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Export Revenues and Drought Operations

Independent Expert Consultant Presentation

PREPARED BY: DAYMARK ENERGY ADVISORS
PREPARED FOR: MANITOBA PUBLIC UTILITIES BOARD
DATE: MAY 18, 2023

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Presentation agenda

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1. Daymark scope of work
2. Context of our review
3. MISO market overview and outlook
4. Inflow forecasting and dependable energy modeling
5. Export price, volume, revenue forecast
6. Keeyask revenue scenarios
7. Operations during 2021/22 drought
8. Key findings

1. Daymark scope of work

Daymark objectives and specific review requirements

Objective

- Determine the accuracy and reasonableness of the forecasted export energy and capacity in the net extraprovincial revenues in the GRA application.
- Determine the reasonableness of the operations performed to minimize the economic impact of the 2021/22 drought.
- Determine if MH's recently-modified modeling and hydrology practices on the impacted the ability to respond to water conditions and the accuracy of its export revenue forecast.

Specific review requirements

- Inflow forecasting and energy modeling
- MISO market overview and outlook
- Export price forecast
- Export contract review
- Export energy volume forecast
- Export capacity volume forecast
- Export revenue forecast
- Keeyask revenue scenarios
- Operations during 2021/22 drought

Daymark activities and deliverables

Daymark approach

- Reviewed MH and intervener materials
- Reviewed publicly available materials related to potential markets and counterparties
- Reviewed relevant portions of the Interim Rate Application, General Rate Application, Information Requests, Minimum Filing Requirements, and written evidence
- Met with MH staff in-person and virtually and received supplemental follow-up information
- Performed additional analysis, as needed
- Integrated the items above with Daymark's prior experience

Relevant Daymark materials

- Produced an Independent Expert Consultant report
- Responded to Information Requests related to report
- Presentation of its report for cross examination at the hearings today and tomorrow.

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2. Context of our review

MH's forecast must reflect the internal and external environments

- There is significant change and uncertainty affecting 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 export energy availability and its own capacity surplus.
- Major MH long-term contracts are set to expire over the next several years.
- The MH metrics used in providing resource adequacy to its system to service Manitobans are unchanged.
- 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.
- Water conditions, broad market trends and province specific physical conditions – all impact the GRA filing and are addressed in Daymark's Report.

3. MISO market overview and outlook

Scope of work

- ## Scope of Work 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

- ## Scope of Work 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.

MISO market is key factor in extraprovincial revenue forecast

MISO conditions impact both *value of* and *demand for* MH products

- The **market pricing** (energy, capacity, ancillary services) and changes to **market products** impacts the value of opportunity sales
- Broader **market activity** impacts the demand for MH products over time
  - Load growth and shape, resource retirements and buildout, resource adequacy rules, state/federal policy, customer preferences
  - Impacts demand for both firm and opportunity sales

Three key questions pertinent to GRA

1. MH forecast export revenue from the MISO market is declining - Is that reasonable?
2. MH does not assume that diversity arrangements for capacity will be renewed, and does not assume new future capacity sales – Is that reasonable?
3. Should MH be assuming a premium for its products in the long-term forecast?

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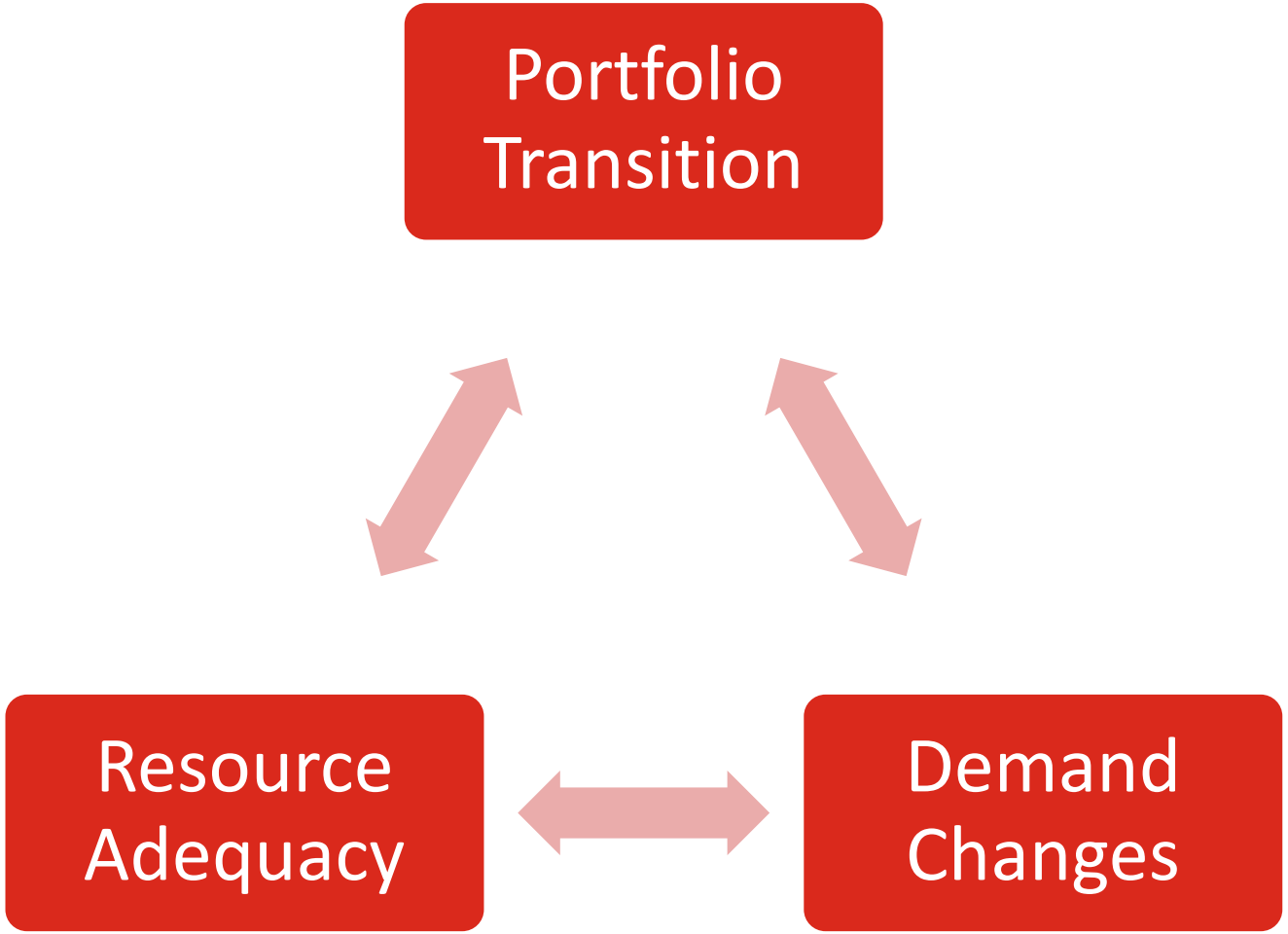
Interrelated market forces



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Portfolio transition

Conditions

- Rapid expansion of renewables
- Retirements of conventional thermal capacity

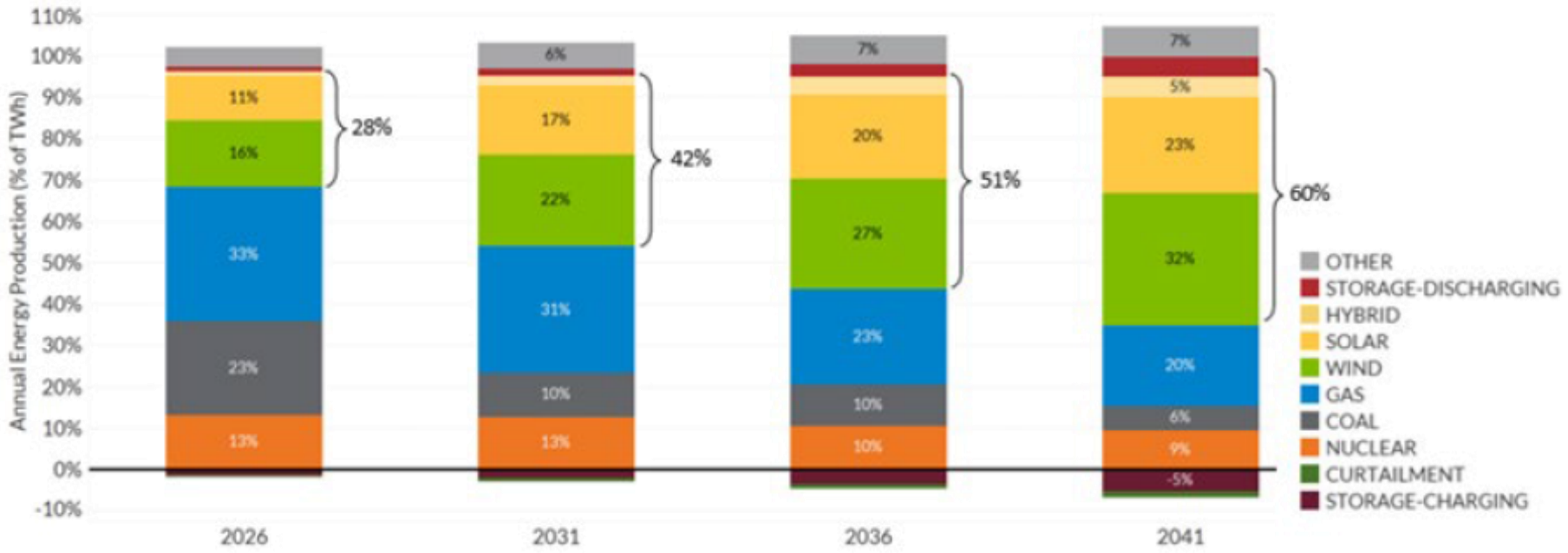
Drivers

- State policy (RPS, CO_2 reduction targets)
- Utility commitments (decarb. supply)
- Federal incentives (ITC/PTC, IRA)
- Economics (price declines + incentives)

Impacts on MH

- Lower market energy prices
- Not a lot of firm capacity (yet)

Figure 6. MISO 2022 RRA results, energy mix



*Solar includes DGPV, while "Other" includes demand response and energy efficiency
Note: expansion was performed for each LRZ using a model that does not include the transmission system

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Resource adequacy

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Conditions

- Large capacity transition underway, esp. Northern MISO (LRZ 1)
- Peak capacity shortfall expected in near future
- Implementation of seasonal peak reqs.

Drivers

- Conv. capacity retirements + VER additions reduces firm capacity
- Extreme weather/load conditions make peaks more difficult to predict, requiring more low-use capacity

Impacts on MH

- Capacity shortfall *should* create market for surplus MH capacity, esp. clean resources that meet RA and decarbonization goals
- However, utility planning for seasonal capacity may result in less relative summer capacity need (next slide)

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

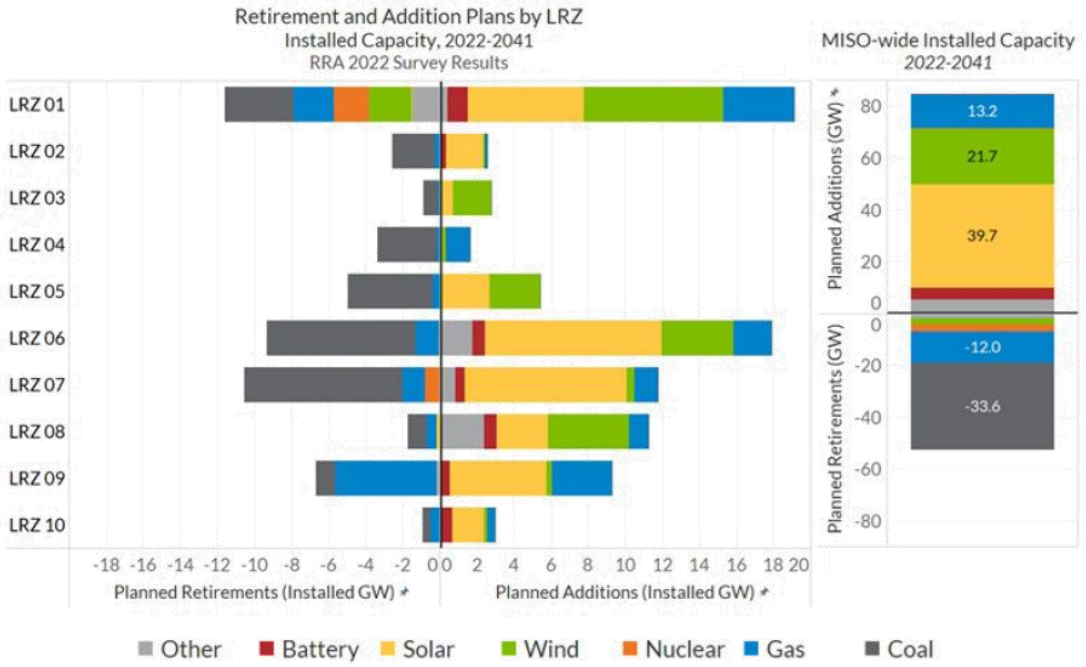
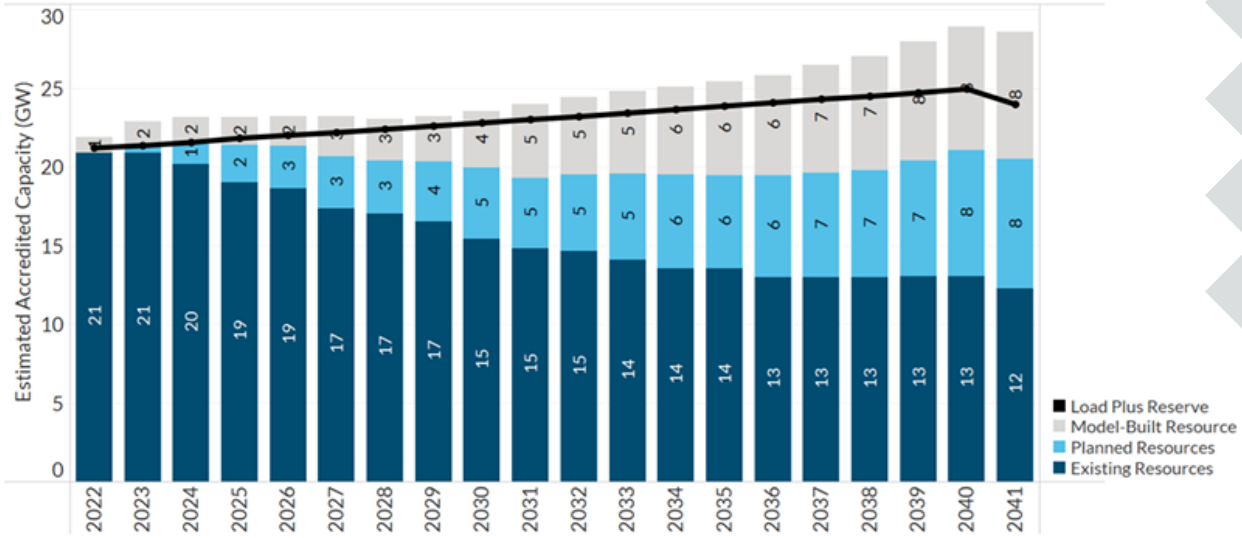


Figure 13. 2022 MISO RRA, LRZ 1 accredited capacity and required reserves



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Demand changes

Conditions

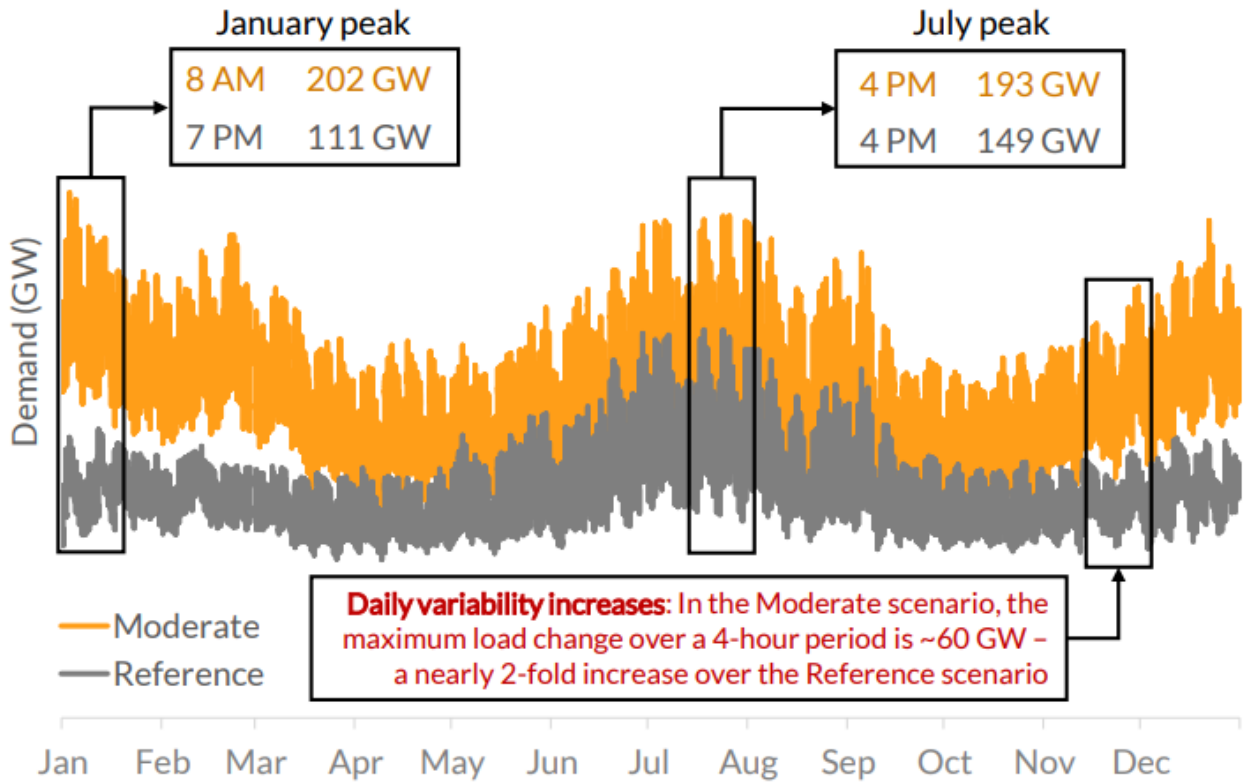
- Electrification of heat and transportation will change load patterns; high Northern MISO impact
- Solar not well-suited to provide capacity during winter peak

Drivers

- Technology developments
- Economics: Tech. cost declines, low electricity prices, policy-driven incentives
- Consumer preferences

Impacts on MH

- If winter capacity becomes planning constraint, utilities will add winter firm capacity, resulting in lower demand for MH summer seasonal capacity



Source: MISO *Electrification Insights,* April 2021

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Long-term market features significant uncertainty

- Clear that the charge towards increased renewables will continue
  - Interconnection queue shows it, MISO transmission planning expects it, economic drivers and incentives support this transition, etc.
- The impacts on resource adequacy, and the response of the market, is the big question mark
  - The MISO seasonal capacity construct is not yet finalized, no capacity trading yet
  - The costs of capacity alternatives are in flux (rapid cost declines in storage were stalled by inflation and supply chain, IRA is likely to promote new development)
  - The next 5-10 years will see major change
- MISO market evolution could create new or expanded opportunities
  - e.g., New ancillary market products, short term capacity shortages as market adjusts
- For GRA, uncertainty supports conservative assumptions

Daymark's findings on three key questions for GRA

1. MH assumes export revenue from the MISO market is declining - Is that reasonable?

2. MH does not assume that diversity arrangements for capacity will be renewed, and does not assume new future capacity sales – Is that reasonable?

3. Should MH be assuming a premium for its products in the long-term forecast?

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4. Inflow forecasting and energy modeling

- ## Scope of Work Item #3:

  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.

- ## Scope of Work Item #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.

Context: MH watershed and hydraulic system

- Manitoba Hydro's watershed is complex:
  - Is one of the largest in North America
  - Extends far beyond Manitoba borders
  - Is ecologically diverse
  - Typically experiences differing flow conditions (flood, drought, etc.) at the same time in various sub-basins or other smaller sections
- Other factors driving change in hydrological forecasting
  - Impacts of climate change
  - Improvements in tools and data

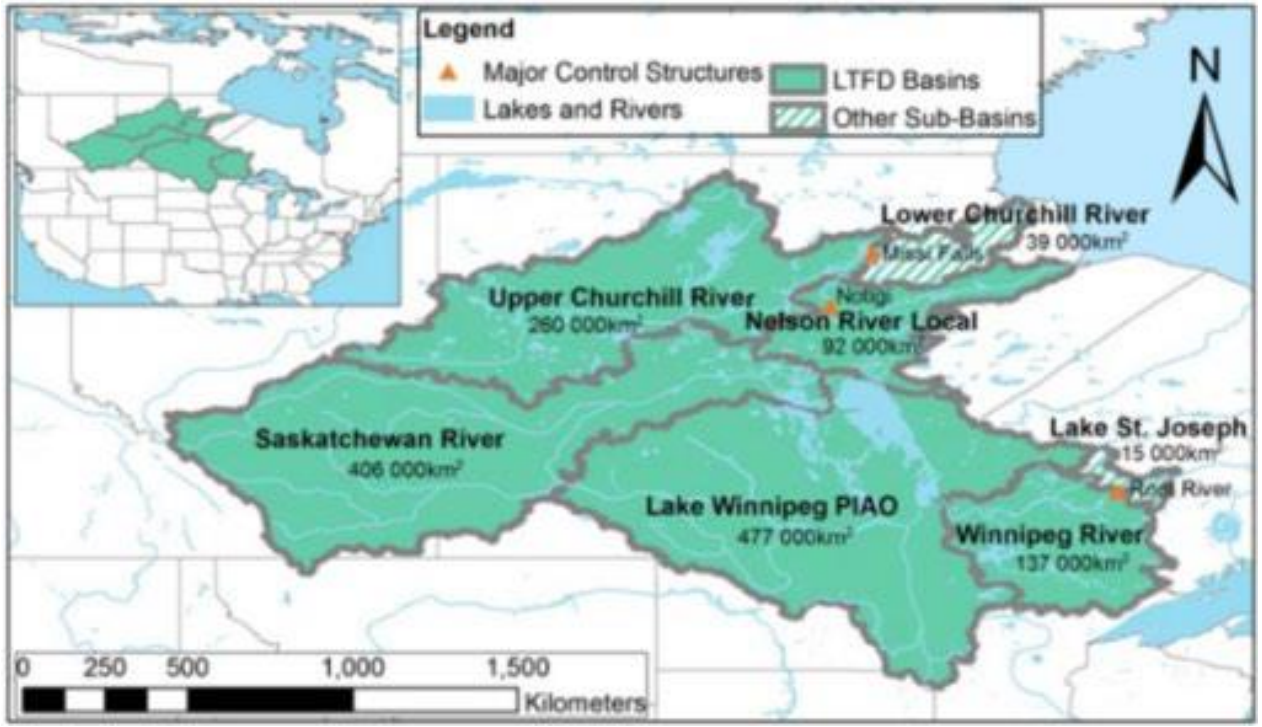

Figure 1. Manitoba Hydro watershed and major sub-basins.

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Inflow forecasting and flow case development

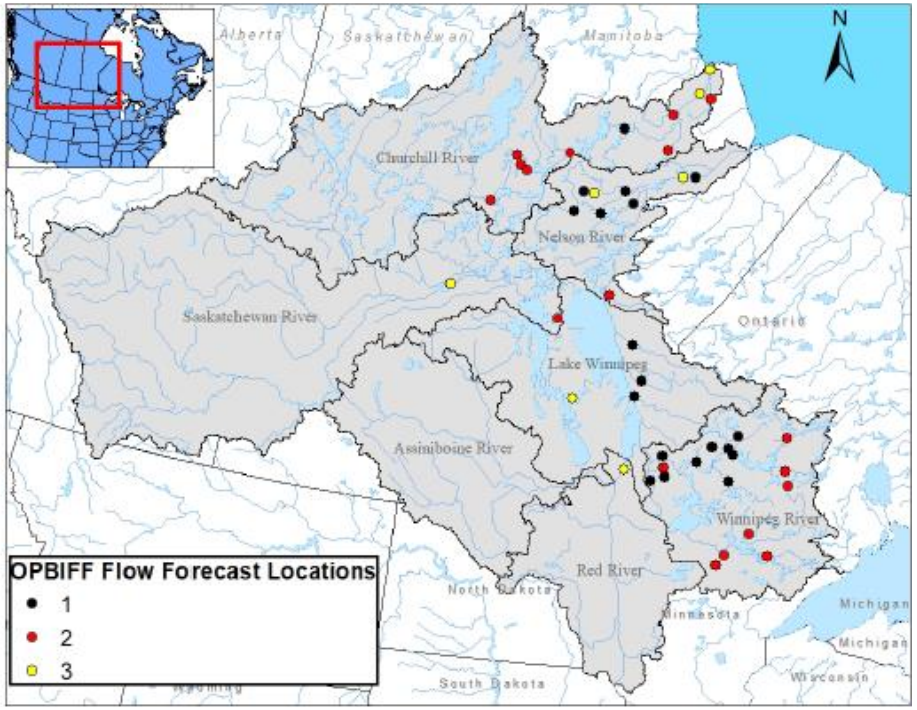

Figure 2. OPBIFF Phases – Forecast Locations

Tool and modeling changes

- New and improved data and tools
  - Delft-FEWS platform
    - Integrates data & models
    - Used world-wide
  - Allows use of best available models and data
    - WATFLOOD and HEC-HMS (Hydrologic Engineering Center hydrological models
    - Environment and Climate Change Canada (ECCC) data
- MH Operational Physically Based Inflow Forecasting Framework (OPBIFF) Project
  - Represents individual forecast locations, or “nodes,” for inflow forecasting over multiple Phases
  - High impact nodes (largest impact on energy) implemented in Spring 2021 as Phase 1

Inflow forecasting and flow case development

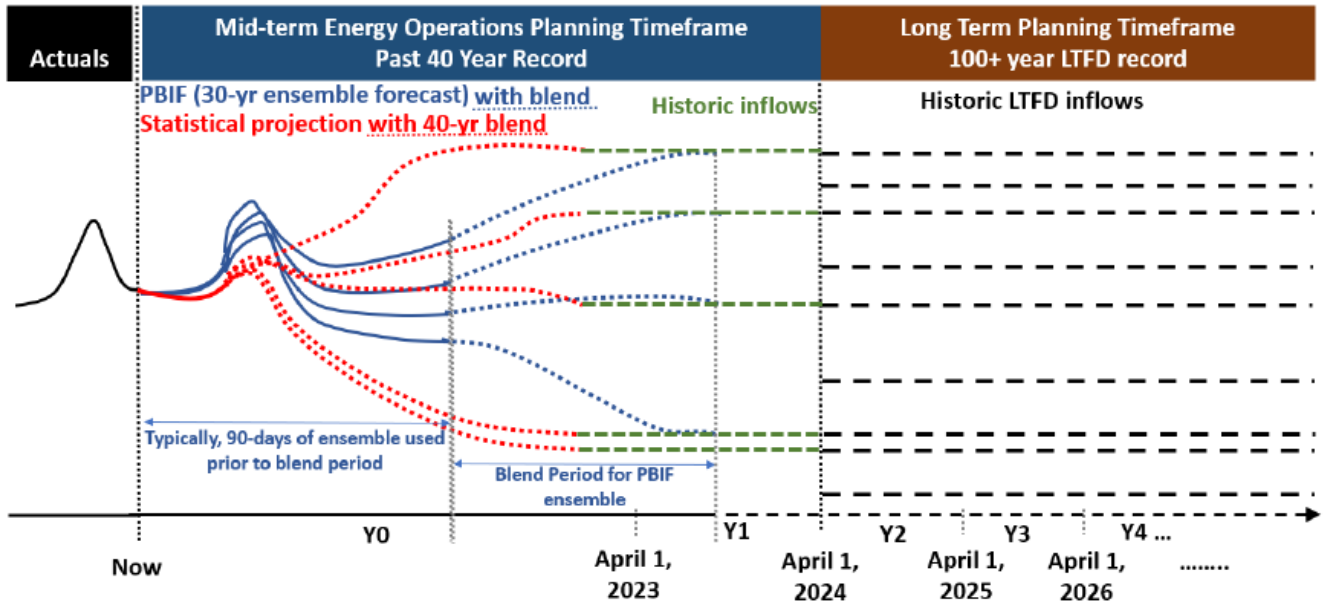

Figure 3. Inflow forecasting and blending timeframes

Changes in forecasting

- Short-term improvements
  - Near-term physically-based forecast leads to single-trace 16-day outlook
  - Remainder of first 90 days based on PBIF or statistically-based
- Remainder of first year based on blend of physically based and statistical forecasting
- Y2 through end of forecast uses traditional 100+ LTFD

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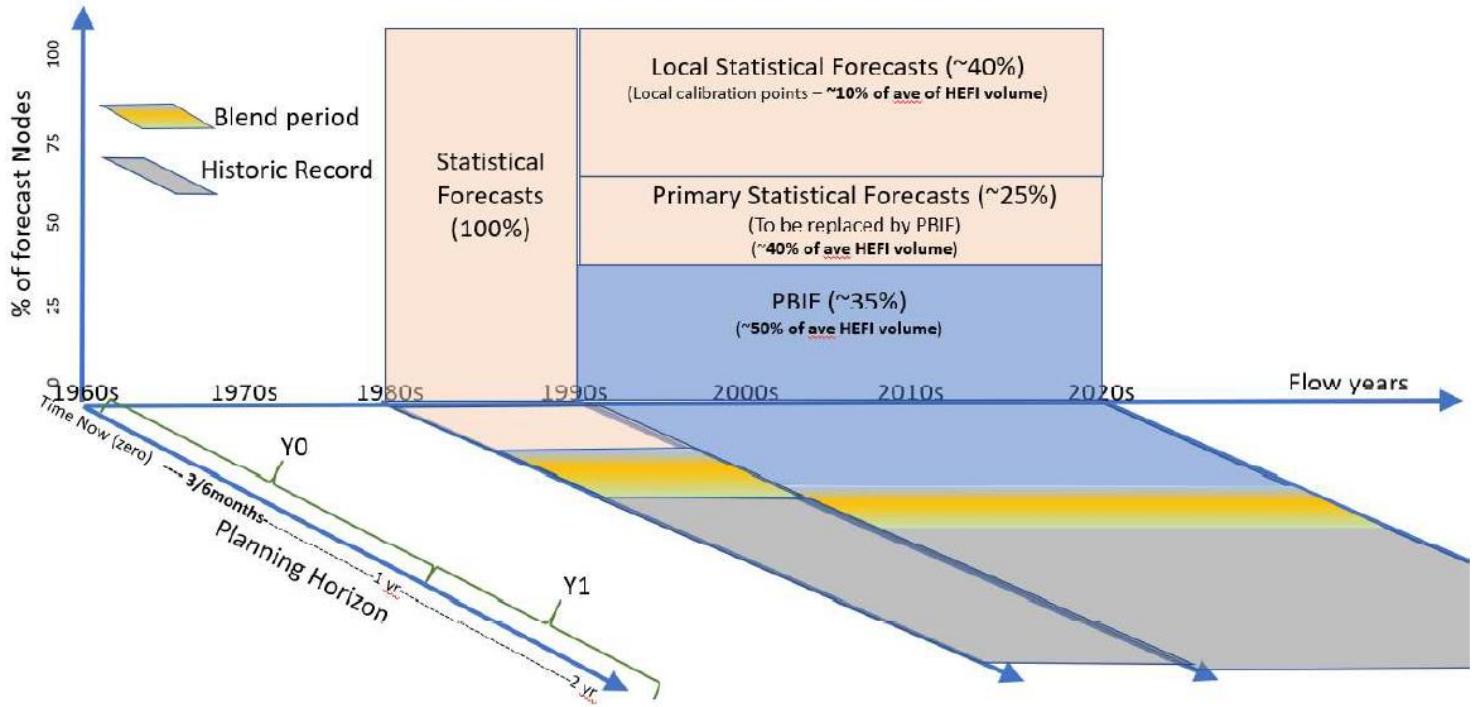
Transition to 40-year flow record for budget year analysis

- "Non-stationarity"
  - There may be long-term hydrology trends that would make using a shorter, more recent flow record more statistically appropriate for forecasting purposes.
- Why 40 years?
  - Testing indicated that 40 years represented 95% of full hydrologic variability recorded
  - The PBIF process requires improved data resolution which is currently only available for the previous 30 years.
  - Statistical forecasting fills in the gap.



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Energy modeling

- Flow case development provides key inputs to energy modeling, forming the foundation of the export revenue forecast.
- Energy modeling remains a combination of short and long term processes
- Process remains bifurcated into two
  - Short to mid term – HERMES
  - Long term – HERMES plus GSPRO (Was all SPLASH in previous GRA)

Short/mid-term

- No material process or tool changes from previous GRA
- Flow cases input into HERMES
- Economically optimizes system to meet load and maximize export revenues, subject to physical constraints

Long-term

- Starts with 100+ HERMES runs for Y2.
- Starting in Y3, MH uses Generation System Simulation, Planning and Resource Optimization (GSPRO) system.

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Long term modeling changes: SPLASH vs. GSPRO

SPLASH *(old)* challenges

- Technology & cost challenges
  - Built on old IT infrastructure; end of useful life.
  - Maintaining and improving SPLASH would have involved significant investment.
- Functionality challenges
  - Reaching limits of its capabilities when modeling new system conditions (for example, it could not model solar resources).
  - "Perfect foresight" of future water conditions, leading to potentially less reasonable results.
  - Only modeled two load period blocks (on- and off-peak).

GSPRO *(new)* advantages

- Technology & cost advantages
  - Future IT infrastructure usable
  - The use of a commercial product puts development costs and responsibilities on the vendor development team.
- Functionality advantages
  - Includes consideration of uncertainty in future water conditions, allowing for a more realistic system simulation over time.
  - Much higher degree of granularity, categorizing load periods into 21 unique monthly blocks.
    - ↓ the error range for modeling load conditions.
    - Provides more realistic results.
  - Includes much more detailed representation of the transmission system.

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Daymark findings

- MH has made significant advances in its inflow forecasting methodologies to improve the near-term forecasting, incorporating new data, methodologies and tools.
- 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.
- MH's justification for the transition to the 40-year flow record from the 100-year record for the budget year is satisfactory.

5. Export price, volume, revenue forecast

Scope of Work: Export energy price forecast

- Scope of Work Item #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.

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Daymark finds export energy price forecast reasonable

Short-term forecast

- MH uses two sources to create the near-term base forecast.
- Both forecasts are provided as monthly prices for on-peak and off-peak prices at MISO MINN HUB.
- Daymark finds that MH's methodology produces reasonable base, low, and high forecasts for use in its analysis.
- Daymark finds that MH's new adoption of using two sources is an improvement.

Figure 16. Near-term MHEB price forecasts

Daymark finds export energy price forecast reasonable

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

Long-term forecast

- MH purchases long-term forecasts from five independent third-party forecasters and averages them together to develop the consensus base forecast.
- Each forecasts are provided as monthly strips for on-peak and off-peak prices at MISO MINN HUB.
- Daymark finds MH's methodology produces reasonable base, low, and high forecasts.
- Daymark finds that MH's approach to forecasting creates a reasonable range of scenarios.

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Daymark finds export capacity price forecast reasonable

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- MH creates a consensus capacity price by averaging forecasts of five consultants.
- Daymark reviewed the range of capacity prices provided by the consultants and the consensus average and finds this a reasonable approach.
- The capacity price forecast is not used in the GRA revenue forecast because the only capacity sales included by MH are current contracts.

Capacity price forecast

Image Source: PUB/MH I-52 (CSI)

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Scope of Work: Export contracts

- Scope of Work Item #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.

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Support for MH's declining export contract revenue forecasts

- Portfolio of 15 export contracts with 8 different counterparties
- Daymark reviewed the forecast and workpapers and conducted an independent review of contract language to assess whether expected revenues were reflected in MH forecast.
- Daymark concludes that the export contract revenue forecasts developed by MH for MFRs 85 and 86 are supported by the contract terms, and correctly represented in MFR 42 revenue forecast.

Figure 20. Firm and opportunity energy sales.

Support for MH's declining export contract revenue forecasts

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- Portfolio of 15 export contracts with 8 different counterparties
- Daymark reviewed the forecast and workpapers and conducted an independent review of contract language to assess whether expected revenues were reflected in MH forecast.
- Daymark concludes that the export contract revenue forecasts developed by MH for MFRs 85 and 86 are supported by the contract terms, and correctly represented in MFR 42 revenue forecast.

Figure 20. Firm and opportunity energy sales.

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Scope of Work: Export energy & capacity volume forecast

- Scope of Work Item #6:

  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.

Daymark finds export energy volume forecast reasonable

- Exportable surplus energy is the result of the energy modeling processes previously described (HERMES and GSPRO).
- Energy export volume is the energy supply (produced by flow cases), less domestic load and firm sales.
- As previously discussed, Daymark concluded that the energy modeling tools produce reasonable outputs based on the flow cases and simulations of the system

Daymark finds export capacity volume forecast reasonable

- Summer capacity grows as long-term contracts expire, specifically in 2024/25 and 2029/30.
- Daymark agrees with assumption of no new capacity sales for GRA purposes.
- Daymark recommends that MH continue to seek to monetize the growing surplus summer capacity.

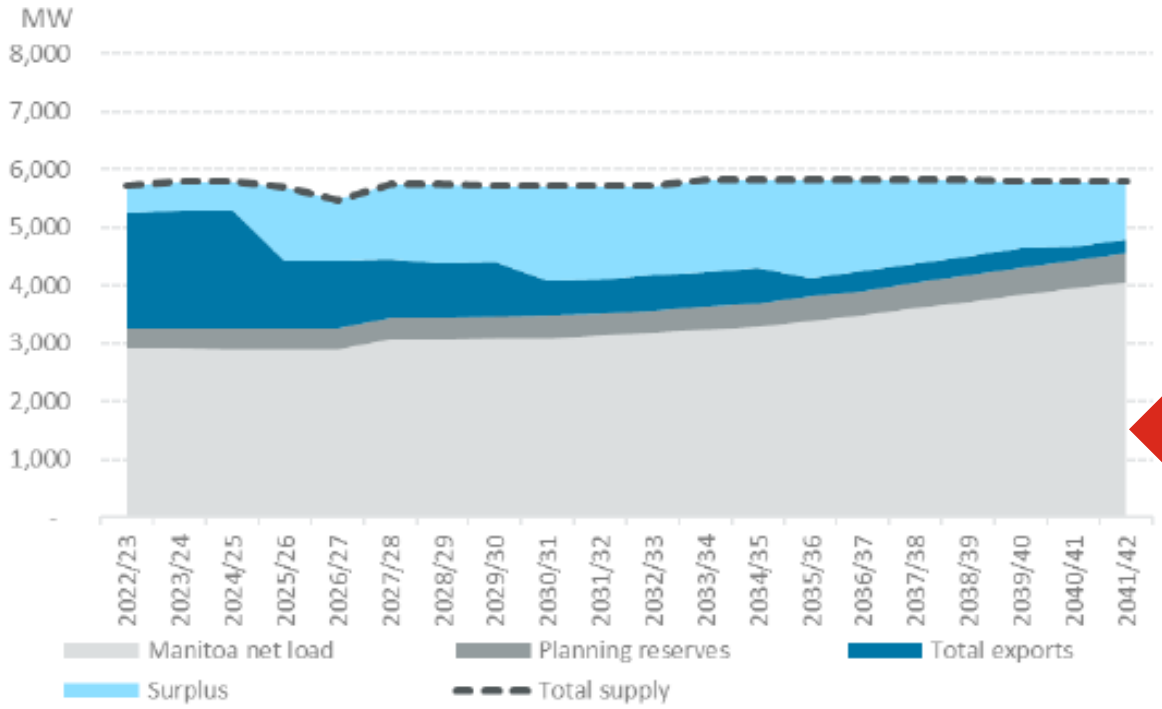

Figure 24. MH summer capacity balance

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Scope of Work: Export revenue forecast

- Scope of Work 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.

Daymark finds export revenue forecast reasonable

Export revenue methodology, results

- Forecasted contract revenue is reasonable
- Near-term market revenue values are outputs from the HERMES model.
- Long-term market revenue values are outputs from the GSPRO model.
- Accepting the export price forecasts, Daymark confirmed that the methodology and revenues generated from both models are consistent and reasonable.

Fuel and power purchases

- Purchased Energy is the largest component of the "Fuel and Power Purchased" expense in 2022/23 and is forecasted to grow.
- The Purchased Energy category includes wind and solar power purchases, as well as Canadian and U.S. opportunity purchases.
- Daymark finds the analysis produced through MH's energy modeling to be consistent with system dynamics.

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6. Keeyask revenue scenarios

Our review process

- ## Scope of Work Item #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.

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Keeyask revenue estimations

- Keeyask Generating Station and related works are owned and operated by the Keeyask Hydropower Limited Partnership (KHLP).
- MH faced challenges in determining the revenues attributable to Keeyask.
- MH approached this challenge by analyzing three scenarios reflecting different revenue assignment of contracts and non-firm energy.
- The estimated revenues are not representative of the economic benefits of decisions made to proceed with Keeyask at various points in time.

Keeyask scenarios and annual total revenue

- **Scenario 1:** 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.
- **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.
- **Scenario 3:** assumes that Keeyask energy is first to serve all firm export sales, then the remainder of the energy is valued at the system average for non-firm energy.

Figure 28. Keeyask scenarios, annual total revenue

Image Source: MFR 28 (CSI).

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Keeyask scenarios present a simplified view

- More rigorous modeling would most likely produce results within the band of the three scenarios chosen by MH.
  - Use of average system revenue per kWh to provide prices that value the Keeyask energy does not capture seasonality.
  - Ignores changes in contracting.
  - Does not capture potential MISO energy price differences between cases.
  - Does not consider Keeyask energy and capacity being used to serve domestic load and maintain reliability.
- Calculated revenues from Keeyask generation were derived through reasonable methodology.

7. Operations during 2021/22 drought

Drought and hedging scope

- Scope of Work Item #10:
  - *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*
    - *effectively used hydrology forecasting tools*
    - *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.*

Drought and hedging scope

- Scope of Work Item #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.*
- Scope of Work Item #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.*

What is 'drought' to Manitoba Hydro?

- 'Drought' is shorthand for a complicated story
  - Manitoba watershed is a very large, ecologically diverse area
  - It can experience drought, flood and normal conditions simultaneously
  - Where drought conditions exist within the watershed has a material impact
  - What the starting conditions of the reservoirs are is important
- What does drought mean to Manitoba?
  - Potential implications for non-power sectors (Agriculture, transportation, fire prevention, etc.)
  - Environmental implications (Maintaining minimum and maximum flows and reservoir levels, etc.)
  - Quality of life implications (waterways as means of travel; availability of water for communities, etc.)
  - Power implications
- Drought implications for delivery of power
  - Competing priorities sometime require hard choices
  - Many stakeholders interested in the use of Manitoba water
  - Cost optimization is important, but sometimes constraints alter the calculus
  - Drought Plan documentation is the guide when priorities collide

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Overview of the drought conditions

Winter 2020/21	Near normal storage; above average system inflows; below average Winnipeg River precipitation; increased Lake Winnipeg outflow to meet winter demand.
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).
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.
Summer & Fall 2021	Continued low precipitation; significantly lower Energy in Storage (EIS); significant operational constraints; significant hedging activity to mitigate financial exposure.

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Manitoba Hydro drought management elements

- Drought Management Planning Document
  - Identifies priorities and constraints
  - Identifies broad set of MH teams engaged in drought management
- Policies
  - Guardrails for team when making trade off decisions
  - Approval authority and oversight requirements
- Broad team meetings
  - Weekly Resource Planning and Production Scheduling meeting
  - Biweekly Executive Oversight meeting

Priorities and Constraints

- 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, 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
- Items (1) – (5) are the constraints while item (6) is the reward function, which MH seeks to maximize within the existing constraints.

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Corporate policies reviewed

P195 – Generation Planning Policy

- *"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."*
- Discusses the conditions under which imports can be considered dependable energy.
- Sets the planning reserve margin for the purposes of procuring capacity.

P190 - 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 for which the approval authority, allowed volumes, terms, and time frames were governed by this policy.

P197 – Wholesale Export Power Policy

- Disallows manipulation.
- Provides latitude to MH in executing wholesale power transactions, requiring only that they have an expected net benefit to MH.
- Establishes the risk management practices that ensure compliance with the Corporation's risk management policy.

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. The meeting includes representation from multiple teams and groups:
  - Energy Supply Planning (ESP), 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).-

Water Resources Department-	• Synthesizes RT system hydrometric data with forecasts within Delft FEWS to calculate physically-based forecasts. • Handed off to Energy Operations Planning at weekly meeting.
Energy Operations Planning	• Uses HERMES model to synthesize physically-based forecasts with statistical forecasts, load forecasts, and other parameters. • Determines weekly resource plan, operating instructions, and blended forecasts. • Handed off to stakeholders at RPPS meetings.

Executive oversight

- To adhere to Section 5.8.1 of the Drought Management Planning document, bi-weekly meetings were established starting in early August.
- At the first meetings of this oversight committee, a set of "drought management fundamentals" was established. 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.

Hydrology modeling implications

Significant improvements in hydrology forecasting

- Physically-based Inflow Forecasting (PBIF) to forecast short-term hydrology.
  - PBIF produces higher quality forecasts versus the old statistical basis.
  - Utilizing the 40-year ensemble modeling with PBIF and statistical methods, based on actual reservoir starting points, provides an improved picture of the range of outcomes that represent energy production uncertainty.
- Drought Reserve Storage (DRS) concept to ensure sufficient water supplies into the future.
  - MH now tests for sufficient energy supply over time by constraining the modeling using the DRS value rather than a simpler volume target.
- "Cold snap" analysis to stress test DRS to ensure resulting water supply target can withstand a [redacted]
  - A conservative plan for meeting domestic and firm export energy under a reasonable "worst case scenario."
  - 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

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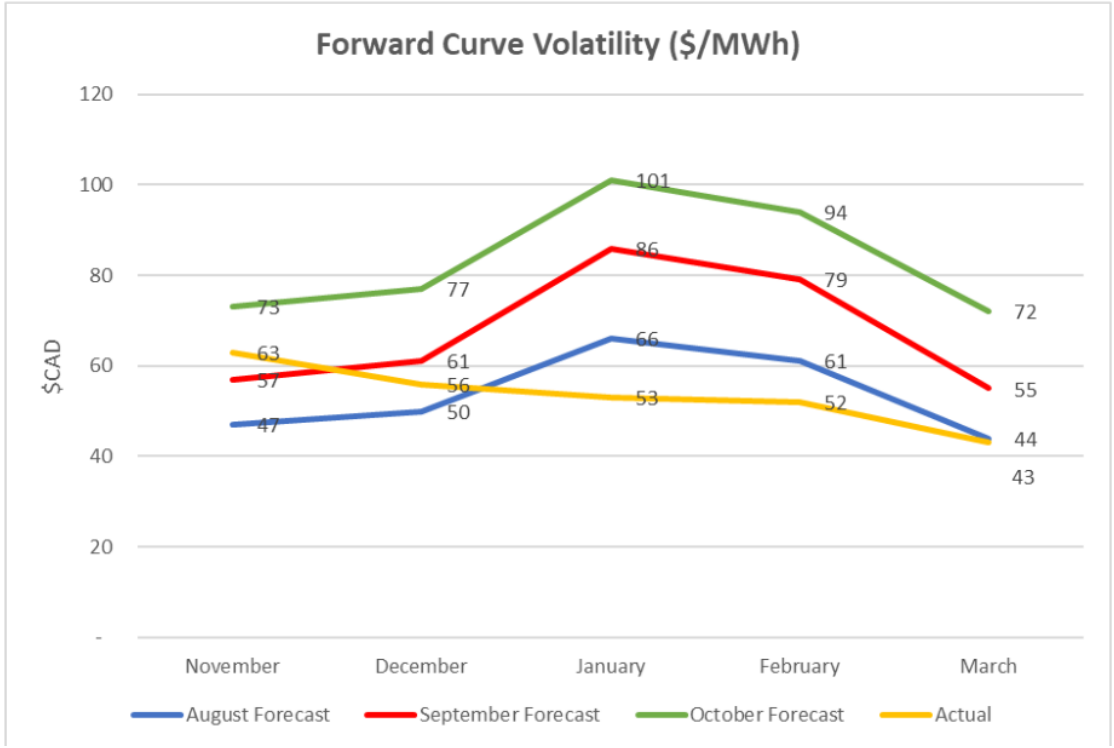
Compliance with policies and processes

- MH did comply with their written policies and procedures and took extraordinary care to continuously balance competing priorities that are part of operating such a large hydrological system.
- The RPPS and oversight meetings (and associated presentations) were critical to ensuring that all priorities were balanced appropriately.
- Through discussion with MH, we understand that MH's Enterprise Risk Committee has recently been formed, and appears to be the appropriate framework and entity to provide such oversight during future extreme droughts.
- MH may have an opportunity to formalize some of the knowledge and expertise from their various groups and committees into additional policies or procedures to assist those teams in managing future adverse conditions and to protect against knowledge gaps due to potential loss of key experts.

Drivers for hedging activity

- Concern over potential costly winter events
  - Forward prices were rising month over month during the August to October timeframe
  - Potential for high gas prices just as MH would need power to supply customers
  - Short periods of badly aligned events can cause high net export revenue impact
- Goal of maximizing potential that any hedges would be backed by physical delivery (purchase or sale)



MH GRA Filing, Appendix 3.2, Figure 2. Forward Market Prices vs Actual Prices

Price hedging strategy, activity, results

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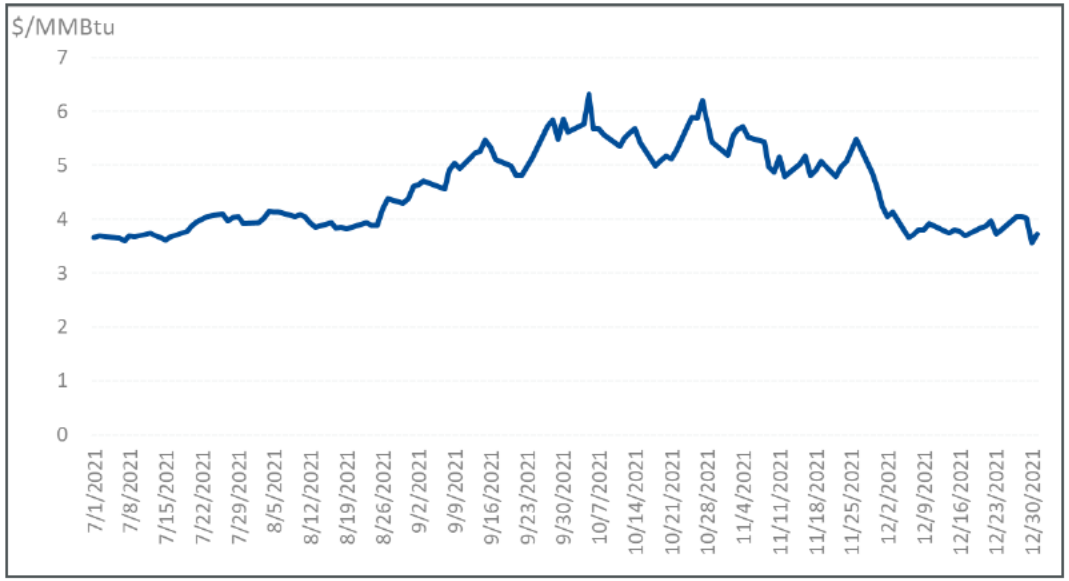
Activity

- Most of the hedging activity during the 2021/22 drought was forward purchases consisting of [redacted] energy and [redacted] natural gas purchase hedges, contracted from late summer/early fall until early December 2021.
- [redacted]
- The price of natural gas (which is the primary driver of MISO pricing) was moving up and down quickly as MH purchasing and sales needs were evolving.



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

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Price hedging strategy, activity, results

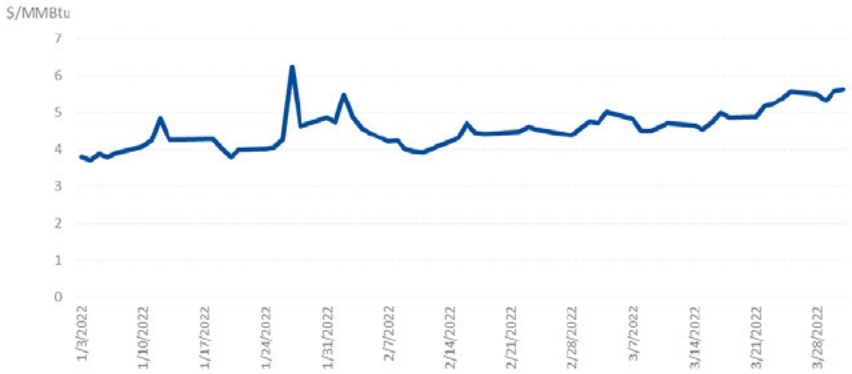

Figure 37. Henry Hub natural gas price, January 3, 2022, to March 31, 2022

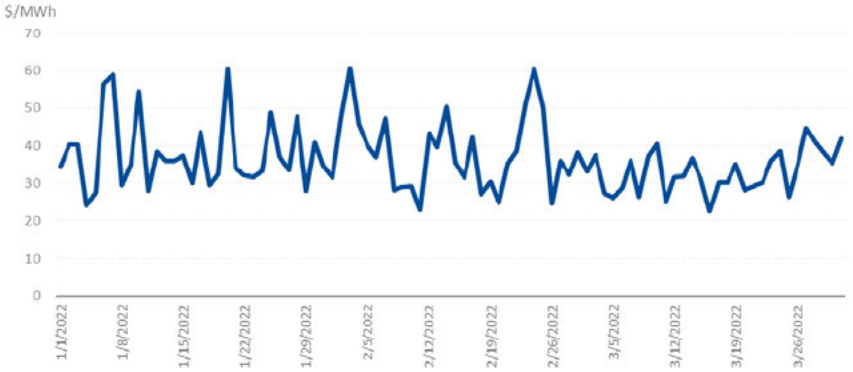

Figure 38. MINN HUB day-ahead energy price, January 1, 2022, to March 31, 2022

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

Results

- 2021/2022 winter end:
  - Natural gas prices did not continue to rise.
  - No significant winter event impacted the price at which MH could have purchased energy.
- Final result:
  -
  -
  -

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Price hedging strategy, activity, results

Compliance with policies, procedures

- MH, through the RPPS and executive oversight committee, spent significant time and resources evaluating market risk, collaborating with key stakeholders within the organization and ensuring proper approvals were obtained throughout the drought period.

Findings

1. MH used proper approvals, including trading volume limits and credit limits.
2. MH had a high expectation that volumes would be backed by physical purchases or sales.
3. MH 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).

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Price hedging strategy, activity, results

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.
- 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.
- There is a lack of symmetry in terms of what market conditions are harmful and what level of financial harm those conditions can produce.
  - Differentiating hedging strategy between purchase conditions and sales conditions could be beneficial to MH and its customers.
  - Combining projected volumes with potential dollar impact for that volume might lead to more nuanced trading limits

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8. Key findings

Finding #1: Export revenues

- Due to the upgrades to MH's hydrology and inflow forecasting methods, as well as its energy modeling tools, revenue forecast is based on more granular data.
- Revenue forecast is reasonable and conservative.

- Daymark offers the following observations in support of this finding:
  - The export price forecasts are reasonable, and the sensitivities reflect a reasonable range of future market conditions.
  - The export contract terms are appropriately reflected in the modeling and export revenue forecast.
  - The inflow forecasting changes align with modeling improvements, increasing the ability to model system conditions and constraints.
  - MISO is creating challenges in maximizing net extra-provincial revenue from current export products.
  - MISO changes could create opportunity to increase market value of MH products.

Finding #2: Drought operations and risk management

- MH managed its hydrology and energy forecasting, operations, and hedging effectively to adjust priorities as drought unfolded in 2021.
- Daymark finds that some policies and supporting documentation enhancements could be beneficial.

- Daymark offers the following observations in support of this finding:
  - MH does not operate its system in a fundamentally different manner during drought.
  - Additional oversight and risk management were executed to ensure they maintained a safe and reliable system.
  - MH's move to a 40 year hydrology provides an improved picture of the range of outcomes and therefore was an effective tool for managing drought.
  - MH policies are reasonable and provide appropriate oversight and approval authority guidance.
  - Institutional knowledge appears to reside in the minds of its many experts and may benefit from increased documentation.

Thank you

Let’s continue the conversation

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Our team brings deep knowledge and an integrated view of energy infrastructure, regulation, and markets to help our clients succeed in the face of uncertainty and transformative change.

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