discussion with MH, we understand that MH's Enterprise Risk Committee [Pg 31 Tab 2, Figure 2.6 and 2.7] has recently been formed, and appears to be the appropriate framework and entity to provide such oversight during future extreme droughts. Across the MH operations, planning, and oversight teams, there is still a large amount of knowledge that is held within the minds of the members of those groups. MH may have an opportunity to formalize some of their knowledge and expertise into additional policies or procedures to assist those teams in managing future adverse conditions.

F. Manitoba Hydro price hedging activity

Manitoba Hydro's Drought Management Planning document states that, "To the extent that Manitoba Hydro is exposed to additional financial risk during drought as a result of uncertain market and natural gas prices, Manitoba Hydro may choose to hedge that price risk by purchasing electricity and/or natural gas forward contracts or options."[99] In Appendix 3.2 to its filing, MH outlined the cause and need for increased price hedging activity in 2021.

> "As a result of the significant energy imports forecast to be required to address the reduced hydraulic generation in 2021/22 and the market conditions causing rising energy market prices for both electricity and natural gas, Manitoba Hydro implemented a hedging strategy to mitigate its price risk associated with energy imports.
>
> The key goal of Manitoba Hydro's hedging strategy was to focus on overall portfolio risk reduction and mitigation of the downside risk to net extraprovincial revenues (i.e., increased power prices negatively impacting net income)."[100]

Hedging strategy

The filing goes on to articulate the approach taken to implement their strategy.

[99] GRA Filing Tab 5, Appendix 5.3 – Manitoba Hydro's Drought Management Planning Document, p. 2.

[100] GRA Filing Tab 3, Appendix 3.2 – 2021/22 Price Risk Management Results, p. 2.

> "Manitoba Hydro's drought hedging strategy employed a balanced approach throughout its hedging activity. Having this balanced and staged approach greatly reduced the potential for purchasing financial hedges that would not be supported by a physical need for imports. The hedging strategy was developed incorporating the principles of Manitoba Hydro's ERM Framework by providing a consistent and systematic method for risk management that supports risk-intelligent decision making."[101]

MH further explained its hedging approach in response to PUB/MH I-9b, where it stated:

> "Manitoba Hydro diversifies its export volumes across all market timeframes including the Long-term, Short-term, Day Ahead and Real Time markets. Opportunity Exports are defined as the surplus energy quantities Manitoba Hydro has available after meeting firm load and Long-term export commitments.
>
> Opportunity exports are very dependent on hydraulic conditions. To diversify a portion of Manitoba Hydro's expected opportunity energy position into the Short-term time periods, physical and/or financial hedging is required.
>
> The physical and financial instruments that Manitoba Hydro implements to hedge opportunity exports can include:
>
> - Physical bi-lateral contract for fixed price energy,
> - Financial bi-lateral contract for financial swaps (fixed for float),
> - Contract for difference for financial swaps (fixed for float),
> - Financial Transmission Rights (congestion hedge)."[102]

Hedging activity

Most of the hedging activity during the 2021/22 drought was forward purchases consisting of [redacted] energy and [redacted] natural gas purchase hedges, contracted over 4 months 3a from early August 2021 until early December 2021.[103] Additional hedging of sales occurred in February 2022. This hedging activity was occurring as MH's available energy

101 Id. at p. 3.

102 PUB/MH I-9a-b.

103 There were some Financial Transmission Right hedges that were contracted as well.

for export (or need for import) was changing rapidly and as the price of natural gas (which is the primary driver of MISO pricing) was rising quickly. Figure 35 shows the spot price of natural gas at the Henry Hub trading location, with vertical lines indicating the days in which MH hedged energy purchases. As can be seen from this graph, [redacted] 4a

[redacted] 4a

Figure 35. Henry Hub natural gas price, July 1, 2021, to December 31, 2021

During most of the purchase hedges, natural gas prices were continuing to rise, illustrating the concern that MH was attempting to mitigate. Late in 2021 natural gas prices began to lower and [redacted] 4a Throughout the period where MH hedged energy and natural gas purchases there was significant discussion at the oversight committee regarding the need for hedging and the recommendations of the WPT. Volumes approved through that process were roughly [redacted] of forecasted 4a opportunity purchases (with respect to energy purchase hedges) or based on forecasted Brandon generation (with respect to natural gas purchase hedges).

In such an environment, hedging trading risk is prudent for any entity such as MH. Not only was there significant uncertainty as to the price of forecasted purchases, but tying the volumes approved to a percentage of forecasted purchases ensured there was a high probability that the hedges would be backed by the physical transmission of energy, meaning that the transactions were not speculative. Therefore, our investigation focused on the process for determining when to hedge and the policies, safeguards, and oversight of the activity.

The primary guiding policy for MH when engaged in market transactions is Policy 197. Within this policy is documented the purpose of trading: "to assist in providing a reliable and dependable supply of power to Manitoba and to optimize operations and development to minimize the net costs to Manitoba customers."[104]

In support of that goal, the policy sets a low risk tolerance, identifying the need that [redacted] 4a
[redacted][05] Additionally, P197 incorporates P190 by reference, which identifies the approvals needed and volume limits governing the actions of the trading group. MH utilized the RPPS and oversight committee meetings to present options around what volume of potential purchases should be hedged.

Finally, P197 identifies the specific risks and management practices designed to mitigate those risks. The two risks that we focused on in our investigation were the volume and price risk and the credit risk. Volume and price risk is defined as "the risk that wholesale power transactions and related agreements are over-committing the available power supply or committing Manitoba Hydro to prices that are not expected to benefit Manitoba Hydro and its stakeholders." Credit risk is defined as "the risk that a counterparty to Manitoba Hydro's wholesale power transactions and related agreements fails to pay or perform its contractual obligations."

Hedging results

The actual results of this approach, given the changing dynamics of both the hydrological system and the outlook for export/import pricing, was presented as part of the application in Appendix 3.2. This figure[106] is reproduced below:

104 Policy 197, Wholesale Export Power Policy (WEPP), p. 1.

105 Id.

106 Negative numbers mean the cost of the hedge exceeded the value of the energy (transactions "out of the money").

Winter Hedging Financial Performance (CAD$ millions)	
Sep 2021	0.1
Oct 2021	2.0
Nov 2021	2.2
Dec 2021	(2.2)
Jan 2022	(8.6)
Feb 2022	(7.3)
Mar 2022	(5.9)
Total	**(19.8)**

Figure 36. Financial performance of Winter 2021/22 hedging activities[107]

By the end of the 2021/2022 winter, natural gas prices had not continued to rise, and no significant winter event impacted the price at which MH could have purchased energy. Figure 37 and Figure 38 show the Henry Hub natural gas price and corresponding MISO energy prices, respectively, for the first three months of 2022, which corresponds to the time of the energy and gas purchase hedges.

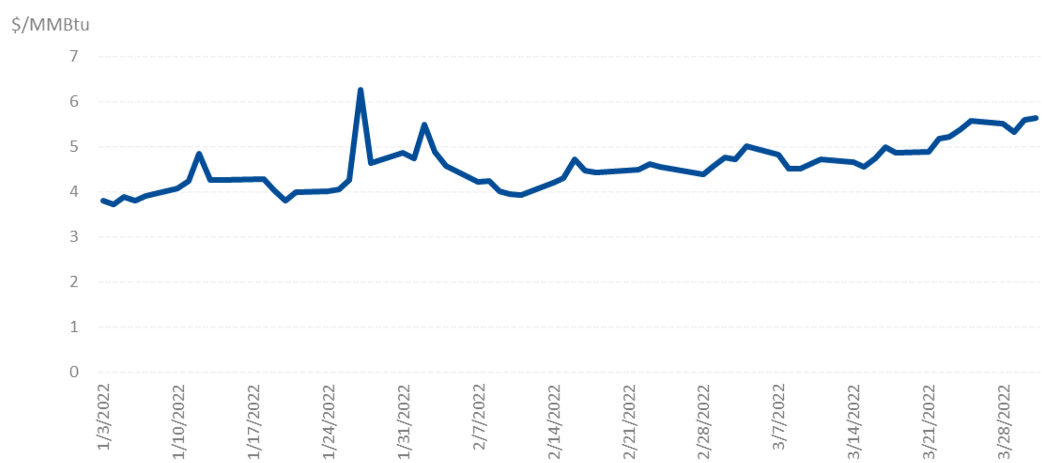

Figure 37. Henry Hub natural gas price, January 3, 2022, to March 31, 2022

107 GRA Filing Tab 3, Appendix 3.2 – 2021/22 Price Risk Management Results, Figure 3, p. 6.

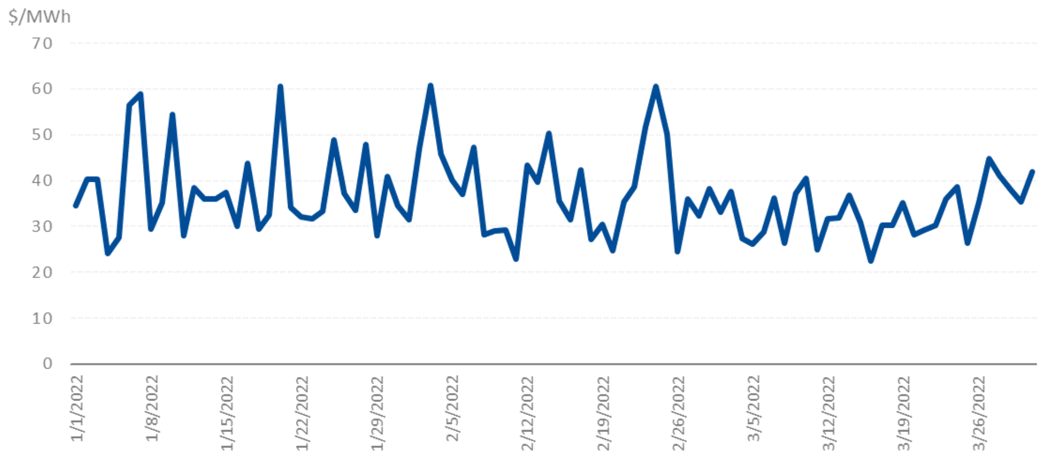

Figure 38. MINN HUB day-ahead energy price, January 1, 2022, to March 31, 2022

MISO prices did not increase throughout the winter. The price of natural gas, while increasing slightly over the first quarter of 2022, did not spike as it sometimes does in winter. Additionally, no significant storm event occurred. In combination, the easing of natural gas prices and the absence of price spikes due to winter storm events created a calmer winter from an energy price perspective, which in turn caused the hedges to be "out of the money" as shown above.

Additionally, water conditions began to improve, and the volume of needed winter purchases did not reach the conservative level forecast when the hedges were contracted. [redacted] 4a

Despite that result, however, the rationale and process for contracting those hedges, however, remains sound. Hedges are used to mitigate risk and provide a measure of price certainty. While P197 states that the goal of wholesale power transactions is, in part, "to minimize the net costs to Manitoba customers," the emphasis is on reducing portfolio risk, not comparing the actual results of any given hedge. Given the potential for significant increases to the cost of procuring power over the winter, it was reasonable to hedge a portion of projected purchases in the fall of 2021 to protect against such a high-cost outcome.

Compliance with Policies and Procedures

The policies that govern MH hedging are clear as to what the intent of a hedging program is and what approvals are necessary. MH, through the RPPS and executive oversight committee, spend significant time and resource evaluating market risk, collaborating with key stakeholders within the organization and ensuring proper approvals were obtained throughout the drought period. In particular, we find that MH:

1. Utilized proper approvals, including trading volume limits and credit limits
2. Had a high expectation that volumes would be backed by physical purchases or sales
3. Reasonably tested and concluded that that hedges were protecting MH and its customers from foreseeable bad outcomes (potential high cost purchases from high NG and/or bad winter storm events)

Observations

MH's hedging strategy is focused on the portfolio risk that is derived from the volume of projected purchases or sales. This is consistent with its policies regarding wholesale power trading and hedging. Approvals are focused on volumes, with hedging pricing being the outcome of WPT negotiating efforts. There does not appear to be any distinction between the revenue risks born by purchase transactions versus the revenue risks born by sales transactions, at least in the documented plans and policies related to hedging. This is a potential area to investigate for future improvements.

Sales and purchases do not necessarily produce the same risk to MH or its customers. Higher prices are beneficial when selling but detrimental when purchasing. Lost sales revenue has an effective floor, although negative pricing does expand that risk as more and more renewables come online in MISO. Additional purchasing costs, on the other hand, have no realistic ceiling in most market conditions.

This lack of symmetry in terms of what market conditions are harmful and what level of financial harm those conditions can produce suggests that differentiating hedging strategy between purchase conditions and sales conditions could be beneficial to MH and its customers. While focusing on volumes to hedge is a reasonable shortcut approach, combining projected volumes with potential dollar impact for that volume might lead to more nuanced trading limits.

APPENDIX A: INDEPENDENT EXPERT CONSULTANT SCOPE OF WORK

Note: The version of the scope of work posted on the PUB website inadvertently combined scope items #2 and #3 in the numbering scheme. For the purposes of this report, Daymark corrected this issue and uses the numbering noted in this Appendix.

http://www.pubmanitoba.ca/v1/proceedings-decisions/appl-current/pubs/2022-mh-gra/dea-scope.pdf

DAYMARK ENERGY ADVISORS – INDEPENDENT EXPERT CONSULTANT – SCOPE OF WORK

Export Pricing and Revenues Review

1. Review and comment on Manitoba Hydro's electricity export price forecast, including the low and high case forecasts, in the context of current MISO market conditions and factors influencing future MISO prices. Manitoba Hydro's price forecast, provided in PUB Minimum Filing Requirement (MFR) 84, is a consensus forecast comprised of third party consultant forecasts which may or may not be individually provided. Regardless, these forecasts are to be taken as a "given" and are to be assumed to be reasonable and accurate with respect to the other tasks in this Scope of Work. Notwithstanding that the third party consultant forecasts are to be accepted for the purposes of this review, if the IEC identifies significant issues or inconsistencies with the third party consultant forecasts in the course of its general review, those issues or inconsistencies are to be identified in the IEC's reports. (Additional References: PUB/MH I-52, PUB/MH I-53)
2. Review and assess for reasonableness Manitoba Hydro's forecasts of exportable surplus energy and capacity by on-peak and off-peak period, taking into account expected inflow conditions, reservoir levels, and tie line capacities for both the test years as well as the next twenty years as provided in PUB Minimum Filing Requirement 42. (Additional Reference: PUB/MH I-49)
3. In Board Order 9/22, the Board stated: *"While Manitoba Hydro indicated the 40 years of data improve the quality of the data for its modeling purposes, the Board notes that the average Net Extraprovincial Revenue, and therefore Net Income, is $19 million less using the 40-year average compared to the 108-year average. The Board further notes that the median (or P50) result of the 40 years of data is $36 million less than the median result using 108 years of data. The Board finds that this issue should be further explored, including comparisons with other jurisdictions and industry best practices, in the 2022/23 General Rate Application when the 2021/22 interim rates are reviewed."* The IEC is to review Manitoba Hydro's change to the use of a 40-year flow record from the previously used 100+ flow record for short-term water flow forecasting. The IEC is to determine whether the change to the use of the 40-year flow record is an improvement to Manitoba Hydro's forecasts of net export revenues. (Additional Reference: Appendix 5.4 Section 5, PUB/MH I-59)

4. Assess and comment on any other changes made by Manitoba Hydro to its hydrology forecasting methods and tools since the 2017/18 & 2018/19 General Rate Application.
5. Review Manitoba Hydro's forecasts for export revenues and fuel & power purchases for the next twenty years as provided in PUB Minimum Filing Requirement 42 and assess whether the forecasts of net extraprovincial revenues are reasonable. Confirm whether Manitoba Hydro has included uncontracted capacity and long-term firm sales revenue in its forecasts and whether such assumptions are supported. (Additional Reference: PUB/MH I-45, PUB/MH I-46)
6. Review the forecast export revenues for each export contract provided as part of PUB Minimum Filing Requirements 85 and 86 and confirm whether these forecast revenues are reasonable and are underpinned by the export contracts.
7. Review PUB Minimum Filing Requirement 28 and confirm whether the scenarios and calculated revenues from the Keeyask generating station are reasonable. If Daymark concludes that the scenarios are not reasonable, provide Daymark's assessment of reasonable scenarios.
8. Assess the reasonableness of Manitoba Hydro's assumption that a minimum level of seasonal diversity contracts will no longer be available following the expiration of its existing seasonal diversity contracts. (Additional Reference: PUB/MH I-48)
9. Provide comments on the factors influencing the MISO market and trends that are affecting market prices, including but not limited to:
    g. state and federal policies on electricity generation and emissions;
    h. existing generation mix;
    i. expected new generation to be installed in the next 20 years;
    j. forecasted generation retirements in the next 20 years;
    k. supply and demand balance in the northern MISO region; and
    l. factors that may affect Manitoba Hydro's ability to export energy and capacity into the MISO market

<u>Reservoir and System Operations During the Drought of 2021/22</u>

10. In Board Order 9/22, the Board stated: *"The Board accepts Manitoba Hydro's account of how it managed the drought from a reservoir operation perspective. The Board will inquire further of Manitoba Hydro on this topic at the next General Rate Application to demonstrate on the public record whether Manitoba Hydro made and continues to make prudent decisions with respect to the management of its water reservoirs."* The IEC is to review Manitoba Hydro's

reservoir operations, generator scheduling, and electricity imports over the period November 2020 to July 2022 to assess whether Manitoba Hydro followed its documented policies and procedures (including Appendix 5.3 Drought Management Planning document) effectively used hydrology forecasting tools, and whether these operations reasonably balanced the risks of a continuing drought and the need to ensure the reliable supply of electricity to domestic consumers with the economic operation of Manitoba Hydro's system in order to minimize the cost of the drought to ratepayers In its assessment, the IEC is to consider whether the existing process and policies are the appropriate process and policies, and whether improvements could be made to enhance the response to future droughts. (Additional Reference: PUB/MH I-60)

11. Review and comment on whether and how the change to a 40-year flow record from the previous 100+ year flow record affected Manitoba Hydro's actions in responding to the drought, including reservoir operations, generator scheduling, and electricity imports.
12. Review and comment on the appropriateness of Manitoba Hydro's price risk management policy. Review and comment on the actions taken, or not taken, by Manitoba Hydro in 2021 and 2022 in response to the drought and whether these actions were in compliance with the price risk management policy. (Additional References: Appendix 3.2, PUB/MH I-9, PUB/MH I-18)

Report and Cross-Examination

13. Provide a report to be placed on the public record that provides the Consultant's findings, opinions, recommendations, and non-commercially sensitive supporting information.
14. Provide a non-public report to the PUB that provides commercially sensitive information and additional calculations supporting the findings.
15. Respond to written information requests on the contents of the report.
16. Respond to oral questioning from Manitoba Hydro, Intervener, and Public Utilities Board counsels during a public hearing of the general rate application.