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Manitoba Hydro 2017-2018 GRA Sustainment Capital Plan

Direct Testimony

Presented to:

Manitoba Public Utilities Board (PUB)

Prepared by:

METSCO Energy Solutions Inc.

January 29, 2018

.3 Direct Evidence Background:
METSCO's Involvement and Basis of Analysis

- METSCO was retained by the Public Interest Law Centre on behalf of the Consumers Coalition, to provide independent expert analysis of Manitoba Hydro's sustainment capital plan for the 2017-2018 test years of the current GRA.

- In conducting our analysis (captured in the October 30, 2017 report), we used information provided by way of pre-filed materials, MFR and IR responses, and the Applicant's presentations during the July 20, 2017 Technical Conference.

- Certain portions of this direct testimony are also based on the Oral Hearing record generated since our report's filing, and are clearly identified as such throughout this presentation.

METSCO was retained as an independent expert, to evaluate Manitoba Hydro's sustainment capital plans, as presented in this proceeding. Details of our qualifications and terms of engagement are available in the Appendix.

.4 Summary of Our Conclusions:
MH has not sufficiently justified its Sustainment Capital Ask

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- On balance, and subject to further information becoming available, it is our professional opinion that Manitoba Hydro has not provided sufficient evidence to justify the reasonableness of proposed Sustainment Capital ask for the Test Years

- Our conclusion is grounded in a review of the analytical underpinnings of the Plan, the state of the Applicant's relevant decision support tools and processes, available performance data, and our knowledge of sector best practices

- Though we often invoke examples of best practices, the reasoning underpinning our conclusions is ultimately reflective of the Applicant's specific circumstances, as represented by its evidence, relative to what we see as attainable today

- Throughout our written report, we also provide recommendations to the PUB as to potential oversight enhancements to facilitate the Applicant's planned or ongoing implementation of AM improvements.

We looked at how MH both plans and executes its work, and the available data on the state and performance of its plant. We find that both scope and nature of information supplied are insufficient to justify the requested funds.

.5 Summary of Our Conclusions (Cont'd):
Data quality, consistency and utilization among key issues.

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We see the following as the major issues contributing to our overall conclusion regarding the sufficiency of information provided to justify the Sustainment Capital ask:

- Limited evidence of reliance on asset health and risk data in preparing the current plan;
- Longer, on average, asset degradation timelines than those of industry peers;
- Inconsistent quality of maintenance records underlying sustainment budgets;
- Inconsistent cost estimation practices and a history of cost underestimation;
- No external evidence to support the reasonableness of proposed capital costs;
- Manitoba Hydro's favourable reliability performance relative to industry peers.

Overall, our conclusions are based on inferences as to whether and how MH relied on objective and consistent evidence in preparing the CEF16 Sustainment Plan, and the insights drawn from the operating data that is available.

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Asset Management Refresher:

What are the Core Components of a Modern AM Framework?

.7 What is "Good" Asset Management?
Balanced Planning, Grounded in Data and Calculated Risks

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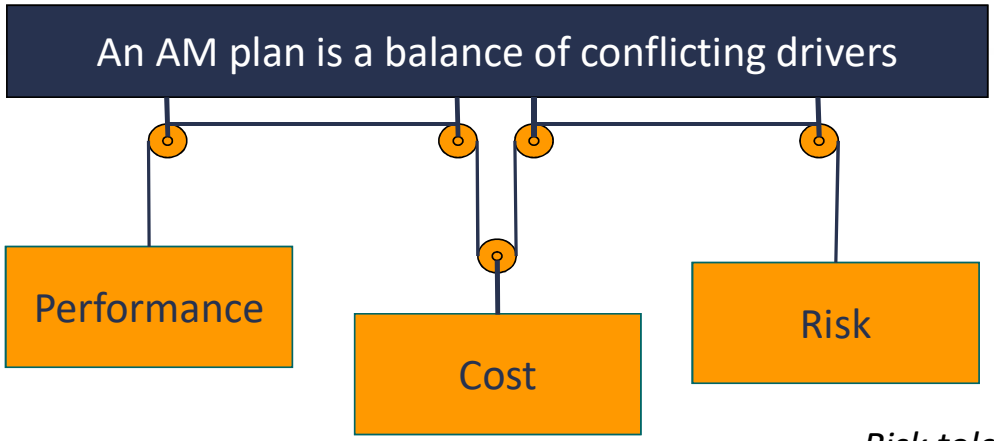

Data on:
- Plant Condition
- Asset Failure Rates
- Reliability Indices
- Growth Needs
- Compliance Req's

Cost considerations of:
- Replacing
- Upgrading
- Δ Maintenance
- New Standards
- Peer performance

Risk tolerances for:
- Outage time/magnitude
- Financial losses
- Injuries / Incidents
- Environmental Issues

A common denominator of a good asset plan is the use of objective, quantifiable information to enable meaningful evaluation of trade-offs.

.8 What Constitutes Objective Planning Information?

Field Data, Quantitatively Assessed Against Corporate Objectives, Constraints and Risk Tolerances

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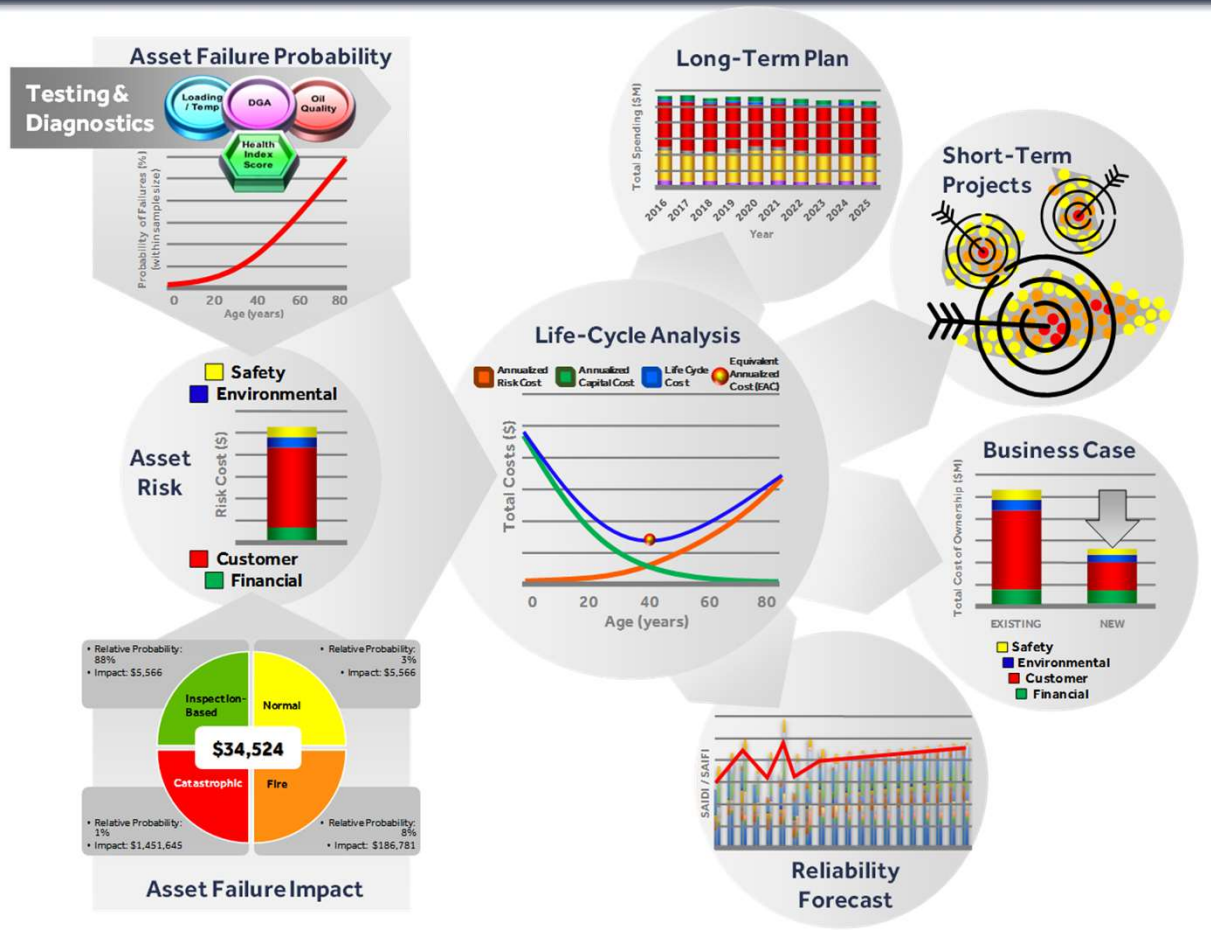
- Field data, regularly collected and processed through consistent analytical frameworks is a starting point, yielding:
  - Asset Testing & Diagnostics
  - Asset Health Index
  - Asset Failure Probability & Impact
  - Asset Risk Profiles
  - Life-Cycle Costing
  - Reliability Forecasts

- Results of this analysis are then assessed in the context of Strategic Priorities and External Constraints to yield short- and long-term plans.

Data techniques and frameworks do not replace individual staff expertise, but they help transform utility plans into more than just a sum of these experts' assessments.



.9 Asset Health Is an Input into Condition-Based Failure Probability

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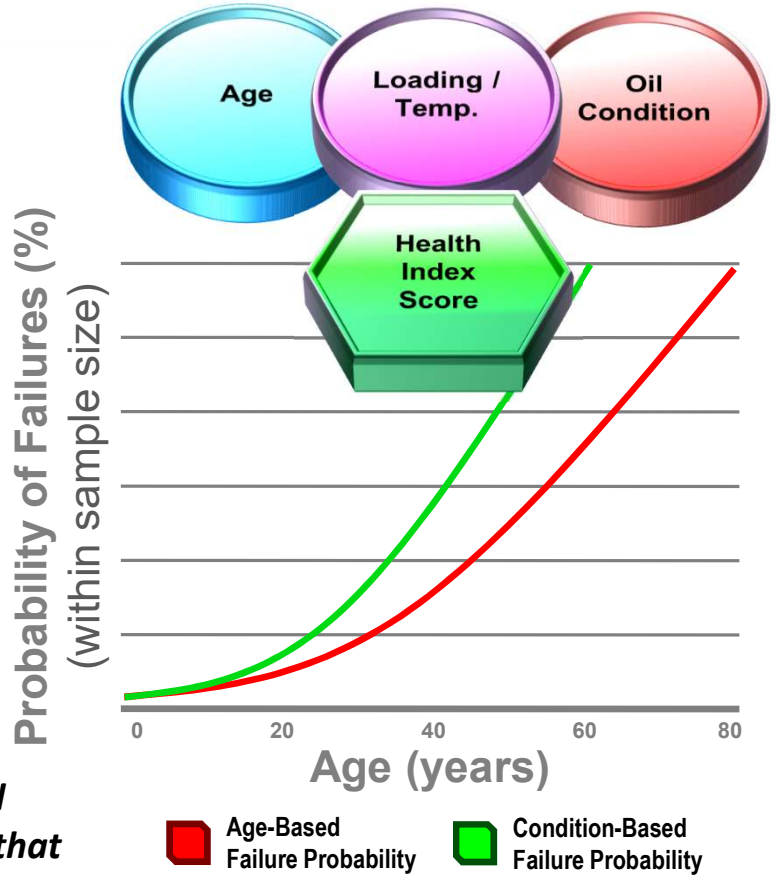
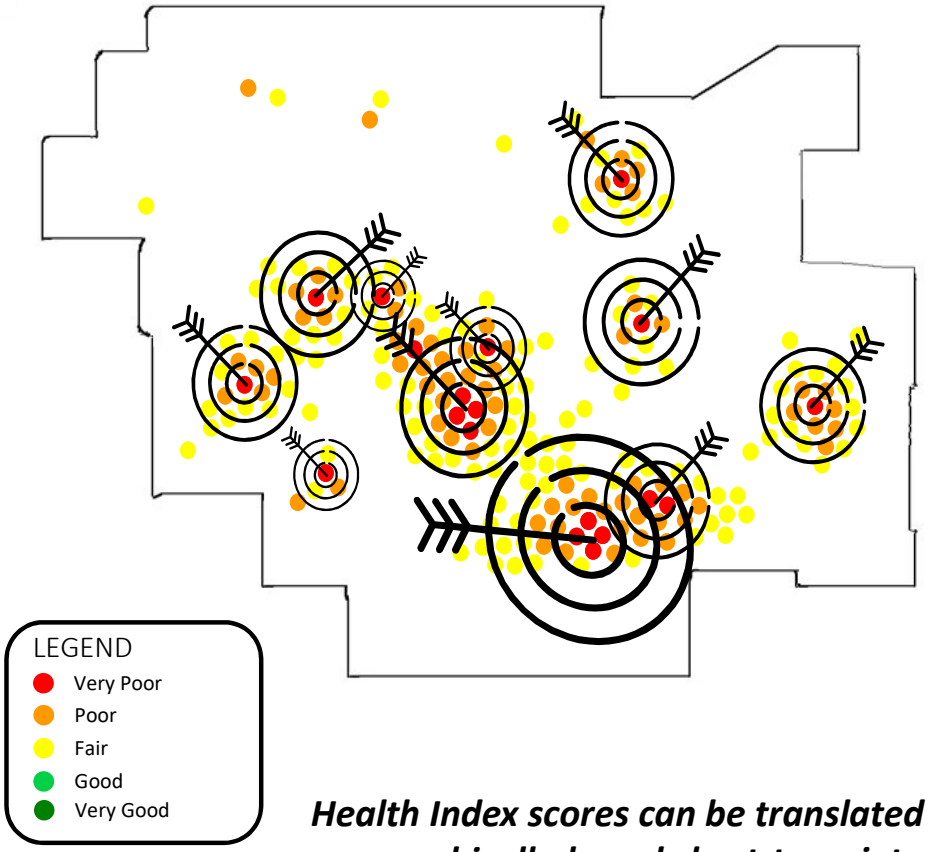
- The health index contains degradation factors that:
  - Contribute to the assets' failure
  - Are destructive in nature, resulting in irreparable damage
  - Have enough supporting data to compute an accurate score
- These factors are weighted according to the overall failure probability of the asset.



Data-driven Asset Health records, correlated with actual field performance, yield data on expected performance that is more nuanced and distinct from age-based insights.

.10 Investment Decision Justification Based on Health Index Results

- Individual health index results can be visualized on a geographical basis in order to identify "hotspots" containing assets that require attention over the next 10-year period.
- From this information, projects can be created to replace those assets found to be in Very Poor, Poor and Fair condition respectively.



Health Index scores can be translated into geographically-based short-term intervention plans.

.11 Adding Failure Impact to the Equation
Prioritizing among replacements with similar HIs

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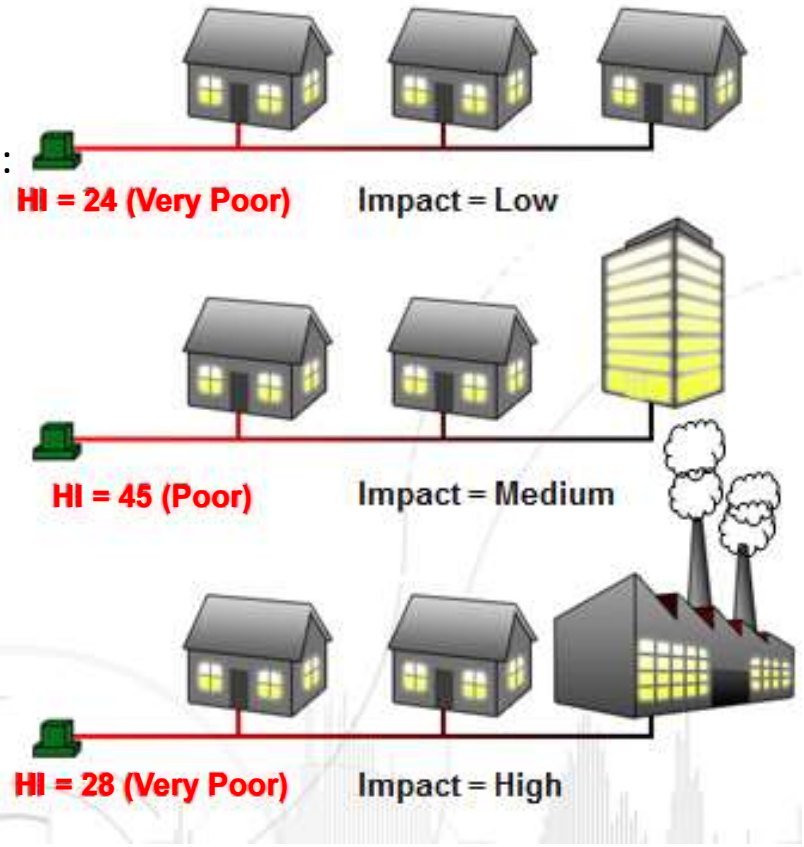
- Applying Failure Probability alone will not yield accurate prioritization results
- Two approaches for Impact calculation:
  - Impact Qualification
    - Categorization
    - Scoring
  - Impact Quantification
    - Direct Tangible Costs
    - Customer Interruption Costs
- No standard approach for impact measurement



Impact magnitude estimation enables asset managers to prioritize among potential projects with similar Health Index scores

Beyond reliability, Impact of failure can be determined by examining the safety, environmental, and financial impacts

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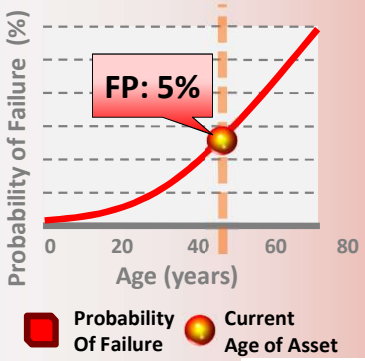
Asset-level risk assessment

- Emergency repair / replace costs
- Revenue loss

- Public/Employee death/injury
- Adjacent equipment/facility damage
- Third-party property damage
- Safety barriers in place



- Customer interruption costs
- Contingency supply
- Protective devices / sectionalization

- Environmental hazard cleanup (PCB's, oil, SF_6)
- Green belt disruption

Collateral Damage

Customer / Reliability

Financial

Impact of Failure

Environmental

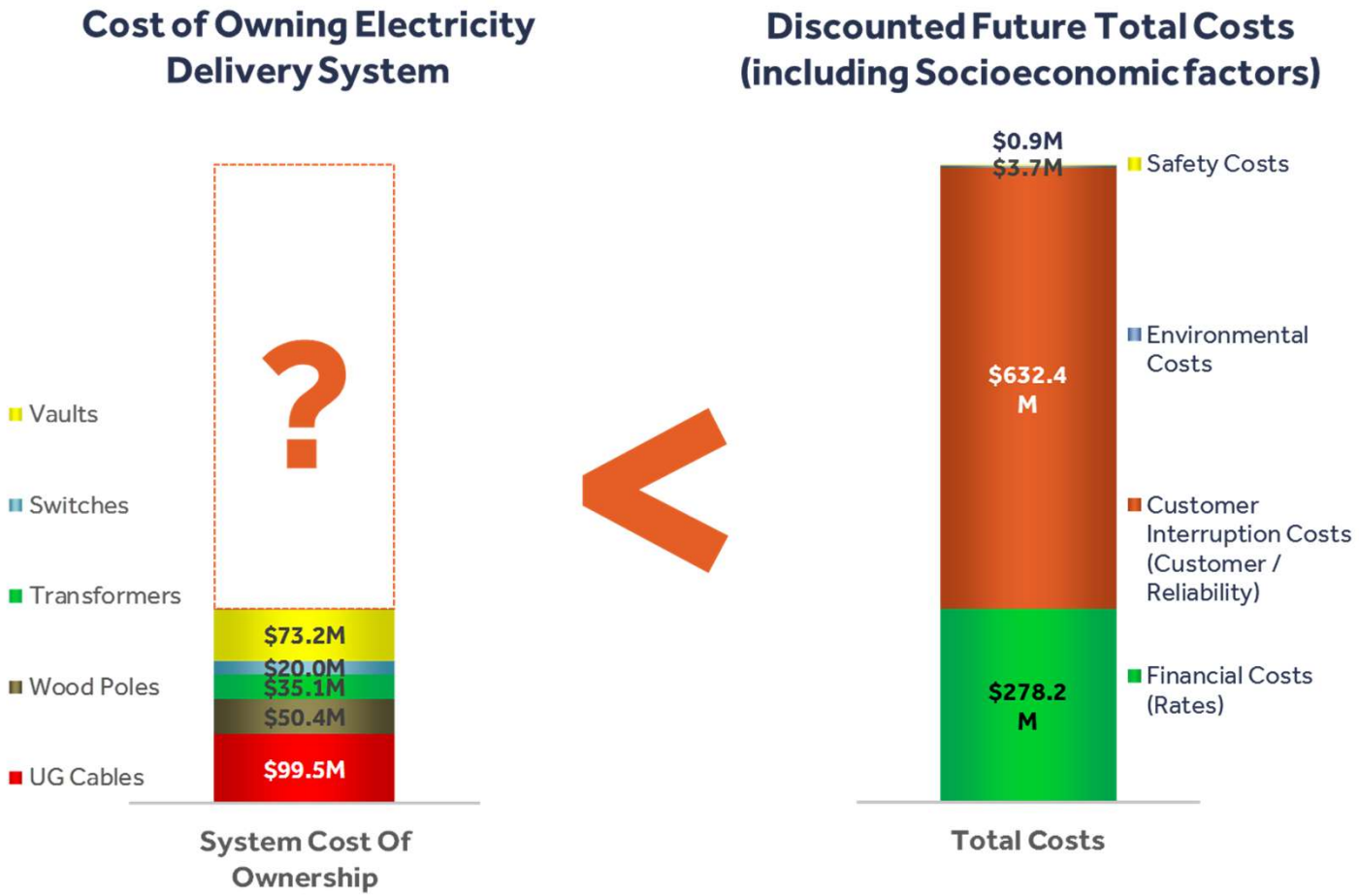
System-wide risk assessment

Risk of Failure

Source: OEB File No. EB-20174744. Toronto Hydro-Electric System Limited's Electricity Distribution Rate Application for 2012,2013 and 2014 Rate Years

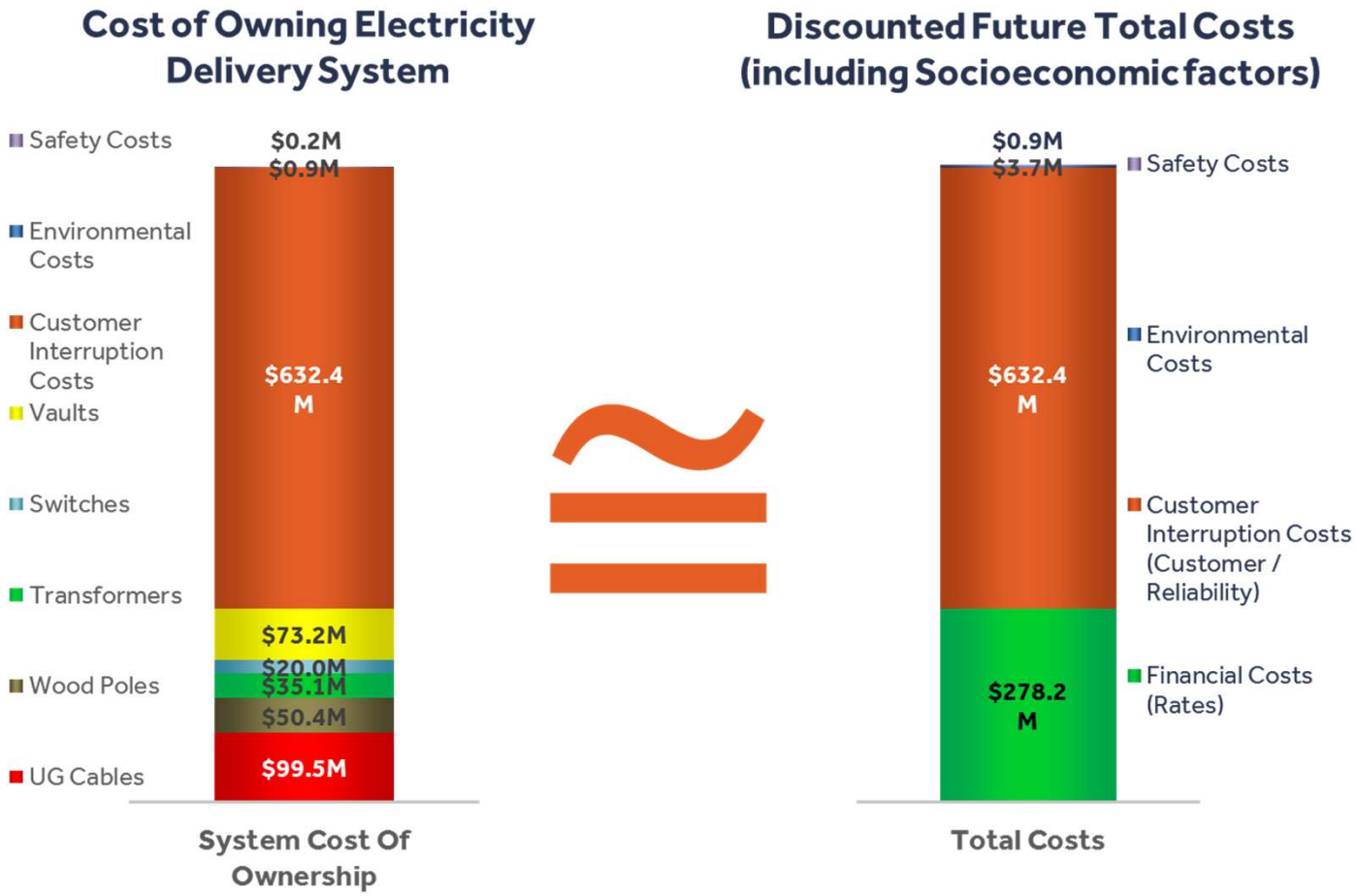
Socioeconomic factors (e.g. customer/reliability, safety, environment) must be included as part of utilities' decision making process.

- Optimal decision-making by the utility cannot be accomplished without taking into consideration the "true" total costs of ownership
- This includes risks/costs associated with socioeconomic factors, including customer/reliability, environmental and safety impacts.
- Customer/reliability is typically the most significant socioeconomic contributor.



Socioeconomic factors (e.g. customer/reliability, safety, environment) must be included as part of utilities' decision making process.

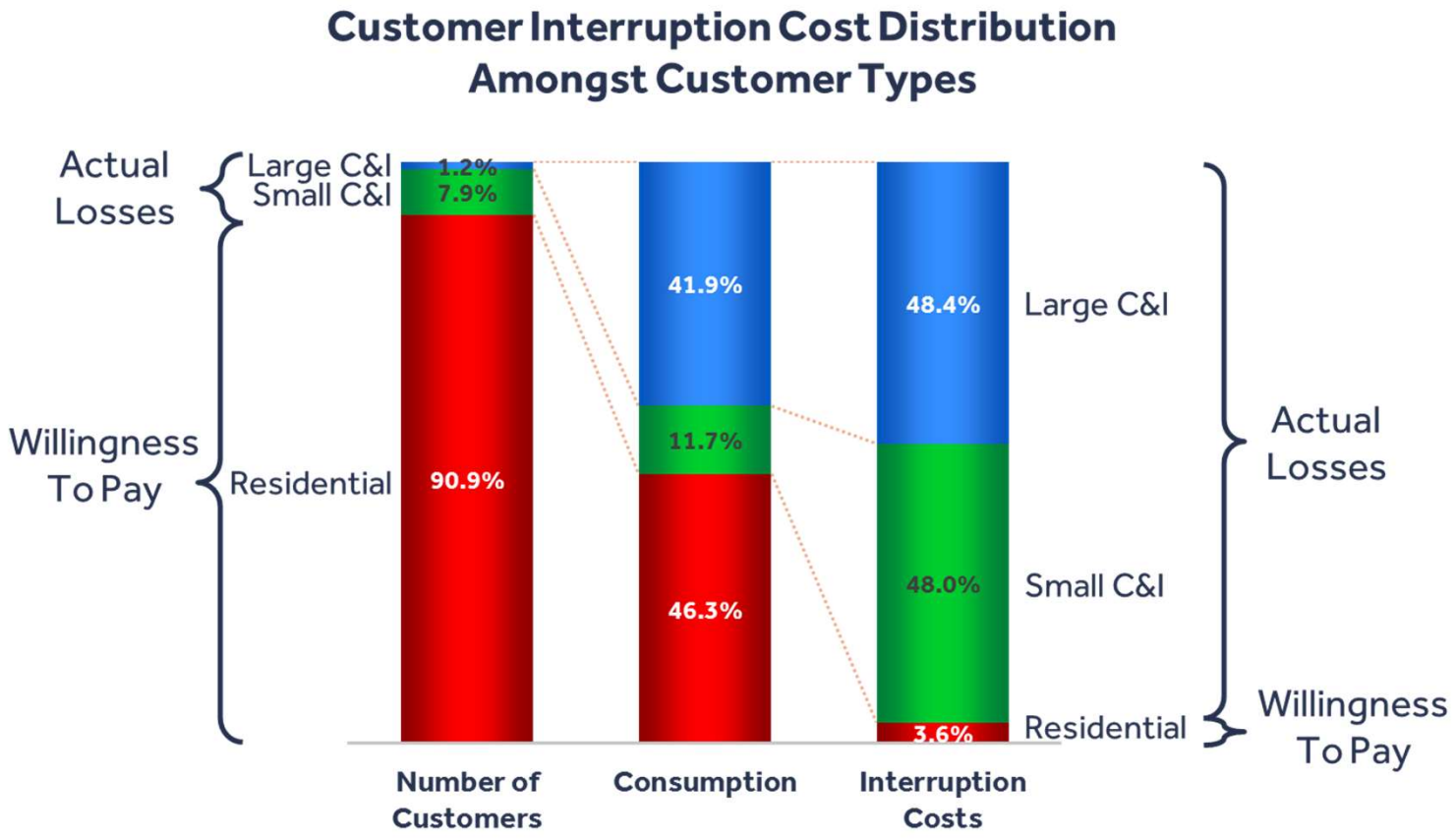
- It is only when socioeconomic factors have been fully considered – in particular the costs to customers during an interruption of electric service – that the costs of owning the electricity delivery system are equivalent to the discounted total costs of ownership.



Full cost of system ownership must include estimations of all economic costs associated with the system.

Measured at a system level, customer interruption costs are mostly driven by actual losses experienced by Small & Large C&I customers.

- Although residential customer interruption costs are typically derived using a “willingness to pay” approach, these costs represent a much smaller proportion of total interruption costs across the system.
- Costs for Small & Large C&I are derived from actual revenue losses, and account for a much larger proportion of total interruption costs measured across the entire system.



C&I customers make up relatively small customer segments but bear a disproportionately large portion of economic consequences of outages.

By balancing the assets' risk of failure with the necessary investment to mitigate the failure, the economic end-of-life can be determined.

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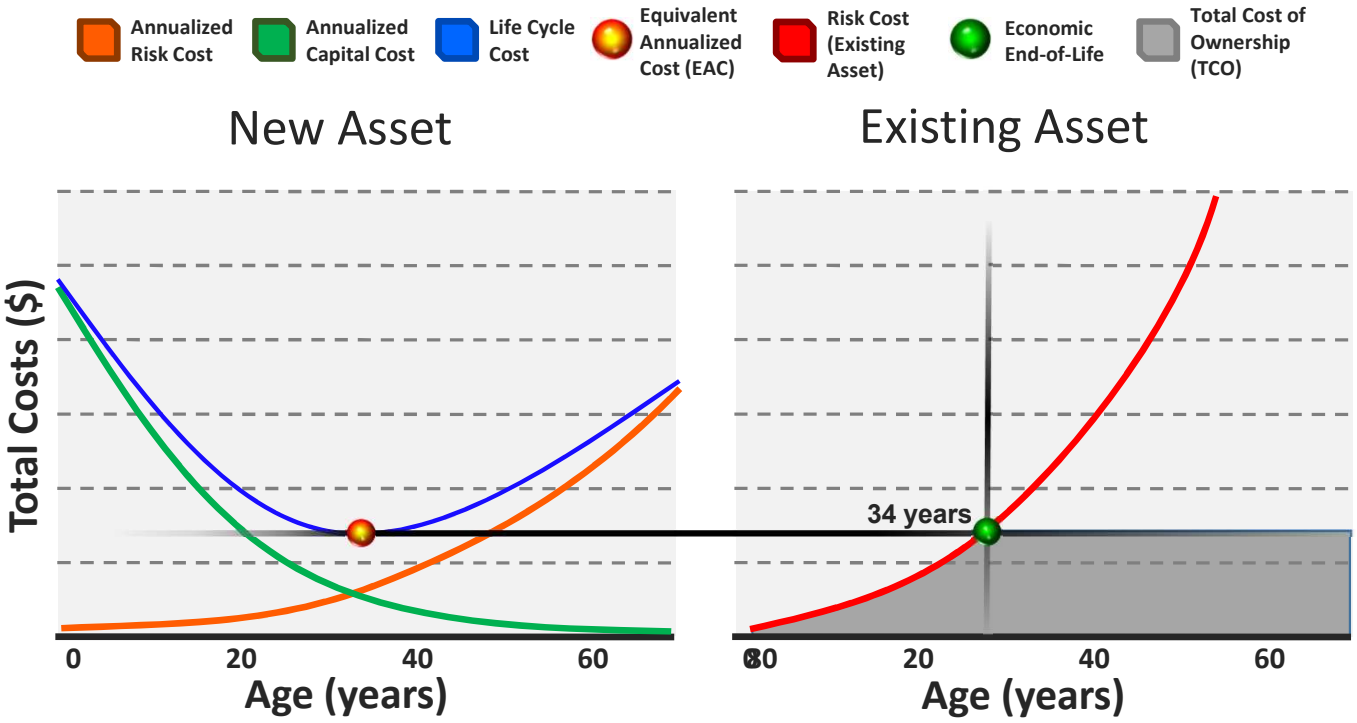
- Risk cost is derived from the product of probability and impact of asset failure.
- Both the risk and capital cost (to mitigate this risk) are annualized across the assets' life-cycle, and sum-totalled to produce the total life-cycle cost, or operating cost of the asset.
- Asset intervention should optimally occur at the lowest operating cost, which is then compared to the existing assets' risk cost, in order to determine the economic end-of-life for the existing asset (in this example, 34 years).



Combining the data inputs discussed above, utilities can derived the economic end of life curves, which represent optimal intervention times.

When the asset reaches its economic end-of-life criteria, a number of different intervention options can be considered and compared.

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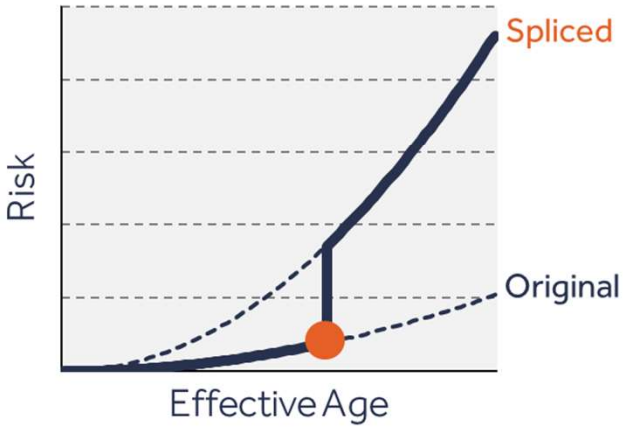
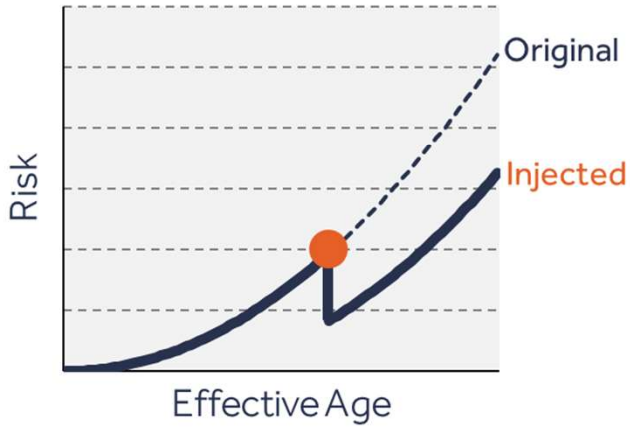
Direct-Buried U/G Cable Intervention Strategies

U/G Cable Splicing



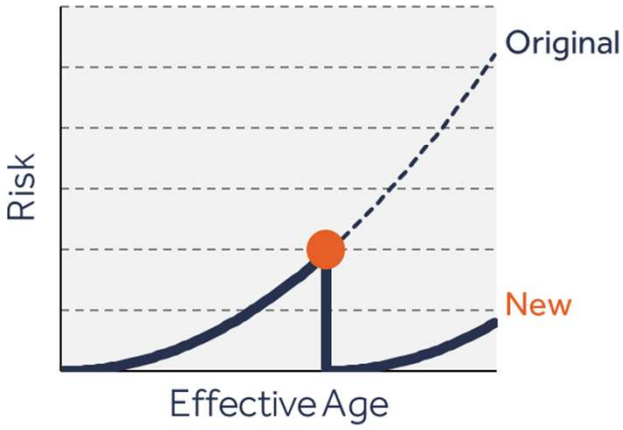
- Splice is a cheap repair option
- Cable segment has 3-4 times elevated chance of failure compared to original cable, due to high leakage current

U/G Cable Injection



- Injection is a cheaper alternative to replacement
- Not always possible
- May extend life of the cable by 20-30 years
- Partial reduction of risks

U/G Cable Replacement



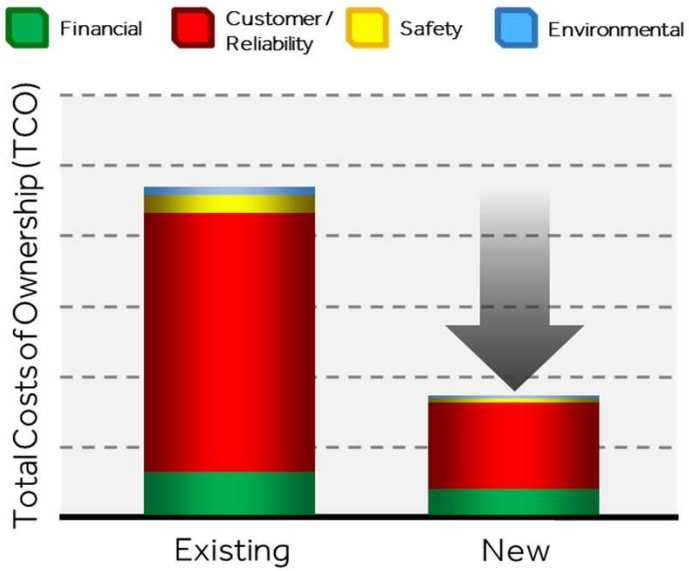
- Replacement is the most capital-intensive option
- Brand new cable has minimal risks of failure

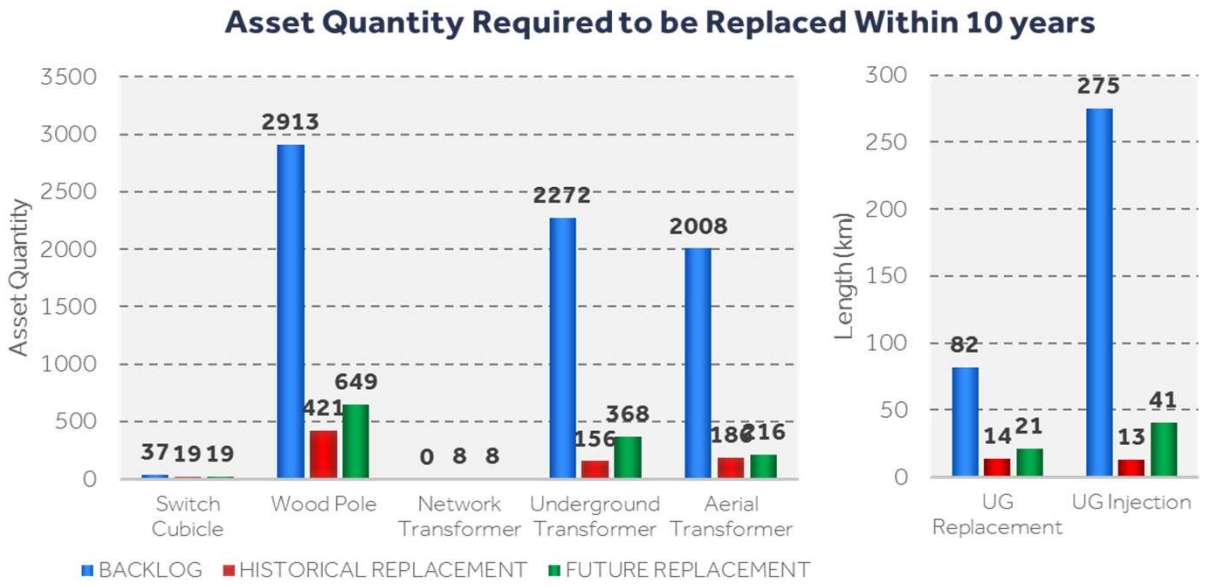
Among other benefits, lifecycle cost curves enable "apples-to-apples" comparisons across various intervention methods

Replacing all system assets at economic end-of-life allows for total costs of ownership (TCO) to be minimized.

By replacing all system assets at economic end-of-life, the utility is able to achieve an “economic steady state”.

This may be difficult to accomplish, however, if there is an entire backlog of assets already past economic end-of-life. Annual replacements may be constrained due to available labour, system constraints and rate increase affordability issues.





Economic EOL replacements drive down total costs of system ownership, subject to real-world constraints

As per TCO approach, different long-term investment options can be compared against each other to determine the most optimal solution.

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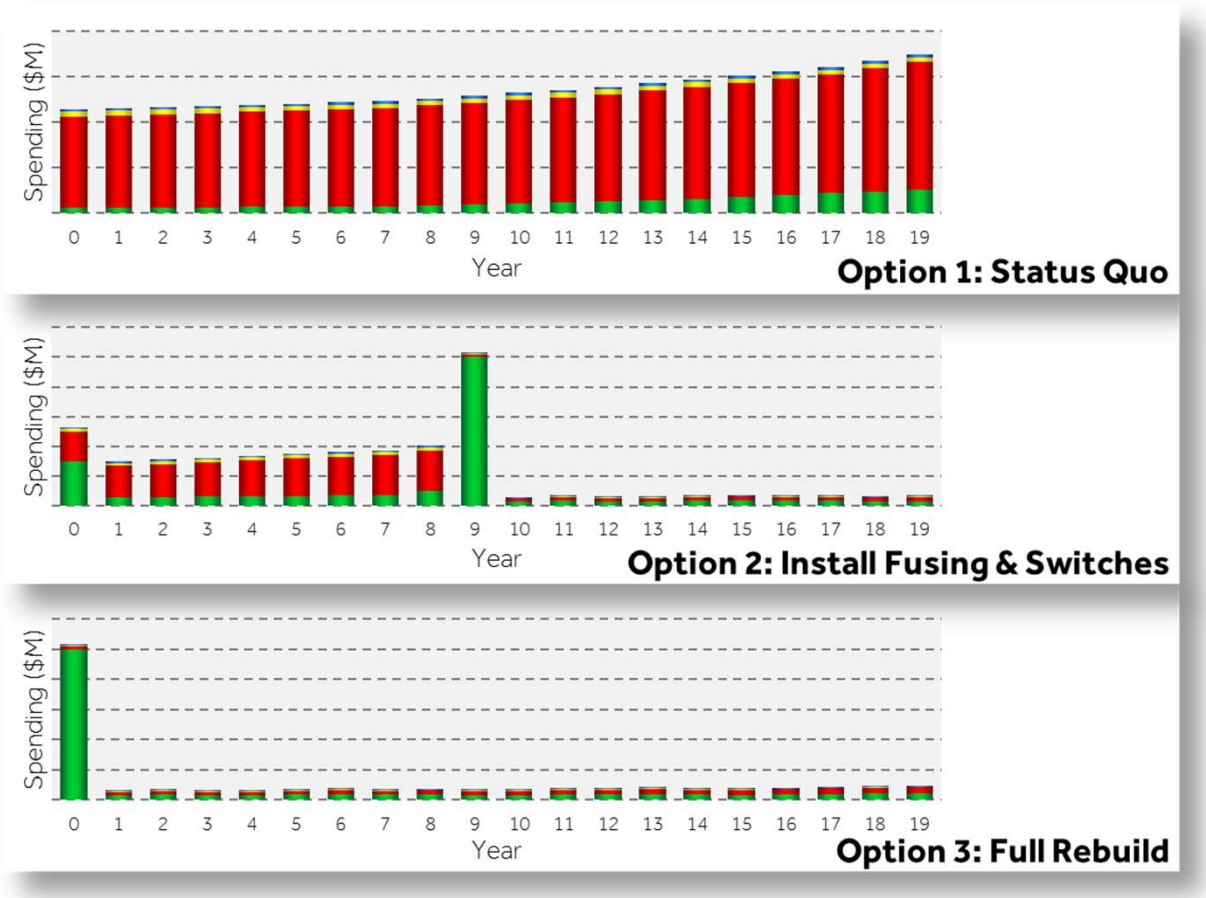
As per this case study, the following scenarios were examined, and the most economic alternative was selected based upon the greatest net reduction in TCO (which represents the net present value of doing the work):

- Option 1: Maintaining the current configuration and life-cycles of the assets (status quo).
- Option 2: Targeted installations of fuses and switches in order to reduce the impact of failure
- Option 3: Total rebuild of infrastructure, including installation of fuses and switches.



Total Cost of Ownership, is in turn, a metric that enables comparisons across long-term investment programs.

Financial | Customer / Reliability | Safety | Environmental

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Our Approach:

How did METSCO Evaluate Manitoba Hydro's Evidence?

.21 Manitoba Hydro's Greatest Challenge Today:
Expansion costs materially constrain the Sustainment dollars

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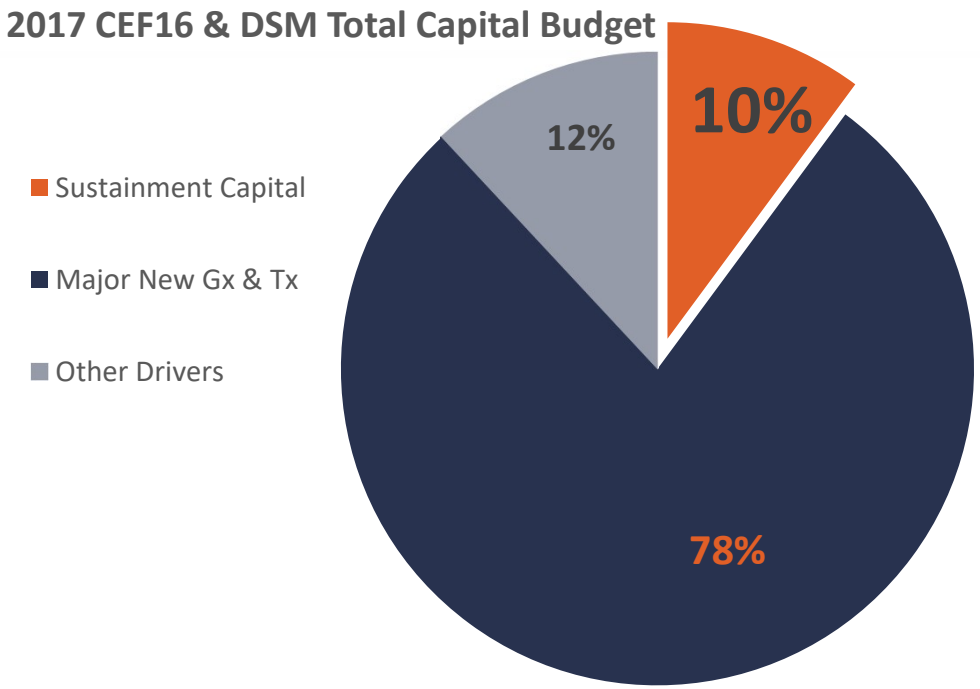
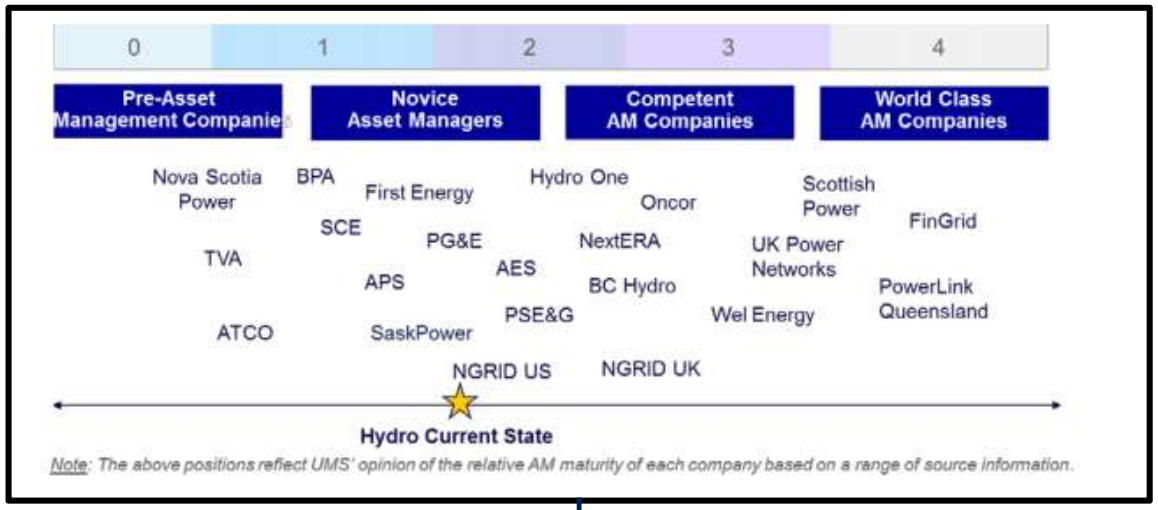


Source: MH Pre-Filed Evidence, Tab 5, Figure 5.4

- Manitoba's Sustainment funding access is significantly constrained by the major capacity expansion project funding needs
- This means that Sustainment capital decisions must reflect the maximum analytical rigour – to make the most prudent intervention decisions
- While greenfield work is often less predictable, Regulators should generally expect a higher degree of precision with sustainment planning and execution.

Manitoba Hydro's present realities highlight the urgency of making optimally informed AM decisions.

.22 We Turned to Available External Assessments
UMS / BCG work yields ample insights into the status quo



"Overall, Manitoba Hydro compares favorably against North American utilities … ***largely as a result of recent progress made*** *(e.g., Capital Investment Optimization-C55, CVF, Asset Health Indices (AHI), Reliability Centered Maintenance (RCM), Failure Curves, etc.)."* (METSCO's emphasis)

Source: UMS, Dec 15, 2016 (p. 11)

UMS rating, invoked throughout the Oral Hearing, is largely grounded in the impact of newer initiatives.
We set out to explore whether and how CEF16 reflects these capabilities, and to gauge progress made to date.

.23 METSCO Asked a Total of 74 IRs
We sought data & supporting frameworks underlying the Plan.

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- Per terms of our engagement as a Technical Expert (see Appendix), METSCO sought to help validate the condition and risk assessment work (among others) that the Applicant claims underlie the CEF16 Sustainment budget
- In numerous cases, we requested specific data tables, spreadsheets, failure curves, diagrams and/or other quantitative materials that could be reasonably expected to be in place to support the noted condition and risk assessment work
- We also requested access to / clarifications on internal reports, policies or statements on record with respect to AM processes and decision-making tools, and frameworks used to prioritize among the investments
- Finally, we looked to gauge the progress of continuous improvement efforts on both gaps and examples of positive developments noted by UMS, BCG, and the Applicant itself

Informed by evidence on record and prior external assessments, METSCO's review strategy was to understand and validate the fundamentals of MH's evolving AM capabilities – tools, processes, and specific calculations they yield.

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Our Observations:

What are the Key Inferences from Evidence on Record?

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Data Collection and Utilization Practices

State of Asset Health- and Risk-based Analytics Underlying the Plan

.26 Condition Data Availability Remains Limited
No Health Data Available for Multiple Asset Classes

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- While MH has made notable efforts to establish the baseline parameters of its asset health across the Gx/Tx/Dx business units[1], much of condition data remains unavailable, particularly with respect to distribution
- Seven out of 23 core distribution asset classes had no condition data available (0% Average Data Availability Index), while another nine had under 50% of data available in the Kinetrics 2016 *Distribution Asset Condition Assessment* Study[2]
- Lack of data is concerning wrt Underground Cables (HV Oil), 40% of which are deemed in Very Poor condition despite the DAI of 0%, and the Ductline and OH Switches, where high % of assets is ranked in poor condition despite low DAI[3]
- The lack of data for significant portions of MH asset population is one indication that the utility's ability to rely on consistent condition assessment data in preparing Sustainment plans may be overstated
- While MH argued at the Oral Hearing that this data may not be required if the assets are in the "Run to Fail" category,[4] METSCO disagrees, as asset health data helps predict the expected number of failures, adding precision to budgeting.

MH is making notable progress in expanding its understanding of asset health. However, with respect to CEF16 in particular, the data gaps observed make METSCO question the precision of the planning inputs.

.27 Inconsistent Regular Maintenance Practices
Documentation, Measurement and Recording Issues

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- Maintenance work is a key element of Sustainment planning, as most condition data is collected and recorded during the maintenance activities. As such, maintenance management issues are reflected in the ensuing capital plans.
- Application record contains internal MH documentation that identifies a number of gaps between maintenance inspection, scoring and record keeping practices – across regional offices, and within the same business unit[5]
- While individual examples of good maintenance practice manuals are also noted,[6] the sole fact of variability in data quality, comprehensiveness, or the types of issues identified, suggests a degree of remaining organizational inconsistency
- Absent clear, consistent, and auditable maintenance execution / data collection procedures, the quality and completeness of data available for operational analysis and planning can be expected to remain suboptimal
- While introduction of new AM tools / processes takes time, METSCO sees no valid reason for the apparent consistency issues in standard maintenance activities for the utility of MH's maturity and capabilities.

Since maintenance records directly inform capital plans, the identified issues raise questions as to the claims made regarding the scale, scope and nature of Sustainment capital needs.

.28 Piecemeal Advanced Maintenance Analytics
Lack of understanding in capital-maintenance tradeoffs

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- Consistent with the UMS report,[7] we found evidence of gaps in the Applicant's efforts to optimize the O&M activities to enhance planning rigour and cost-effectiveness through understanding of capital-maintenance trade-offs

- As the capital replacement activities proceed, the Applicant could expect to see some reductions in the volume of maintenance work (e.g. reactive maintenance). Performing this analysis was among the Key UMS suggestions[8]

- To date, MH is yet to quantify the capital-maintenance relationship across its replacement programs, citing the relatively low volumes of replacement work as one of the reasons for forgoing this work to date[9]

- In a similar manner, MH appears inconsistent in utilizing the Reliability Centered Maintenance (RCM) framework, and particularly in distribution, despite a 2001 Business Case Report that estimated a $25M NPV for doing so in T&D Units[10]

- Notably, RCM was among the initiatives explicitly listed by UMS as the reason for a higher overall maturity ranking provided to the Applicant
  - While MH disputed our finding that RCM was not used for Distribution assets in its Rebuttal evidence,[11] this appears to contradict its own IR response to COALITION/MH I-195 a.

The gaps is RCM utilization and understanding of capital-maintenance cost trade-offs cast further doubt on the rigour of the analysis underlying MH's maintenance and capital planning, and points to potentially missed efficiencies.

.29 Industry Curves Overstate MH Asset Failure Rates

MH assets fail later than those of peers whose data it relied on to date

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- Aside from several instances METSCO understands that the asset failure curve data used as a reference in CEF16 preparation was exclusively based on industry peers data provided by Kinectrics in earlier reports.

- However, the findings of the July 20, 2017 Kinectrics *Asset Degradation Curve Development Study*[12] suggest that industry curves may overstate the propensity of MH assets to fail sooner:

Asset Class	Kinetrics Comments re: MH Asset Service Life vs. Industry	Kinetrics Report Page Reference
Transmission Transformers	"Much Longer"	p. 26
Distribution Transformers	"Much Longer"	p. 34
Generation Transformers	"Much Longer"	p. 37
>100 kV Oil Circuit Beakers	"Much Longer"	p. 42
>100 kV Air Circuit Beakers	"Longer"	p. 49
Generation Oil Circuit Breakers	"Longer"	p. 61
Electromechanical Relays	"Outer Age of Curve Range"	p. 75

Source: METSCO Report, p. 26 drawn from the 2017 Kinetrics Report

To the extent that industry failure curves were used to inform the CEF16 sustainment planning, they may have led MH to conclude that assets tend to, on average, fail sooner than the available field data would suggest.

.30 Reliance on Quantitative Work may be Overstated
Our requests for specific data were largely unsuccessful

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- As recently as in the course of the Oral Hearing, the Applicant states that its sustainment plans are grounded in risk and condition analysis performed by MH staff.[13] We sought to review and validate this work through our IR requests[14]
- With minor exceptions, IR responses provided no data to enable methodological or computational verification,[15] often noting that spreadsheet software was not used, or statistical analysis data was not available
- Through IRs, METSCO established that MH does not have defined quantitative thresholds of asset health risk acceptance level, and does not engage in forecasting of asset population risks over time[16]
- Multiple responses pointed to the individual subject matter experts' assessments as inputs into planning work, noting that local expertise and operational experience as sources of its confidence in the underlying analysis[17]
- Though METSCO has no reason to question the technical expertise of MH staff, the fact that the nature of work and its underlying assumptions could not be empirically verified, makes the degree of implied planning rigour uncertain

On balance, we found little objective evidence to substantiate MH's claims that CEF16 is supported by consistent application of objective asset condition and risk assessment tools, as these terms are understood in the industry.

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Progress of Corporate AM Initiatives

AM Tool and Process Improvements Underlying the Plan

.32 Progress & Targeted Outcomes of Corporate AM Improvements are Limited / Unclear

- Manitoba Hydro's four core corporate Asset Management (AM) initiatives comprising the Corporate Asset Management Framework are among the key reasons behind UMS's assessment of the utility's AM maturity level as 1.5/5. They are:
  - Capital Portfolio Management Program (CPM)
  - Enterprise Asset Management Initiative (EAM)
  - Corporate Value Framework (CVF)
  - Kinetrics Asset Condition Assessment (ACA)

- As stated in IR responses and confirmed in the Oral Hearing,[18] the overall Corporate Asset Management Roadmap remains undeveloped to date. Absent a Roadmap, METSCO finds it difficult to see the project as being meaningfully underway

- While the Oral Testimony points to more progress (e.g. completion of EAM for the Generation Unit),[19] the timelines and sequencing for the remaining steps across the initiatives remain unclear, complicating accountability going forward

- Moreover, we note that the targeted benefits of ongoing strategic AM initiatives are largely unquantified,[20] which limits the Applicant's and PUB's ability to gauge the progress / success of this work relative to the past practices.

Despite some progress to date, it is notable that CEF16 does not reflect any of the new capabilities, and should be reviewed as such. Progress / benefit tracking will remain subjective until milestones and measures are developed.

.33 New AM IT Applications May be Underutilized
C55 and Meridium software still missing key functionalities

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- While MH states that Copperleaf (C-55) implementation is proceeding,[21] some information on record suggests that the system is yet to be meaningfully leveraged even in the business units where it has been implemented:

> *"Full implementation of investment decision optimization will require data and process refinement, which are future steps."* (COALITION/MH-I-201 a-c)

- Absent the activation of investment optimization functionality, it is unclear to METSCO what purpose the C-55 software can presently serve to MH. While it was not used to prepare CEF16, the use of C-55 in future plans may require monitoring
- Similarly, application record suggests that the Meridium generation performance management software still has key application modules (e.g. RCM and Asset Performance Management) that remain inactivated to date[22]
- Though full capabilities utilization may be expected to occur at a later date, METSCO is unaware of any documents on record to suggest the schedule and/or clearly identified critical path towards the implementation of new IT tools.

While the implementation of new IT tools is a time-consuming process, the PUB may wish to monitor whether and how the MH ratepayers are deriving optimal value from new IT capabilities that their rates help finance.

.34 C-55 Tool May Benefit from Further Modifications

Corporate Value Framework does not include rate impact

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- METSCO commends the Applicant for developing a Corporate Value Framework to support AM prioritization using the Copperleaf Software – and particularly the decision to account for Customer Interruption Costs (CICs) using industry data

- While CEF16 has not benefitted from this framework's application,[23] the planned utilization of CICs is evidence of awareness of, and willingness to implement industry-leading planning practices on the part of Manitoba Hydro

- We note, however, the vast majority of studies underlying the quantification of interruption costs are not optimally positioned to reflect the preferences of Manitoba's residents as businesses:
  - Most studies were performed before 2000,[24] and only two of 10 were conducted in geographic regions similar to MH's
  - While CIC studies are costly, we encourage MH to explore opportunities of acquiring more current/relevant data

- A notable shortfall of MH's Corporate Value Framework, as currently designed, is the absence of an assessment category specifically relating to Customer Rate Impact[25] – to account for the economic burden placed on Manitobans

- While this need not be a definitive criterion, and recognizing that other parts of the framework seek to minimize costs, the Rate Impact consideration can act as an important threshold to demonstrate the incremental value of proposed plans

The Corporate Value Framework is a sensible approach to prioritization, but further steps are beneficial to reflect in full the impact of AM decisions on Manitobans – both in terms of cost consequences of outages and rate increases.

.35 Impact of Interim AM Governance Steps is Unclear

Available evidence provides limited insights

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- MH notes that in lieu of the targeted AM improvements that remain under development, it established a Corporate AM Executive Council,[26] tasked with reviewing projects over $15M and investment portfolios of all operating groups

- While centralized oversight can be effective in the environment where analytical tools and processes are well understood and consistently implemented, absent this (as appears to be the case in MH), it may become a bottleneck

- MH has also established a new Strategic Business Integration Division[27] to address the functional duplication of tasks across divisions. Yet, MH did not disclose the Division's specific mandate, stating that it is out of scope of the proceeding

- The Division's establishment is a positive step. However, given the lack of information regarding its mandate or activities, we conclude that the functional duplication observed by UMS remained in place in preparation of CEF16

- Finally, as of September of 2017, MH was yet to establish the 2017/2018 Corporate Dashboard and targets.[28] Reasons for absence of this critical strategic management tool are not clear, notwithstanding widespread change management work.

While some steps have been taken to address the AM governance gaps in the interim, their effectiveness could not be verified, and in any case does not appear to have had a bearing on CEF16 preparation.

.36 Evidence of Missed Learning Opportunities
Lack of formal efforts to explore lessons learned

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- Both BCG and UMS engagements provided MH with multiple important insights as to the gaps in the current AM planning and work execution processes, relative to industry norms.[29] In our IRs, we explored whether and how they were internalized
- With respect to BCG's Keeyask and Bipole III analysis that identified a number of issues, the Applicant could not point to any specific "lessons learned" activities (e.g. planning assumptions / process reviews) stemming from the findings [30]
- Similarly, based on MH's IR responses, the utility does not appear to have either developed a formal stance / responses to the UMS recommendations, nor has it requested the detailed information underlying UMS assessments [31]
- Given the apparent scale and scope of the AM process changes that MH plans to implement, METSCO is concerned that the implied lack of proactive efforts to explore and rectify the specifically identified gaps, amounts to missed opportunities.

Continuous learning is at the core of strategic and operational planning for utilities. The apparent lack of effort to explore in detail the implications of external consultants' recommendations, amounts to a missed opportunity.

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Cost Estimation and Validation Issues

Observations on Plan Costing and External Validation Work

.38 Cost Estimation Procedures Require Improvement

Estimation work lacks discipline expected of a mature utility

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- MH states that it includes the latest estimates available for each project into their financial plans [32], which places projects of various vintages and estimation procedures into the same plan – resulting on average, in material cost underestimation:

Project Category	Completion Estimate vs. Original Estimate	Actual Cost vs. Completion Estimate	Actual Cost vs. Original Cost Estimate
Generation (9 Projects)	105%	6%	114%
Transmission (6 Projects)	34%	12%	47%
Marketing and Customer Service (32 Projects)	26%	2%	27%
HR & Corporate Services (2 Projects)	0%	42%	42%
Combined Average (49 Projects, unweighted)	**40.5%**	**5.4%**	**46.7%**
Weighted Average (49 Projects, Weighting by Actuals)	98%	6%	106%

- While cost variation is to be expected, over a large sample of projects, METSCO would expect average variation to approach 0%, as some project cost overruns are offset by the lower-than predicted costs of others.

The current practice of including projects of various estimation vintages into the same Plan, significantly limits PUB's and ratepayers' abilities to hold MH accountable for its project delivery costs.

.39 Cost Estimation Procedures Require Improvement
Annual ISA estimates, are consistently higher than actuals

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- While its project cost estimates appear to be materially lower than the final costs, MH's estimates of achievable in-service additions (ISAs) appear to be overestimated, compared to the actual work achieved by year-end
- Between the 2014/15 and 2016/17 plans, the Applicant came short of its forecasted ISAs by the weighted average of 11% within the Major Generation and Transmission category, and 18.4% for the Business Operations Capital projects [33]
- As we note elsewhere, over/under-estimation is to be expected to some degree, and particularly with greenfield projects, however, better precision can be expected wrt the Business Ops projects, which reflect more typical work
- Based on the evidence provided in the Oral Hearing,[34] METSCO speculates that the observed under-estimation of ISAs may be a function, in part, of the past practice of Unallocated Target Adjustments that the Applicant is moving away from
- Irrespective of the ultimate driver(s), METSCO encourages the PUB to explore the issue of cost estimation variances with MH in greater detail, including the feasibility of introducing standard expectations of planning rigour applied to Test Year projects

Consistent underestimation of individual project costs, paired with evidence of regular overestimation of planned ISAs point at potential project cost management issues and warrant more exploration

.40 Lack of Capital Cost Benchmarking Evidence
The capital ask is not supported by any peer comparisons

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- Evidentiary record lacks benchmarking evidence comparing MH's capital costs with those of its industry peers – a common application practice in jurisdictions where METSCO operates, which enables regulators to gauge utility cost efficiency

- While such evidence may not have been strictly required by the PUB, an objective comparison of the Applicant's capital construction costs with industry peers would entail an instructive tool for assessing the reasonableness of the ask

- METSCO notes that the record does contain an O&A cost benchmarking study performed by BCG.[35] While many items within the Generation business are within industry norms, many Transmission and Distribution cost categories are in the 4th quartile

- Since as much as 50%-70% of MH's capital costs appear to be made up of capitalized labour (a key component of O&A costs)[36] METSCO infers that opportunities for better cost management may be present

- We do note that MH's average pole replacement costs used for planning purposes ($3,500)[37] compare favourably to the results of a recent Navigant study conducted in Ontario (peer group avg. of $7,105)[38]

    - However, we were unable to establish whether MH cost estimates comprising the $3,500 figure are comparable to those used in the study's methodology, or the extent to which MH actual pole ISAs are similar to the planning estimate.

Capital benchmarking would aid both the PUB and MH – to assess the ask and identify improvement opportunities

.41 Cost Breakdowns Reveal Potential Duplication
Potential overlap across several category descriptions

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- Project cost breakdowns reveal opportunities for exploration of potential efficiencies:

	Pointe du Bois Spillway Replacement ($M)		Riel 230/500 kV Station ($M)	
Category	Expenditure ($M)	Percentage of Total	Expenditure ($M)	Percentage of Total
Activity Charges	$ 43.3	7.8%	$ 37.5	11.8%
Overhead	$ 8.1	1.5%	$ 7.7	2.4%
Interest	$ 49.4	8.8%	$ 40.6	12.7%
Material	$ 2.5	0.4%	$ 87.2	27.4%
Construction and Maintenance Services	$ 390.2	69.9%	$ 124.0	38.9%
Consulting	$ 51.1	9.2%	$ 17.6	5.5%
Study Costs	$ 5.7	1.0%	$ -	0.0%
Travel Expenses	$ 3.9	0.7%	$ -	0.0%
Building and Property Costs	$ 1.9	0.3%	$ 2.1	0.7%
Motor Vehicles	$ 1.1	0.2%	$ -	0.0%
Other	$ 1.0	0.2%	$ 1.8	0.6%
TOTAL ($M)	**$ 558.2**	**100%**	**$ 318.5**	**100%**

Source: COALITION/MH-I-185a; COALITION/MH-II-69

Activity charges vs. Travel and Vehicle Cots and Consulting Costs vs. Study Costs, among others, showcase areas of potential duplication that could be explored by way of internal and external capital cost benchmarking

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Reliability and Equipment Performance

Category-Specific and Aggregate System Performance Trends

.43 MH Reliability Performance is Favourable

Aggregate indices point to good reliability relative to peers

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- The Applicant's aggregate reliability performance (both SAIDI and SAIFI) has consistently remained above the CEA median for the 10-year period for which the data was provided, both in aggregate and for the City of Winnipeg[39]

- This indicates good, but not necessarily cost-effective asset stewardship. Assessing cost effectiveness would require evidence of how the Applicant's capital costs compare with peers over time (e.g. cost benchmarking)

- SAIDI/SAIFI are lagging indices, and do not fully reflect the current state of MH plant, or the emerging failure trends that may be occurring. To test this, we looked at the contributions to SAIDI / SAIFI from Defective Equipment outage cause codes:

Transmission							
	2012	**2013**	**2014**	**2015**	**2016**	**Average**	**Trend**
SAIDI	9%	40%	46%	5%	13%	22%	
SAIFI	4%	7%	6%	3%	4%	5%	
Distribution							
	2012	**2013**	**2014**	**2015**	**2016**	**Average**	**Trend**
SAIDI	33%	46%	33%	34%	28%	35%	
SAIFI	28%	30%	31%	26%	25%	28%	

Source: MTSCO report p. 39 as derived from COALITION/MH-II-63d

The 5-year trends of defective equipment outage contributions to total reliability indices do not indicate a consistent increase. The approximately 1/3 of distribution outages caused by defective equipment is in line with other utilities.

.44 Some Evidence of Rising Equipment Failure Rate
Yet the highest increasing trends limited to smallest assets

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Distribution Equipment Failure Incidences 2012-2016

	2012	2013	2014	2015	2016	Total	Avg. Growth Rate	Trend
Cut-Out	473	536	578	664	762	3013	13%	
Fuse Separation	209	391	462	471	460	1993	26%	
Connector	278	353	377	396	432	1836	12%	
Transformer	286	366	387	397	359	1795	7%	
Conductor	256	275	288	293	324	1436	6%	
Insulator	147	137	109	151	123	667	-2%	
Farm Thermal	77	112	108	90	99	486	9%	
Other	30	59	80	79	77	325	32%	
Hardware	57	42	45	39	22	205	-19%	
Customer-Owned	126	25	35	8	9	203	-26%	
Arrestor	27	37	23	47	38	172	21%	
Disconnect	34	22	13	35	19	123	12%	
Pole	20	9	16	22	9	76	0%	
OCR	16	10	12	13	14	65	0%	
Protective Control Equipment	6	7	16	12	9	50	24%	

Source: METSCO Report, p. 39, as derived from COALITION/MH-I-148 g

Certain system components are failing at higher rates, but these are largely limited to the smaller asset classes.

.45 MH Does not Forecast Reliability

Reliability outcomes not used as a quantitative AM driver

- Despite showcasing the ability to produce well-structured and granular evidence of its reliability performance drivers (by system, cause code, equipment type) the Applicant is yet to forecast reliability[40] as an input into AM planning
- While METSCO agrees with the Applicant's position expressed at the Oral Hearing that reliability is just one of many drivers underlying the asset management decisions, it appears that it has sufficient data to commence forecasting work
- Reliability forecasting work is well aligned with the ongoing implementation of the Corporate Value Framework, in that the forecasts can become another input into the prioritization model – complementing the CIC / willingness to pay inputs
- Our research indicates that most North American utilities are still in early stages of developing their reliability forecasting capabilities – as such, MH could attain competence levels commensurate with industry norms in relatively short order
- As shown by the EPCOR and Toronto Hydro examples referenced in METSCO's report – forecasts of reliability implications – across individual investments or aggregate plans – can become one way of selecting an optimal investment portfolio
- We note, however, that we agree with MH that reliability alone is an insufficient indicator to base planning prioritization on. While it represents a large portion of total system ownership costs, other quantitative inputs need to supplant it.

We recommend that MH explore the adoption of reliability forecasting, as another evidence-based input into its development of advanced AM capabilities.

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Concluding Observations

Recommendations for further inquiries, oversight & MH Rebuttal comments

.47 MH Rebuttal Evidence Commentary
Standalone examples not supportive of wholesale rigour

- In its rebuttal evidence, MH points at a number of "erroneous statements and assumptions" made by METSCO[41]
- Notably, it does so by presenting substantially new information on the record, such as discrete examples of projects that illustrate the use of certain tools or processes used by the Applicant in preparation of the plan
- However, these examples are largely standalone, and not indicative of internally consistent and universally applied analysis that would support the applicant's claims – and do little to respond to the evidence of planning shortcomings on record
- MH's explanation as to the source of cost variances[42] – where projects are internally approved on the basis of estimates that include limited engineering analysis – is actually an argument in favour of stricter estimate & completion governance
- The instances where METSCO's inferences are corrected on the basis of new factual information (e.g. cable replacement amounts budgeted in the Test Years) is an example of clarity and comprehensiveness of evidence currently on record

While MH's rebuttal supplied compelling examples of individual projects or initiatives, it falls short of confirming that this work has occurred universally and consistently in preparation of CEF16.

.48 Summing It All Up:
CEF16 lacks the evidentiary rigour of capabilities MH is working to establish now

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- METSCO commends MH for the work it has initiated to enhance and modernize it's AM processes and collect more objective information regarding its system – which is already paying off in the way of asset health data availability, among others
- While some progress is evident, little of it underlies of CEF16. The utility that prepared CEF16 is not the utility that was ranked as 1.5/5 by UMS, as most capabilities that led to this ranking were in nascent stages
- MH claims that health and risk analysis was used, have not been supported by objective evidence of such analysis being applied to the entire work program, (e.g. no evidence of programmatic risk forecasting, large asset health data gaps, etc.)
- Maintenance process status quo evidence indicates multiple gaps and inconsistencies – this is a major concern, given that sustainment planning is informed directly by information collected through maintenance activities
- MH's cost estimation record further challenges the Applicant's ability to deliver the programs within the test years and budgets specified. Lack of benchmarking evidence prevents PUB from assessing whether the forecasts are reasonable
- While some asset failures showcase increasing trends, this is not consistently reflected in equipment-related outages, whereas the aggregate reliability statistics remain positive.

The utility that prepared CEF16 is not the utility that was ranked as 1.5 by UMS

.49 Potential Areas of Reduction
Discretionary elements of the program

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- Since the rate case commenced, MH showcased an ability to reduce the requested Test Year sustainment budgets via:
  - Project scope revisions (BP II Valve Hall Bushings, Gillam town site improvements discussed at the Oral Hearing[42])
  - Cancellation (Slave Falls Spillway Rehabilitation)
  - Deferral (BP II Thyristor Valve)[43]

- As 65%-68% of Test Year system renewal budgets are comprised of smaller projects below the materiality threshold, other similar opportunities may be available with respect to the scope and/or timing of other projects not explicitly referenced

- Among the areas where further reductions may be feasible are:
  - civil components (non safety-related) of projects,
  - the scope or timing of area voltage upgrades based on the latest load data,
  - non-critical spares procurements (e.g. proposed replacement of spare of BP II Porcelain Valve Hall Bushings)

Based on evidence to date, we believe that further project scope and/or timing revisions could be available within the 65%+ of Test Year Sustainment projects currently below the materiality threshold – subject to a detailed examination.

.50 Regulatory Oversight Recommendations
Greater outcome-related accountability should be sought

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- MH is facing a long and complex path of implementing and entrenching the planned AM tool and process changes. The 3-5-year timeline for the initial stages, as discussed by the Applicant's experts during the Oral Hearing, is not unreasonable

- However, MH's assurances that "work is ongoing" should also not be seen as an sufficient form of progress reporting. To this end, the PUB can explore the adoption of a variety of outcome-oriented incentive tools, including:

    - *Project Specific Implementation Milestones* – established jointly with MH, and potentially including at-risk funding
    - *Variance Accounts* – to capture any project/portfolio over or under spend, subject to ex-post review
    - *Outcome-based KPIs* – reliability improvement, risk reduction, efficiency enhancements, etc.
    - *Stricter Oversight of Project Spend and Delivery Schedules* – changes plan-to-plan largely done at MH initiative and are difficult to track / audit by the PUB or other parties

- Similar tools are standard in many jurisdictions, and can, in METSCO's assessment, contribute to a more informed dialogue and better accountability on the part of both the Regulator and the Utility

These tools are not proposed to constrain MH's ability to plan and/or execute its work, but rather to create an environment more conducive to a dialogue informed by timely and objective information, understood by both parties.

.51 Endnotes

(1) For instance, the Kinetrics reports provided by way of pre-filed and subsequent submissions
(2) Filed in response to COALITION/MH-I-160
(3) Kinetrics 2016 Report "Manitoba Hydro 2016 Asset Condition Assessment" filed in response to PUB MFR 29, p.14
(4) Dec 11, Oral hearing Transcript, p. 1428
(5) COALITION/MH-I-181-Attachments p. 13 of 86
(6) COALITION/MH I-203 Attachment 4
(7) Tab 5, Appendix 5.1 p. 20
(8) Tab 5, Appendix 5.1 p. 8
(9) COALITON/MH-I-176
(10) COALITION/MH I-203 Attachment 4, p. 31
(11) MH Rebuttal, p. 50 lines 33-34
(12) COALITION/MH-I-160, Attachment 1
(13) Dec 6, 2017 Oral Hearing Transcript, p. 689
(14) For example COALITION/MH-I-150 b, d, e, f; COALITION/MH-I-163 i; COALITION/MH-I-171 a; COALITION/MH-I-188 a.
(15) *Ibid*, COALITION/MH-I-160
(16) COALITION/MH-I-184 a
(17) For example, COALITION/MH-I-166 f; COALITION/MH-I-180; COALITION/MH-I-183 b.
(18) Dec 11 Transcript, p. 1418
(19) Dec 11 Transcript, p. 1364
(20) COALITION/MH-II-59-a
(21) Dec 11 Transcript, p. 1376-1377
(22) COALITION/MH-I-181-Attachments p. 55 of 86
(23) Dec 11 Transcript p. 1377
(24) COALITION/MH-I-197-a-k-Attachment
(25) COALITION/MH-I-197-e
(26) COALITION/MH-I-177a
(27) COALITION/MH-I-177a-b
(28) COALITION/MH-I-17i
(29) For example BCG September 19, 2016 Report, "Review of Bipole III, Keeyask and Tie-Line Project" p.3
(30) COALITION/MH-I-215
(31) COALITION-II-67b
(32) COALITION/MH-I-191-B
(33) METSCO calculations based on COALITION/MH I-142a-d response
(34) Dec 11 Transcript p. 1304
(35) Tab 10, Appendix 10.12
(36) Calculated on the basis of project details provided in response to COALITION/MH-I-185a; COALITION/MH-II-69]
(37) COALITION/MH-I-198b
(38) COALITION/MH-I-198b
(39) COALITION/MH-I-148g
(40) COALITION/MH I-148a
(41) MH Rebuttal, p. 43
(42) Oral Hearing Transcript, January 23, p, 5933-onwards
(43) MH Rebuttal, p. 53
(44) All examples are drawn from Manitoba Hydro's response to COALITION/MH-I-167a-b

.52 Appendix
Duties of the METSCO Team in the 2017-2018 Manitoba Hydro GRA

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The Public Interest Law Centre retained METSCO's services to assist the Consumers Coalition with its participation in the Public Utilities Board review of Manitoba Hydro's Application on issues related to Manitoba Hydro's sustaining capital, including a good practice consideration of Hydro's management of its portfolio.
METSCO's duties include the following tasks: 54

1. Conducting a detailed review of the processes, data, asset risks, failure rates, business cases, and unit costs in Manitoba Hydro's Application, as well as the methodology used by Manitoba Hydro relating to the necessity and justification for: a. sustaining capital expenditures, and
b. management oversight of large capital projects.

This task includes:
- assisting in the development of the overall case theory;
- preparing briefings for the Consumers Coalition;
- developing information requests;
- assisting in the identification of required additional expertise; and,
- providing briefings to other experts as required.

2. Preparing a critical analysis of Manitoba Hydro's sustaining capital expenditures and, if necessary, providing written and oral evidence, and drafting supplemental information requests and preparing responses to any information requests the Consumers Coalition receives

METSCO's retainer letter includes that the firm is to provide evidence that:
- is fair, objective and non-partisan;
- is related only to matters that are within their area of expertise; and
- to provide such additional assistance as the Public Utilities Board may reasonably require to determine an issue.

METSCO's retainer letter also includes that their duty in providing assistance and giving evidence is to help the Public Utilities Board. This duty overrides any obligation to the Consumer’s Coalition.