

Asset Management Gap Assessment Report of Findings to Manitoba Hydro

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INTRODUCTION

Overview of Project

UMS Group was engaged by Manitoba Hydro (Hydro) in September 2016 to conduct a Gap Assessment of its Asset Management capabilities. The scope of this assessment was to evaluate the organization's current asset management capabilities and practices and make recommendations for implementing a best practice Asset Management System.

The project comprised a review of Hydro's existing corporate and business unit level Asset Management practices and comparison to industry best practices, as well as to international standards for Asset Management (PAS 55 and ISO 55000). From this review, UMS developed a detailed and prioritized listing of the gaps between Hydro's current Asset Management practices and industry best practices and identified necessary steps to bridge the gaps.

To perform the assessment, UMS collected and reviewed asset management-related process and practice documentation, as well as current plans to monitor and maintain asset performance, asset condition and risk levels. Additionally, interviews were held with the Executive team to understand their views on asset management, objectives for the assessment, and perceived issues/gaps. Following those interviews, individual interviews were held with personnel involved with asset management from across the Hydro Generation Operations, Transmission, and Customer Service and Distribution business units. The focus of these interviews was to understand current and planned asset management roles and responsibilities, practices, processes, and tools.

Finally, individual workshops were held with each of the Generation Operations, Transmission, and Customer Service and Distribution business units to discuss asset management standards and best practices and walkthrough a self-assessment of the Business Unit maturity compared to industry standards – International Organization for Standardization (ISO) 55000 and Publicly Available Specification (PAS) 55 – and best practice. Individual workshops were also held with each of the Business Units to review the Asset Lifecycle and Risk Strategy Process and gain a better understanding of how Hydro addresses the steps in the process and where gaps exist.

The Gap Assessment Methodology is described in Appendix A. Manitoba Hydro personnel who were interviewed and/or participated in workshops are listed in Appendix B.

As a definitional note, there are several terms used in the report which might not be familiar to readers. There are defined below:

- **Management System** – The set of interrelated or interacting elements of an organization (i.e., policies, processes and procedures) used to ensure that it can fulfill all the tasks required to achieve its objectives.

- Model – A high level representation of a system made up of concepts which communicate basic facts about the system
- Framework – A high level guide which identifies the key elements of a structure.

What is Asset Management?

Asset Management is a system that uses data-driven decision-making to ensure the right work is being undertaken to achieve the desired performance outcomes in the most efficient way. Its overall objective is to ensure that short term decisions meet the long term needs of stakeholders in the optimal manner.

Good Asset Management means spending limited resources in the most effective way to meet business objectives. It does so by proactively investing in the asset in a way that meets the strategic objectives of the company, rather than merely reacting to asset deficiencies as they occur. This investment is based on economic modeling of benefits versus its costs, rather than historical spend or “pet” projects. By providing the focus and accountability for the best use of its resources, Asset Management optimizes the total expenditure needed to achieve the desired business and asset performance outcomes.

Strategic Value of Asset Management

Improving its Asset Management capabilities has the potential to provide significant strategic benefit to Manitoba Hydro by ensuring that it is optimizing its capital and operating expenditures, managing risk within a set tolerance level, and delivering long-term value to customers by reliably and safely providing service in a cost-effective manner.

Specific benefits that can be achieved by Hydro through the maturation of its asset management system include:

- Improved asset productivity through life extension and reduction in failures
- Increased efficiency in asset maintenance through better targeting of needed work and elimination of non-valued added work
- Reduced uncertainty through better forecasting of failures and understanding of risk
- Ability to compare investments across asset classes through consistent approach and monetization of benefits
- Improved effectiveness of expenditure dollars through focus on performance management and continuous improvement
- Optimizes use of human resources by matching the workforce – in terms of size and composition – to the work required, rather than creating work to keep the workforce busy
- Greater transparency for internal and external stakeholders through use of data-driven decision-making and quantitative analysis

In 10 previous utility asset management transformations we have performed, we have found that utilities see significant improvements in productivity and overall cost savings of 20-30% over 5 years with the application of an asset management system.

Achieving these benefits means adopting a process model whereby the responsibilities and accountabilities for the different Asset Management roles are clearly defined and understood by personnel. The three key roles in an Asset Management process model are the Asset Owner, Asset Manager, and the Service Provider.

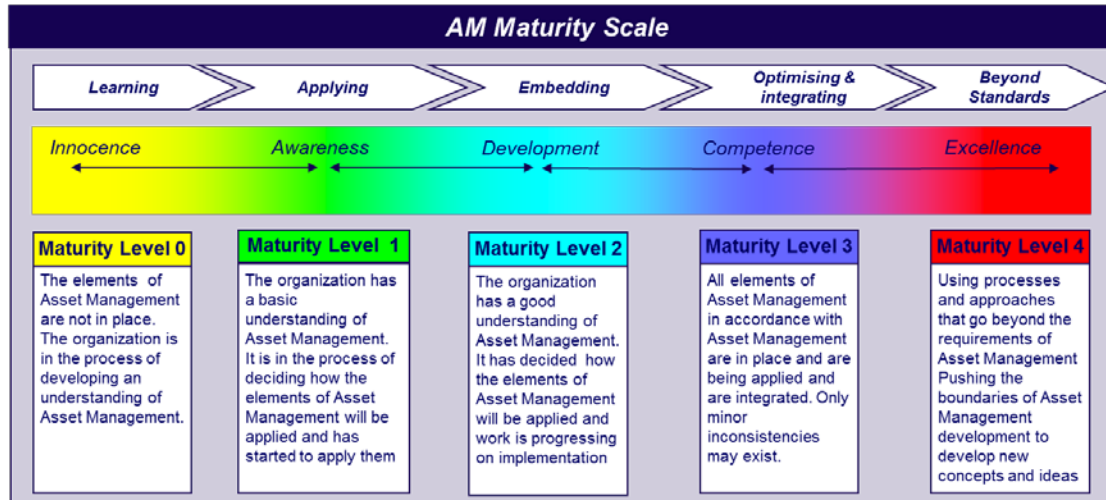


The Asset Owner identifies needs and requirements of stakeholders and sets the business values and risk tolerance levels for the Asset Manager. The Asset Manager then determines what has to be done, when, and where to realize the objectives set by the Asset Owner and agrees on a service level for performing work with the Service Provider(s). In turn, the Service Provider determines how the work is performed while keeping costs to a minimum for the specified levels of work and quality as agreed to with the Asset Manager.

The three roles operate in a chain and need each other to work closely together based on formalized agreements.

EXECUTIVE SUMMARY

Using the methodology described in the *Introduction* above, UMS Group assessed Hydro against ISO 55000 and best practice Asset Management on the following scale:



Notes on the use of the maturity scale:

- 1 As indicated by the colour transitions, the boundaries of the maturity scale are not hard values
- 2 Compliance with the AM Standard is at Competence maturity level 3
- 3 There is no upper limit to excellence as defined by the red colored zone

Overall, Hydro scored a 1.5 with the individual Business Unit Scores as follows: Generation Operations (GO) = 1.7, Transmission = 1.6, and Customer Service & Distribution (CS&D) = 1.3. While these scores may seem low compared to a competence standard of 3, it is important to realize that many North American utilities would rate a 0 (unaware of major Asset Management System requirements) or a 1 (aware of, but not yet developing). In addition, the individual components which make up these average scores ranged from 0.5 to 3.0 corresponding to the fact that while Hydro is fully Competent in some areas, there are others where it is just starting to develop its capabilities.

Against the industry, Manitoba Hydro compares favorably versus North American utilities in terms of its Asset Management maturity level. However, North America lags global Asset Management best practice as embodied by utilities overseas who have been developing their capabilities for more than two decades.

Hydro has followed a typical path along the Asset Management maturity curve by starting with grassroots-led tactical solutions to solve specific problems. As with many utilities, the initial role Leadership played at Hydro with regard to Asset Management has been providing approval and direction when requested. If Hydro seeks to become an asset management-focused company, Leadership will want to place a greater emphasis on the strategic value of asset management, challenge progress within the Business Units, demand accountability for results, and commit the resources needed to achieve its objectives.

Between the three Business Units, Hydro has developed a number of the key components of best practice asset management such as:

- The development of Asset Health Indices (AHIs) and use of Condition Assessment to drive replacement decisions;
- The use of risk (likelihood x consequence), rather than just criticality (consequence) to drive some replacement decisions;
- The use of Reliability Centered Maintenance (RCM) to develop maintenance plans based on specific asset failure modes; and
- The development of Computerized Maintenance Management Systems (CMMS) to tie together asset data, maintenance data, and cost information

In addition, Hydro has already identified a number of existing gaps and plans/actions to close these gaps are underway including:

- The recent adoption of a monetized risk-based decision-support tool for capital planning -- Copperleaf's C55 and the Corporate Value Framework (CVF);
- An alliance with Siemens which aims to develop sophisticated capabilities for managing, maintaining, and evolving Distribution assets; and
- A new CMMS (SAP Plant Maintenance (PM) – Enterprise Asset Management (EAM)) to improve the ability to tie costs to assets

However, there are also a number of key gaps which UMS Group has identified and for which no current initiative is underway to close. Below is a summary of these key gaps along with corresponding key recommendations. A detailed assessment which describes all gaps and all recommendations is provided in the following *Assessment* section.

Key Gaps

The Business Units, and sometimes the functions within the Business Units, have been operating with their own objectives and limits for making asset decisions, as there is confusion over the Asset Owner role. While the Corporate Asset Management Executive Council (CAM EC) has been chartered with most of the responsibilities of the Asset Owner, this role has not been formally communicated to the organization, nor have the Business Units been provided with concise direction on Policy, Strategy, and Objectives, although the CAM does have a plan to develop these over the next few months.

Responsibilities for Asset Management are divided with a lack of clear understanding of what constitutes the Asset Manager and Service Provider roles, as well as what the responsibilities and accountabilities of each are. In addition, the fact that Asset Management has developed independently in each Business Unit and that the Asset Management functions are split within the Business Units has led to a lack of standardization of processes (and systems) and hindered the sharing of best practices.

Risk is a key basis for decision-making in best practice asset management systems and Hydro is increasingly incorporating risk in its asset-related decisions today. However, there are no corporate risk standards, tolerance levels, or risk assessment requirement

to guide the Business Units leading to a situation in which risk is being avoided rather than managed.

Some of the key elements of an Asset Management System are missing from Hydro today. These include audits, controls, and performance metrics which Leadership can use to ensure the suitability, adequacy and effectiveness of the system.

Different functions within each business unit have different roles in the asset life-cycle leading to a situation where no one group or function is responsible for optimizing total asset life-cycle cost. In addition, most asset management efforts are focused on Capital spending with minimal attention given to optimizing O&M, which is a key part of the asset life-cycle.

While significant effort is being made to develop and implement sophisticated tools to support Asset Management, there is a lack of formal Data Management and Governance processes and metrics to ensure that sufficient data of sufficient quality is available to use with those tools.

Performance Management at Hydro is currently focused more on compliance than on driving improvement with few metrics available to identify opportunities to continually improve the asset management system.

Key Recommendations

Formally acknowledge the CAM EC's role as the Asset Owner by designating it such with the authority to oversee and approve the development of asset management policy, objectives, risk tolerance, and financial constraints and communicating this role to the organization.

Provide communication on acceptable risk for Manitoba Hydro by defining a risk tolerance level for key strategic objectives, defining a corporate standard for risk assessment, and creating a corporate standard risk register. Establish a formal process to regularly review risks identified by the business units and provide direction as a result of the review.

Decide on and declare the Operating Model for Asset Management – roles, decision-making processes, goals and key performance indicators (KPIs), and the timetable for implementing these changes.

Formalize the Asset Manager and Service Provider roles and clarify accountabilities with regard to responsibilities within the key asset management processes. Group the functions focused on asset management to create a life-cycle orientation in decision-making. Create an Asset Strategist role with overall responsibility for the integrated Asset Life-cycle Strategy. Use this role to develop and document Life-cycle Strategy Plans for key asset classes to optimize total cost

Develop processes and implement tools to address Operations & Maintenance (O&M) spend and the trade-off between O&M and Capital in each business unit. Establish the

preeminent role of the Asset Manager in making maintenance decisions, in terms of whether the maintenance is justified by cost versus benefit.

Develop a robust data governance structure to ensure data integrity and validity, and to enable effective data analysis for making asset-related decisions. Identify needed data to support asset management decision-making and assess where data repositories, data collection methodologies, data quality, etc. are out of alignment with needs.

Refine the current Performance Management framework to align asset objectives, plans and KPIs with performance reporting and accountability. Develop metrics for monitoring asset performance, asset management performance, and asset management system performance.

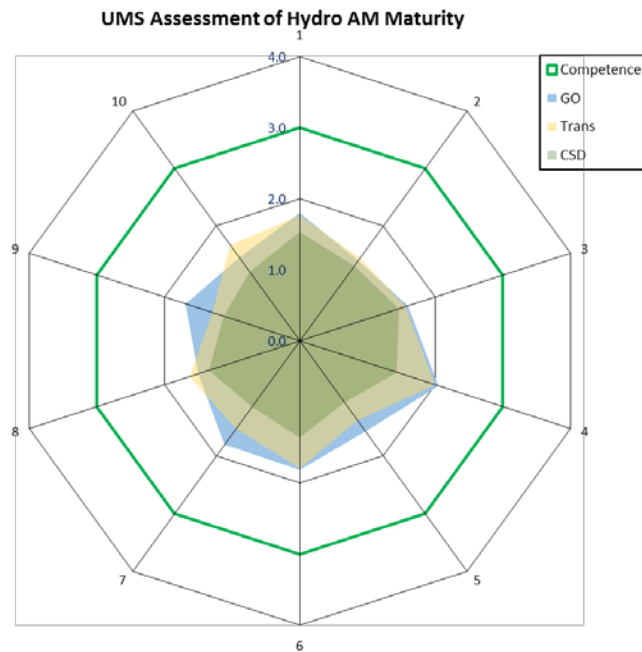
Develop controls and an internal review function for the asset management system to ensure corporate and business-unit level processes and procedures are being followed.

ASSESSMENT

Overall Assessment

UMS Group assessed Hydro against ISO 55000 and best practice asset management using a 0 to 4 scale where 0 = Innocence, 3 = Competence (in compliance with the standard) and 4 = Best Practice.

1	Context of the Organization
2	Leadership
3	Planning
4	Support
5	Operation
6	Improvement
7	Asset Life-Cycle & Risk Strategy
8	Investment Delivery Assurance
9	Performance Management
10	Data Management



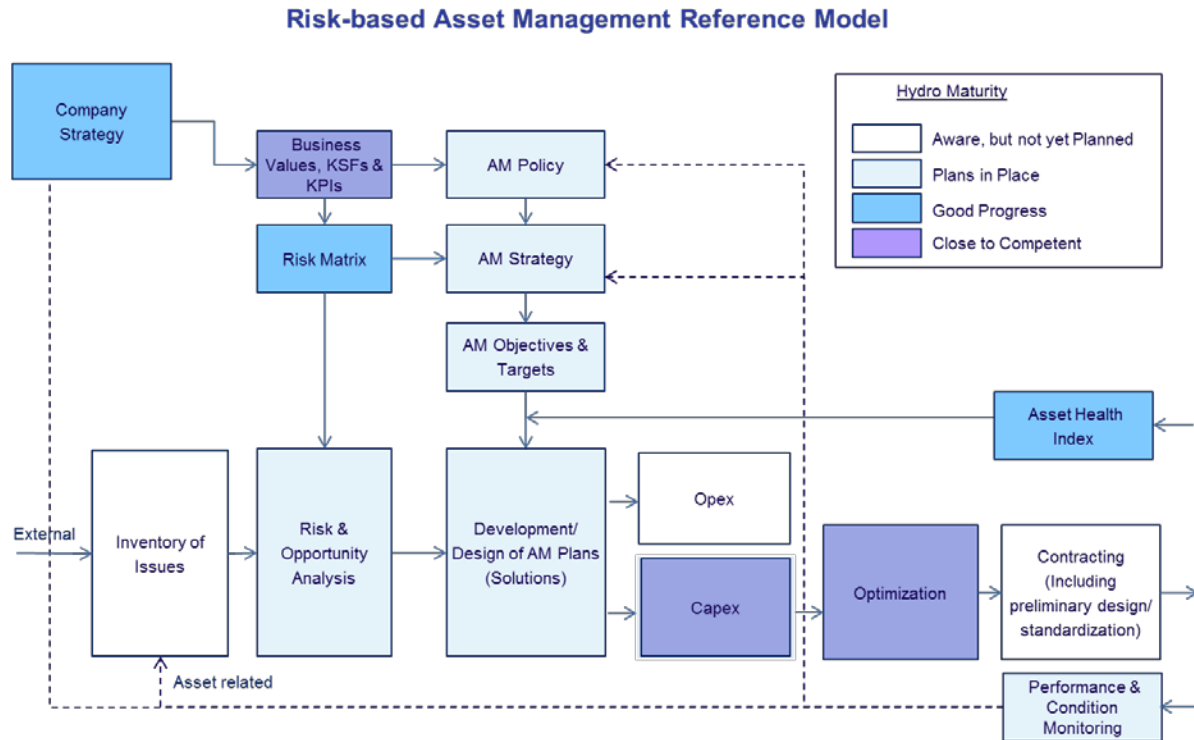
Overall, Hydro scored a 1.5 with the individual Business Unit Scores as follows: Generation Operations (GO) = 1.7, Transmission = 1.6, and Customer Service & Distribution (CS&D) = 1.3.

Each of the 10 domains evaluated has multiple components in which individual scores are averaged. These individual scores ranged from 0.5 to 3, so the averages reflect the fact that while Hydro is Competent in some areas (further described below), it also is missing some key components.

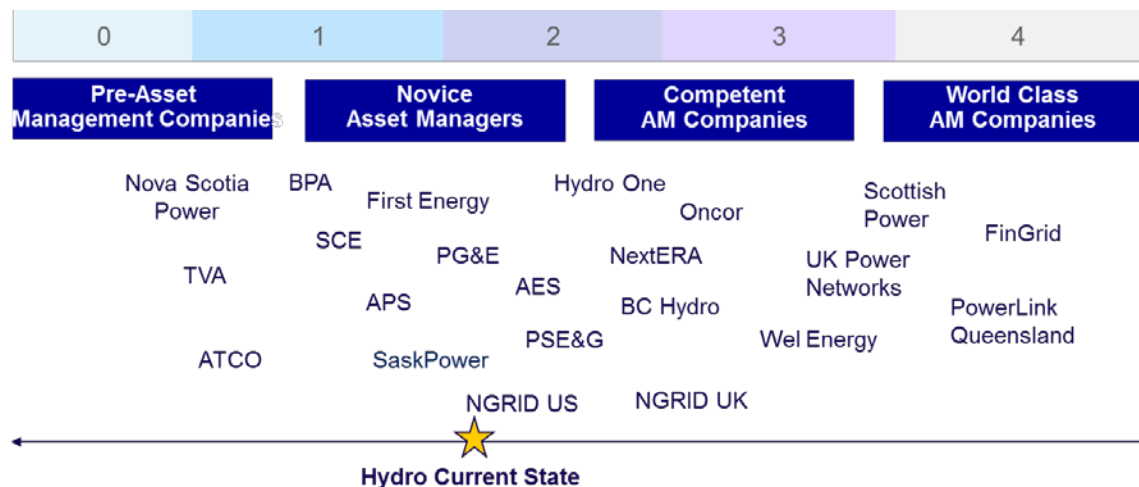
The recommendations provided in this assessment are those that are required to take Hydro to a 3 in every area, which would signify Competence with the ISO 55000 standard. Companies which reach this level, typically push forward towards Excellence (4.0) in a strategic manner where specific areas are targeted for improvement.

The specific level of competence to which Hydro should aspire is a matter for the Corporate Asset Management Executive Council (CAM EC) to determine. While, some of the benefits of Asset Management can be realized with a piecemeal approach, significant improvement only occurs when the entire Asset Management System is functioning at a high level.

The Chart below shows UMS Group's Reference Model for Asset Management. The colored boxes provide an indication of the level of maturity of specific



While its score may seem low compared to a competence standard of 3, it is important to realize that many North American utilities would rate a 0 (unaware of major Asset Management System requirements) or a 1 (aware of, but not yet developing). Overall, Manitoba Hydro compares favorably against North American utilities in terms of its Asset Management maturity level, 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.).



Note: The above positions reflect UMS' opinion of the relative AM maturity of each company based on a range of source information.

North America lags global asset management best practice as embodied by utilities in Australia, New Zealand, UK, and Northern Europe who have been developing their asset management capabilities for more than two decades and are generally considered global best-in-class. Most North American utilities fall into the Pre-Asset Management or Novice Asset Manager classification. Hydro is on the cusp of moving from the Novice to Competent stage, a process which takes most companies 3-5 years.



As part of its assessment, UMS Group led each of the Business Units through a Self-Assessment of Asset Management Maturity (see Appendix A for details). The table below shows a comparison of the Hydro Self-Assessment scores for each Business Unit, along with the UMS Assessment scores.

	Hydro Self-Assessment			UMS Assessment		
	GO	Trans	CSD	GO	Trans	CSD
Context of the Organization	1.8	1.5	1.9	1.8	1.8	1.5
Leadership	1.8	1.3	1.6	1.4	1.4	1.3
Planning	1.8	1.8	1.3	1.6	1.6	1.5
Support	2.4	2.2	1.2	2.1	2.0	1.4
Operation	2.3	2.0	0.8	1.6	1.4	1.1
Improvement	1.9	2.1	0.8	1.8	1.8	1.4
Asset Life-Cycle & Risk Strategy	1.3	1.6	0.7	1.8	1.5	1.1
Investment Delivery Assurance	1.8	1.4	1.1	1.5	1.6	1.3
Performance Management	1.8	1.1	0.8	1.7	1.3	1.1
Data Management	1.4	1.9	1.0	1.5	1.7	1.2

Detailed Assessment

In its assessment, UMS Group identified a number of gaps in Hydro's Asset Management capabilities and developed recommendations for closing those gaps. These gaps and their corresponding recommendations have been grouped into seven major themes which

provide a logical structure for understanding what best practice in that area looks like, what the gaps are for Hydro in that area, and how Hydro can close the gaps in that area. The themes are described below:

- Leadership – Addresses the elements of direction, oversight, and control which are needed to guide the development and operation of Asset Management System at Hydro
- Risk – Addresses the responsibilities of the Asset Owner to establish risk tolerance and standards for risk assessment for the company, as well as to review and direct the application of risk management by the Asset Manager.
- Roles and Responsibilities – Addresses the accountability model for the three key roles in the Asset Management System – Asset Owner, Asset Manager, Service Provider.
- Consolidation of Functions – Addresses the need for organization along process rather than functional lines, as well as the need for a bringing together all pieces of the asset management function to ensure a lifecycle focus on the assets.
- Lifecycle Optimization – Addresses the elements required to ensure that asset decisions are made based on total lifecycle costs. These elements include processes, data, and tools.
- Performance Management – Addresses the components of performance management needed to support asset management. These components include metrics on asset, asset management, and asset management system performance, as well as feedback loops to drive continuous improvement.
- Data and Technology – Addresses the systems and data requirements needed to support the Asset Management System, in addition to data governance and analytical capabilities.

The assessment detailed below is focused on a corporate level and cross-functional assessment. For the individual Business Unit assessments, please refer to Appendices C (Generation Operations), D (Transmission), and E (Customer Service & Distribution).

Leadership

Leadership throughout all levels and across all business units at Manitoba Hydro has been a substantive and critical element in the continuous development of the Asset Management system. Corporate Leadership has recognized the role that Asset Management can play in ensuring that scarce resources are optimally deployed and wishes to further leverage the already considerable progress Hydro has made in this area to achieve greater stability in financial and operational planning, more informed decision-making regarding investment in assets, and enhanced collaboration across the business units.

Best Practice

Leadership demonstrates leadership and commitment to asset management by:

- Ensuring that Asset Management Objectives, Policy, and Strategy are established and compatible with the organizational objectives
- Communicating the importance of effective Asset Management
- Promoting cross-functional collaboration within the organization and continual improvement

Leadership ensures that the responsibilities and authorities for relevant roles are assigned and communicated within the organization.

Leadership exercises control over the Asset Management system to ensure conformity and effectiveness and identify the need for corrective action.

Assessment of Hydro

Corporate Leadership has not formally communicated to the organization its role as the Asset Owner, nor yet provided the Business Units with concise direction on Policy, Strategy, and Objectives. The absence of a clearly identified Asset Owner at Hydro has led to the Business Units (and sometimes the functions within the business units) operating on their own objectives and limits for making asset decisions, as well as created confusion as to who is being held accountable as the Asset Owner.

The Corporate Asset Management Executive Council will be an important permanent mechanism and is the natural nexus for the role of Asset Owner. It should be formally endowed with that responsibility as well as the task of translating the Business Strategy of the corporation into specific asset management goals and objectives each year.

Similarly, the Corporate Asset Management Steering Committee is an excellent multi-functional body and governance aid for driving Hydro's asset management transformation. Its existence should help channel and accelerate the progress made in Asset Management adoption in each of the three business units by assuring consistency and encouraging shared lessons learned and best practices. The membership is at the right level and has the right diversity to ensure that all required perspectives and capabilities are brought to bear on this significant set of challenges.

Key elements of a mature asset management system that should exist are missing from Hydro today. These include management system audits, controls, and performance metrics which Leadership can use to ensure the suitability, adequacy and effectiveness of the asset management system.

Hydro's assets are long-lived so decisions made today have repercussions decades into the future. The new leadership has yet to express its long-term vision for how it sees the energy industry changing over the next 10, 20, and 40 years, nor for the role that Hydro will play in the industry. Lack of this strategic direction will hamper the Business Unit's ability to develop effective asset strategies to achieve that vision.

Recommendations

1. Decide on and declare the Operating Model for Asset Management – structure, roles (i.e., responsibilities, authorities, accountabilities, internal & external relationships, etc.), decision-making processes, goals and key performance indicators (KPIs), and the timetable for implementing these changes. (Note: more detail is provided in the *Implementing an Operating Model* section below)
2. Formally acknowledge the CAM EC's role as the Asset Owner by communicating to the organization its role in overseeing and approving the development of asset management policy, objectives, risk tolerance, and financial constraints, as well as the responsibility for overseeing the development and update of the Corporate Asset Management Strategy. The Vice President of Strategy and Business Transformation should be added to the CAM EC roster and its charter clarified regarding the responsibility for setting the tolerance/limits that will drive asset-related decision-making. (Note: more detail is provided in the *Implementing an Operating Model* section below)
3. Change the focus of decision-making within the Business Units away from “being the best” towards meeting defined Asset Management Objectives in the most efficient way possible. This means assessing alternatives not solely on their performance or system impact, but also on the cost efficiency of their impact. It also implies an understanding that once an objective has been met, exceeding that objective is an inefficient use of resources that could be more productively applied elsewhere.
4. Develop a formal Asset Management Roadmap and Asset Management Strategy for Hydro. Not only would these documents assist in communicating Leadership's vision for asset management throughout the organization, but they would also provide a guide to ensure that the processes and tools being developed are effectively integrated.
5. Transition to a more competitive process for capital across the Business Units. With the implementation of Copperleaf C55 and the Corporate Value Framework (CVF, Hydro should be able to more directly compare the value of Generation, Transmission, and Distribution projects in terms of monetized risk reduction. While it would be impractical to make the entire capital budget competitive due to resourcing issues, these tools will provide the opportunity to set aside a portion of the budget for competitive projects. This portion should start small and grow over time in line with Management's comfort level with the results.
6. Once the asset management policy, vision and objectives have been clarified, develop and deliver a road show to communicate these changes and their implications for all groups across the organization.

Risk

Hydro is using risk to support its asset management decisions, mainly with regard to Capital Planning. The rigorousness of risk assessment and risk management varies both across the Business Units and within individual Business Units. In addition, risk is just beginning to be monetized (i.e., converted from qualitative impact to a quantitative cost) in most cases, although Generation Operations has been using risk of lost revenue to justify investments. No corporate level risk tolerance has been communicated leading to differing levels of risk avoidance driving decisions made in different parts of the business.

Best Practice

The Asset Owner has defined risk tolerance levels for the key strategic objectives and identified a minimum standard of risk assessment for the Asset Manager

The Asset Owner has established a formal process to regularly review and discuss risks identified by the Asset Manager, and to provide direction to guide decision-making.

A corporate standard and process exists for identifying risks, assessing them against risk tolerance levels, identifying mitigation actions, assigning ownership for mitigation, and tracking action on mitigation. This information is captured in a risk register.

Assessment of Hydro

Risk is a key basis for decision-making in best practice asset management systems. While Hydro is incorporating risk in its asset-related decisions today and implementing more sophisticated risk monetization tools (e.g., C55 / Corporate Value Framework), guidance on and attention to asset-related risk from Leadership has not been provided.

This lack of clear communication on an acceptable “risk tolerance” has led middle managers to use their individual perception of risk levels in the business to make decisions generally resulting in risk avoidance. This risk adverse posture may be too conservative and therefore push up the life-cycle cost of assets due to decisions on design, spares, and maintenance. These factors are targets of opportunity in moving to a more mature Asset Management System in which risk is proactively “managed” rather than “avoided.”

In Generation Operations (GO), outside of Dam Safety, minimal risk assessment is performed on assets. Without asset-level risk assessment, it's difficult to determine which risks need to be mitigated, what opportunities exist to accept more risk (i.e., current risk is below tolerance level), and what strategies should be adopted to manage risk. While GO capital planning processes use risk-based modeling to drive decisions, risk is essentially defined as lost revenue potential. Other types of risk (e.g., safety, environmental, etc.) are not monetized today; however, this should change with the implementation of the CVF.

In Transmission, only HVDC is currently performing risk assessments for their systems and developing mitigation strategies. However, no formal risk register or risk assessment process exists for assessing risk at the asset (rather than project) level for the other Transmission functions. Transmission has made a good start in terms of using risk and

criticality in prioritizing projects through development of the System Reliability Risk Model (SRRM) and the Capital Budget Ranking Tool (CBRT). While the SRRM is a quantitative assessment of risk, the CBRT is largely based on a qualitative assessment of risk.

In general, Customer Service & Distribution (CSD) is relatively immature in the measurement and use of risk to drive decision-making. Risk assessment, in most cases, is qualitative and not quantitative. The CSD Business Plan does include a formal high level risk assessment on key threats to the system, and as part of its Asset Condition report, CS&D also has a Risk Evaluation Framework where the different types of risks have been identified, likelihoods developed and risks assessed for the major asset classes. However, this risk assessment is essentially qualitative, rather than quantitative, and does not monetize non-financial risks. Finally, while no risk register exists for electric distribution assets; there is one for gas assets.

Recommendations

7. Provide more oversight and communication on acceptable risk for Manitoba Hydro by defining a risk tolerance level for key strategic objectives, identifying a minimum standard of risk assessment for the business units, and establishing a formal process to regularly review risks identified by the business units and to provide direction as a result of the review.
8. Implement a corporate risk assessment methodology and a risk register addressing each key asset class to identify asset-specific risks, assess them against risk tolerance levels, determine which risks need to be mitigated, create mitigation actions, and track risk status and mitigation.

Roles and Responsibilities

Hydro lacks clarity around the various asset management roles mainly due to a lack of understanding of what the roles are and how they are intended to interact with each other. This lack of clarity has led to a diffusion of responsibilities resulting in a lack of accountability, as well as disagreement over whether some asset management related processes/procedures are rules or suggestions.

Best Practice

The organization has clearly delineated between the Asset Owner (AO), Asset Manager (AM), and Service Provider (SP).

The organization has defined the accompanying responsibilities, authorities, and accountabilities for each role.

Each part of the business understands and accepts the importance of its role in Asset Management.

Assessment of Hydro

The role of the CAM EC as the Asset Owner is not well understood within the organization. In addition, its responsibilities do not appear to be fully understood by all the CAM EC's members.

In each Business Unit, responsibilities for Asset Management are divided and/or unclear. There is a lack of understanding of what constitutes the Asset Manager and Service Provider roles and what the responsibilities and accountabilities of each are. This has led to an environment in which many asset management decisions tend to be made by committee/consensus. The result is that no one is ultimately accountable for the results.

Questionable clarity of goals and responsibilities for individual managers constrains the level of accountability that can be established and enforced. In addition, there is a lack of good practices for holding people accountable and imposing consequences for failure to meet performance targets. For example, measuring productivity across crews, etc. does not seem to be a priority.

Recommendations

9. Formalize the Asset Manager and Service Provider roles within each business unit and clarify accountabilities with regard to responsibilities within the key asset management processes. While the roles do not need to be identical within each business unit, they should be relatively consistent in accountabilities and relationships between key positions. (Note: more detail is provided in the *Implementing an Operating Model* section below)

Consolidation of Functions

The Asset Management functions within Hydro all exist within the business units, rather than at the corporate level. Within each business unit, the various functions are generally spread out among different groups, rather than in one department. In some cases, functions may be duplicated in different departments, to serve specific asset classes that department is responsible for.

Best Practice

The organization appoints (i.e., grants authority to) an owner for each decision and attaches full accountability for the results of the decisions made by that person.

Functional silos are broken apart and restructured into process and responsibility groups.

The organization considers the unique, environmental and political conditions in which it operates and evaluates the trade-offs in synergy and scale versus jurisdictional differences, regulatory drivers and operational uniqueness between functions.

Assessment of Hydro

Asset Management is fragmented across and within the Business Units and the nature in which these silos operate hinders standardization of processes (and systems) and limits the sharing of best practices. While the recent development of an Asset Management Governance Structure (CAM EC and CAM SC) is designed to help remedy this situation, a significant effort will be needed to overcome the existing culture (particularly at lower levels) in which functions and business units are focused primarily on their own interests and responsibilities, rather than those of the company in general.

The fragmentation of Asset Management has also resulted in a duplication of effort and inefficiencies as groups develop their own processes and tools rather than adopt (or modify) those already developed by other groups.

The use of steering committees to make decisions, is a good approach to speed agreement and strengthen ownership. But it will likely slow the rate at which Hydro can make major change in the organization, and will diminish the value Hydro will be able to extract from Asset Management. Compromise is the hallmark of steering committees and usually dilutes the power of resulting decisions. Best performing organizations tend toward decision-making systems that appoint (i.e., grant authority to) an owner for each decision, and attach full accountability for the results of the decisions made by that person.

Recommendations

10. Develop an organizational structure for Hydro which consolidates asset management functions to reduce redundancy and speed development of competency across the corporation. This can either be a centralized model with one Asset Management group serving all the business units, a decentralized model where each business unit has its own Asset Management group, or a hybrid model where some Asset Management functions are in a central group and others are in the business units. (Note: more detail is provided in the *Implementing an Operating Model* section below)
11. At either the Corporate or Business Unit level (depending on the model chosen), group the functions focused on asset management in a single group to create a life-cycle orientation in decision-making. Provide adequate resources to ensure that asset management processes can be successfully executed. (Note: more detail is provided in the *Implementing an Operating Model* section below)

Lifecycle Optimization

Hydro has few processes focused on life-cycle management or life-cycle optimization of the assets. What consideration is given to life-cycles is done in an ad hoc manner with no defined methodology or tools to support such analysis. Hampering Hydro's ability to address life-cycle costs is the fact that the various life-cycle processes are split into different functional groups within the business units. In addition, no single person or group has accountability for managing the assets' life-cycles.

Best Practice

The organization manages its assets with a view towards optimizing the total cost of the asset over its life-cycle.

The organization develops life-cycle strategies for each major asset class which detail how the life-cycle cost of the asset will be optimized while meeting the AM objectives

The organization has an Asset Strategist function which is responsible for the development of the Asset Management Plans for key asset classes

The organization utilizes asset condition data and the probability of failure to drive decision-making about use of sustaining capital.

Assessment of Hydro

There is no assigned accountability for addressing the full asset life-cycle. As different functions within each business unit have different roles in the asset life-cycle (i.e., specifications, procurement, spares, design, construction, operation, maintenance, replacement), decisions are being made to optimize only that part of the life-cycle, resulting in sub-optimization over the total asset life-cycle.

The financial focus of asset management at Hydro is on Capital spending, with minimal attention given to optimizing O&M (i.e., are we doing the right work, are we working efficiently, do we have the right resource mix, etc). This has led to a dearth of processes and tools to support effective decision-making around O&M expenditures, as well as weak productivity management. As operations and maintenance decisions have significant impacts on asset life, life-cycle optimization requires these functions to be managed with the same rigor as capital.

Asset Life-Cycle Plans have not yet been developed for each asset class. This has resulted in the lack of integrated strategies intended to optimize total life-cycle costs. As no clear accountability for Asset Life-cycle Strategy has been assigned, the current ability to generate these plans is questionable.

A relatively advanced Maintenance Engineering function exists with skills (Reliability Centered Maintenance (RCM), Root Cause Analysis (RCA), Preventive Maintenance (PM) Optimization, etc.) which will provide a solid foundation for developing Asset Life-cycle Strategies moving forward. Transmission Apparatus' RCM program is one of the most advanced that we've seen in a North American utility.

In addition, fairly comprehensive condition/inspection strategies and lifecycle approaches have been developed for some critical asset classes. While not full scope life-cycle strategies, these strategies are a step in the right direction.

While capital planning and maintenance planning processes are both strong, they are not integrated so it's difficult to optimize or even understand lifecycle costs when making capital planning decisions, or to trade-off maintenance/capital alternative solutions.

Recommendations

12. Develop and document Life-cycle Strategy Plans (also referred to as an Asset Management Plan in ISO 55000) for the key asset classes, which detail the assets and their current state, evaluate the trade-offs among Asset Management Objectives (including risk), and define an integrated strategy to be followed to optimize life-cycle costs in each area of the asset life-cycle (design, procurement, construction, operation, maintenance, replacement/retirement).

13. Review existing design specifications and maintenance plans with an eye towards life-cycle optimization. Challenge overly conservative, risk adverse standards, and consider varying application based on criticality, age, condition, etc.
14. Create an Asset Strategist with overall responsibility for the integrated Asset Life-cycle Strategy of specific asset classes. This role can be direct in the form of a person who develops the life-cycle strategy with his/her team or indirect in which a person facilitates the integration of content from the various organizations/functions.
15. Develop processes and implement tools to address O&M spend and the trade-off between O&M and Capital in each business unit. This would include establishing the preeminent role of the Asset Manager in making maintenance decisions, modeling the cost/benefit of different maintenance strategies, assessing the value of corrective maintenance vs replacement, and identifying innovative tools and practices for improving maintenance efficiency/effectiveness.
16. Integrate O&M into the existing processes used for optimizing capital spend. This would include using concepts like Asset Health Indices (AHIs), failure probability, and consequence of failure to drive maintenance decisions.
17. Increase the capabilities of processes and tools to enable assessment of the assets as a group. While this type of analysis is performed manually today, existing processes and tools should be adapted to support these analyses. For example, GO shouldn't just consider whether to refurbish a specific unit, but also whether it makes economic sense to maintain smaller and less economic hydro facilities and the dams that support them.
18. Where they don't exist today establish AHIs for all key assets and transition from technical life serving as the basis for driving replacement, to economic life driving such decisions. To the extent possible, AHIs should be based on condition data and failure curves should be based on actual failures experienced at Hydro.

Performance Management

Hydro currently has a performance management framework that is focused on ensuring that work was performed, rather than on identifying opportunities for improvement. In addition, few metrics exist to measure asset management performance or asset management system performance. There is no formal link between asset metrics and investments, so Hydro is unable to ensure that its investments are delivering the benefits promised.

Best Practice

The organization has a set of processes for consistently identifying and implementing continuous sustainable improvements across the business. A framework aligns asset objectives, plans and Key Performance Indicators with performance reporting and accountability, and drives a balance between leading and trailing operational indicators.

There are controls and an internal review function for processes to ensure they are being followed. Additionally, performance metrics are line-of-sight to ensure continuity in performance evaluation and corrective planning.

To assure that investments are meeting their objectives, there is a robust process which ensures that approved investments are delivering the benefits that they are expected to provide. In addition, the performance management framework which supports this Investment Delivery Assurance process tracks budget performance and asset management performance.

Assessment of Hydro

Performance Management at Hydro is currently focused mainly on compliance, with inadequate attention paid to driving improvement. Metrics are designed to ensure work was performed on time and that reliability/availability/safety targets were met, essentially ensuring compliance with processes and procedures. However, they do not provide the degree of insight needed to identify opportunities to continually improve the asset management system.

While a Transmission Asset Strategies function has also been created to propagate best practices across the functions and try to drive consistency across processes within the Business Unit, there is no organized process for identifying asset management best practices/ processes/tools, assessing their effectiveness, and implementing them across the business units. While individuals are participating in industry groups, attending technical conferences, and meeting with vendors, greater efficiency can be achieved with a defined process and assigned roles and responsibilities. Within best practice Asset Management organizations, this process is typically called “Industry Intelligence” and includes benchmarking, new technology monitoring, industry outreach, etc.

Performance metrics are focused mainly on reliability/availability, rather than cost efficiency, making them most effective at monitoring work rather than driving improvement. No metrics exist to measure workforce productivity, work management effectiveness, work quality, etc. Asset performance is measured at the aggregate level rather than at the asset class level and does not tie performance results back to initiatives (i.e., maintenance or replacement) to measure and assure the capture of benefits.

Recommendations

19. Develop controls and an internal review function for the asset management system to ensure corporate level and business-unit level processes and procedures are being followed. The review process should both address the sufficiency of the controls and identify any process issues that may require corrective action.
20. Improve performance accountability by refining the current Performance Management framework to align asset objectives, plans and KPIs with performance reporting and accountability, and drive a balance between leading and trailing operational indicators. Develop metrics for monitoring asset performance, asset management performance, and asset management system performance. While these metrics will differ

somewhat by business unit, they should be consistent in the type of performance they measure.

21. Create a Resource Optimization capability to measure and assure workforce operational effectiveness, efficiency/productivity, and appropriate staffing levels for each business unit and functional groupings within.
22. Create an Investment Delivery Assurance process that tracks execution of approved investments to ensure they are completed, assesses if they are delivering the benefits anticipated, prioritizes work in alignment with business objectives, exercises (or ensures) quality control / quality assurance oversight of work, and drives continuous improvement by the Service Provider.
23. Define and implement a corporate-wide process for identifying and sharing Asset Management best practices. This function would be responsible for identifying best practices in processes, tools, practices, etc. within the Business Units or from outside Hydro, sharing them, and assisting the Business Units in connecting with the right personnel to drive assessment and implementation. This role would be best performed by a corporate level entity, but could also be performed by a team made up of representatives from each business unit.

Data and Technology

Hydro currently lacks formal structures and processes around Data Governance and Data Management. Data quality varies greatly between and within the Business Units with the main driver for quality being use of the data (i.e., data not currently used tends not to be as good quality as that being used). As each Business Unit has developed their own Asset Management/Maintenance Management technology, there is a variety of systems in use with varying capabilities. While some of the systems, such as RMS, have advanced capabilities and perform as well or better than packaged software, the existence of multiple systems performing the same function implies a duplication of effort and inefficient use of resources.

Best Practice

Appropriate enabling technology has been implemented to support the decision making process by providing timely, accurate, accessible data along with tools to support the asset management analyses that need to be performed.

The organization has a data governance structure which ensures data integrity and validity to enable effective data analysis for making asset-related decisions.

There are defined processes for resolving data issues and performance metrics around data quality, consistency and availability.

The organization has a Data Architecture and Asset Register which supports condition, failure, and performance data for assets.

The organization utilizes technology to automate data collection and minimize errors.

Assessment of Hydro

There is no formal Data Governance structure or accountability for Data Quality within the Hydro business units. While efforts are being made to improve and assure data quality within the business units, formal processes and metrics still need some improvement.

Significant effort is being made to develop and implement sophisticated tools for calculating Asset Health Indices (AHIs), determine probability of failure, perform economic modeling, etc. However, it doesn't appear that sufficient condition data currently exists to support these tools on a wide-scale basis.

Current analytical processes and tools to support decision-making using "big data" are rudimentary. This lack of tools has resulted in large condition data sets (i.e., vibration analysis) not being leveraged to the extent possible due to lack of resources to perform unaided, manual analysis.

Different tools and methodologies are being used for key asset management processes. While these tools work well for their intended purpose, this replication of functionality hinders the ability to drive consistent practices across the business unit and is likely an inefficient use of resources.

While some of the Business Units have developed Asset Management Roadmaps/Strategies to guide the development of tools needed to support asset management, there is no such corporate plan to guide efforts or set boundaries for which decisions can be made at the Business Unit level and which at the Corporate level.

The role of Information Technology (IT) in supporting Asset Management is not well-defined in terms of whether it is a control function or support for the Business Units. This has led to a lack of clarity around IT decision-making and been a contributing factor to the number of different systems performing duplicate functions. Hydro has also not set a corporate standard of preference for large, permanent IT solutions that provide consistency and consolidation versus smaller, more flexible approaches which may be less expensive and quicker to implement, but lack integration and may duplicate functionality.

Recommendations

24. Develop a robust Data Governance structure to ensure data integrity and validity, and to enable effective data analysis for making asset-related decisions. The Data Governance structure should have a cross-functional steering group, assigned data stewards in each business unit, clear roles/responsibilities/accountabilities, a defined process for resolving data issues, and performance metrics reported and trended for data quality, consistency and availability.
25. Perform a Data Inventory and Gap Assessment to identify needed data to support asset management decision-making and assess where data repositories, data collection methodologies, data quality, etc. are out of alignment with needs. This will differ by business unit as each has differing levels of data quality. Assess the cost of

collecting needed data vs. the benefit of the data as a precursor to developing a plan to close gaps.

26. Improve AHIs by using more objective, rather than subjective, data; using multi-variate regression to determine weightings, and including failure multipliers (i.e., manufacturer, vintage, operating hours, etc.) as part of the algorithms.
27. Develop a plan/roadmap for improving analytical capabilities to support asset management decision-making using large data sets. The focus should be on moving away from using generic data or averages to support decisions to using very specific data to get to a greater level of granularity. This will likely require new tools as well as new skill sets and perhaps new resources (i.e., data scientists / data analysts).
28. Improve data quality by ensuring that the Field/Plant understands what the data will be used for, highlighting the importance of the data to decision-making, and providing aids to assist in providing good quality data (e.g., examples of degradation/failures, drop-down lists / check boxes, etc.)

IMPLEMENTING AN OPERATING MODEL

In the Assessment above, the first recommendation made is for Hydro to decide on and declare the Operating Model for Asset Management. Asset Management has grown organically at Hydro without a defined Operating Model. This has led to confusion over roles and responsibilities, duplication of efforts, and key gaps in capabilities. While the recommendations above are not listed in priority order (instead they are listed by theme), the Operating Model is important because it defines the key components by which Asset Management will be used to deliver value to its stakeholders. Furthermore, creation of the Operating Model, if done in a collaborative manner, helps build alignment among the Executive Team on the key components – Organization Structure, Roles and Responsibilities, Process Ownership, and Accountability.

Organization Structure

Hydro's current organization structure, with split accountabilities and responsibility for asset management functions diffused throughout the business units, does not provide the optimal platform for enhancing its Asset Management maturity. As identified in the gap assessment, there is significant value in consolidation and reorganization.

There are a number of variations in organization structure used for the Asset Management process model today as multiple approaches to organization can be implemented to successfully manage the business. Typically, the structural variations in organization revolve around the following:

- Where the asset management organization reports within the business
- The level of centralization/decentralization within the Asset Management organization
- The number and focus of groups within the Asset Management organization itself

Various combinations of these can be found within utilities today and competent Asset Management can be performed in a variety of structures as long as roles and responsibilities are clearly defined and processes are in place to support the key asset management functions. Therefore, organization structure decisions are typically driven by existing constraints, culture, and the relative priority of objectives. For example, if resources are constrained or consistency is a key priority, then a centralized model may make more sense. If a premium is placed on keeping close alignment between Asset Management and the Field or there is a desire to identify Best Practices by trialing different methodologies/tools, a decentralized model might be preferred

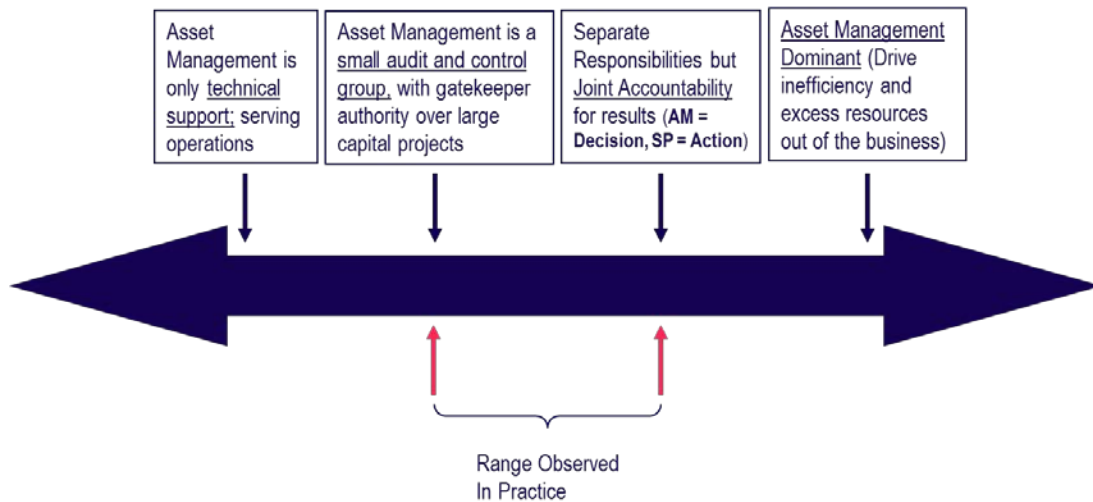
There are also variations in the split of activities between Asset Management and the Service Provider (i.e., the Plant or Field force). These typically occur in the following areas:

- Outage planning and management
- Outsourcing / Contractor Management

- Work planning and scheduling
- Equipment performance management
- Maintenance standards and program design

As with organization structure, the split of activities varies among companies. The key factor is that regardless of the split, Asset Management should have Governance and Oversight of these activities. As long as the oversight is in place, where the actual performance of the activity occurs should not have a significant impact on outcome.

Finally, there are variations in the relationship and degree of separation between the Asset Management group and the Service Provider. These range from “one side dominant” to “balance and partnership.” This division is usually driven from historical relationships and authority bases. Getting this relationship correct is a significant element in making the organization work in the Asset Management process model. As with organization structure, the decision where to set this point on the continuum is dependent on the corporation’s culture, management style, and objectives.



With regard to the organization itself, there are three main alternatives for an organization seeking to align its structure with best practice Asset Management – Centralized, Decentralized, and Hybrid.

In the Centralized model, there is one corporate Asset Management group which houses all the Asset Manager functions. Typically this group is led by an Executive at the same level of the leaders of the Business Units to ensure it has equal standing in corporate decision-making. The advantages of the Centralized model are as follows:

- Asset Management sponsorship by an Executive with a strong mandate from the CEO and Board can accelerate competence development
- Moving asset strategy decisions from the functional organizations into a central Asset Management group may increase ability to embrace bolder changes
- Provides more consistency in risk management, asset lifecycle strategies, and how tradeoffs are made between Capital and O&M

- Startup cost for new tools and skills development are likely to be lower

The disadvantages of the Centralized model are as follows:

- Requires one additional Executive position
- There is a risk that culture change across the organization may be less sustainable
- Functional Vice Presidents and Division Managers may be less supportive of Asset Management
- Loss of stature among functional managers may raise resistance to Asset Management
- Central group focus on highest leverage areas may disenfranchise and leave other groups behind
- Can lead to misalignment among the executive team and require more direct involvement of the CEO

In the Decentralized model, there is an Asset Management group which houses all the Asset Manager functions within each Business Unit. The advantages of the Decentralized model are as follows:

- Provides a single point of accountability for operating and business results within each Business Unit
- Enables the ability to customize Asset Management solutions to the specific assets within each business unit
- Asset Management sponsorship by functional Vice Presidents can have a larger impact on culture change than a “central program”
- Leveraging lessons learned across three separate Asset Management groups can help accelerate progress

The disadvantages of the Decentralized model are as follows:

- There is a risk of different standards for risk management, asset lifecycle strategies, and tradeoffs between OPEX and CAPEX being adopted across the Company
- Typically takes longer to drive sustainable culture change across the organization
- If Asset Management advocacy by the functional Vice Presidents is tepid, can dramatically reduce the likelihood of success
- Requires more total resources and startup cost for new tools and skills development is likely to be higher

In the Hybrid model, there is a central Asset Management group which houses some of the Asset Manager functions, while others are within each Business Unit. The advantages of the Hybrid model are as follows:

- Supports a more consistent approach than the Decentralized model while also supporting a greater degree of business unit asset strategy customization than the Centralized model
- Reduces some of the duplication of effort found in decentralized structures
- Provides more control over processes that requires greater corporate oversight
- More likely to generate support from functional Vice Presidents than Centralized model
- Having the Asset Strategy function close to the Field (i.e., under the functional Vice Presidents) is more likely to generate support and alignment from Field for Service Provider role

The disadvantages of the Hybrid model are as follows:

- More resource intensive than either the centralized or decentralized model
- Can lead to differing levels of competence in the Functional Areas
- Can lead to confusion on accountability for areas of joint responsibility
- May generate disagreements over “boundaries” between Central group and Decentralized groups

UMS Group believes that any of these models could work for Hydro; however, each comes with its own challenges. The Centralized model would be the most efficient in terms of resource use and would provide the most consistent application of Asset Management. However, it would also likely be the least effective in driving the culture change needed in the Field/Plants to successfully achieve a high level of performance.

The Decentralized model would be the easiest to implement as Asset Management functions are already in the business units today and the close link that already exists between these functions and the field would speed culture change. However, decentralization will require more resources overall and will also require additional effort to ensure consistency.

The hybrid model is a trade-off between these two. By consolidating Asset Management governance and key functions where consistency is most important, Hydro can drive faster change throughout the organization, yet still keep a close connection with the Field in functions like Maintenance Engineering and Life-Cycle Strategy. However, this is likely to be the most resource intensive model and runs the risk of confusion / loss of accountability over results.

Rather than recommend that Hydro adopt a specific model, UMS Group views its role as assisting Leadership in understanding the pros and cons of the different alternatives and facilitating a discussion of which structure makes the most sense for Hydro given its current situation and strategic objectives.

Roles and Responsibilities

Developing an Operating Model will require defining the roles and responsibilities of the Asset Owner, Asset Manager, and Service Provider, as well as designating who in the organization will fulfill these roles.

The Asset Owner's role should be to translate stakeholder needs & objectives into Asset Management business values, critical success factors and key performance indicators. The CAM EC is well positioned to fill this role and should be declared the Asset Owner, with the inclusion of the Vice President of Strategy and Business Transformation as part of this group.

The Asset Manager's role should be to translate the Asset Management business values, critical success factors and key performance indicators into asset investment and maintenance strategies and plans in keeping with the Asset Owner's capital and operating cost constraints and risk tolerance. Specifically, the Asset Manager should:

- Manage and monitor assets
 - Develop and maintain asset register
 - Monitor asset conditions
 - Develop preventive maintenance and diagnostic programs
 - Optimize PM plans based on asset condition and diagnostic program results
- Develop asset strategies and plans
 - Convert owner's needs and objectives into an asset management plan
 - Develop business cases for investments and retirements against a consistent standard
 - Prioritize asset investments given Asset Owner's capital resources and strategy
 - Develop asset life-cycle plans and risk strategies
 - Manage capital projects
- Manage service provider use of assets
 - Provide budgets to Service Provider for routine maintenance and investments
 - Define annual work program and maintenance strategy/standards
 - Monitor and manage service provider performance via Service Level Agreements (SLAs)
 - Define requirements for Service Provider reporting on asset condition
 - Respond to Service Provider's issues with assets

The Service Provider's role should be to operate and maintain the assets in order to achieve the Asset Owner's critical success factors and key performance indicators and

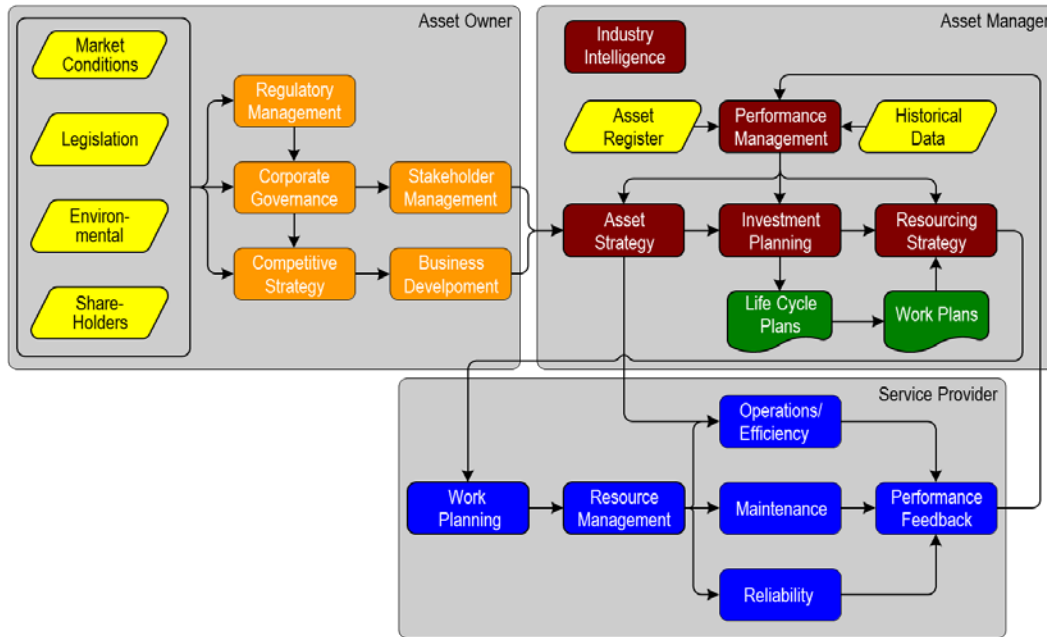
within specifications, operating limits, maintenance standards and asset plans set by the Asset Manager. Specifically, the Service Provider should:

- Operate the asset
 - Deliver performance results to the Asset Manager per SLA
 - Operate the assets within specified limits
 - Provide Asset Manager with operational performance data
- Maintain the asset
 - Maintain the assets per the Asset Manager's maintenance plan
 - Provide condition information to the Asset Manager
 - Provide maintenance history and failure analysis data
- Drive continuous improvement
 - Provide recommendations to the Asset Manager and Asset Owner to improve performance and reduce operating costs
 - Manage plant/field work activities to produce results
 - Manage plant/field resources, knowledge and capabilities
 - Drive continuous improvement in safety, productivity, etc.

Identification of which groups/functions should perform which roles is dependent on the decisions made around organization structure. The Maintenance Engineering groups seem to have many of the competencies needed to develop asset life-cycle strategies and would seem to be the natural center for the Asset Manager role.

Process Ownership

As part of defining the Operating Model, there is also a need to ensure that processes are assigned consistent with roles and accountabilities. The Asset Manager has five major processes to perform: Asset and Risk Strategy, Investment Planning, Resourcing Strategy, Performance Management, and Industry Intelligence.



The organization structure which Hydro selects will drive the necessity for having common process ownership in these areas. If a centralized model is chosen, then there will only be one owner for each of these processes and responsibilities will be clear. If a decentralized model is chosen, then for processes which are owned by groups within the business units where consistency is a requirement (e.g., investment planning), Hydro will need to institute common process ownership. This process ownership could be performed by a central group, as in the hybrid model which has a central process owner and decentralized process executors.

Absent a central group to serve as a common process owner, a committee could be used. However, as noted in the gap assessment, management by committee is fraught with difficulties often resulting in compromises, rather than the best solution. In addition, committees are difficult to hold accountable for results, so Hydro should try to avoid this solution if possible.

Authority Model

One of the results of Hydro's current asset management structure is that there is a general lack of accountability for results. Because there is no one group or function with complete responsibility for the assets, there is no one directly accountable for results.

Whether or not Hydro decides to modify its organization structure for Asset Management, it should ensure that accountability for results is clearly defined in the authority model. In addition, the model should focus on establishing behavioral norms biased towards speed of decision making and coordination of action, as well as focusing on improvement rather than just measurement.

A good practice which Hydro should consider implementing is RACI charts for the Asset Management processes (see example chart below). These charts identify the key elements of the process, as well as the functions/personnel involved in the process. Each element and function is charted as either being **Responsible**, **Accountable**, **Consulted**, or **Informed**. The act of producing these charts requires thought about the Authority Model, identifies unclear or overlapping responsibility/accountability, and provides a tool for communicating roles throughout the organization.

Capital Specifics & IP BLANKETS	Asset Strategy	Investment Delivery Assurance	Transmission Engineering	Distribution Engineering	Substation Engineering	Protection & Telecom Engineering	OH/UG Construction	SPT Construction	Project Management	Project Controls	Procurement / T&D Services	External Affairs	Construction Permitting	Environmental Permitting	Safety	ESD / Operations	Planning, Sourcing, Legal
Initiation of Project / Task	R/A		C	C	C	C			C	I							
Development of Budget	C		R	R	R	R	C	C	A	A	C	C	C	C			
Specifics Work Plan	C	R	C	C	C	C	C	C	R/A	R	C	C	C	C	C		C
Blankets Work Plan	C	R	C	C	C	C	C	C	R/A	R	C	C	C	C	C		C
Integrated Work Plan	C	R/A	C	C	C	C	C	C	C	R	C	C	C	C	C		C
Design Scheduling			R	R	R	R	I	I	A	R							
Engineering Design		I	R	R	R	R	I	I	A		I	I	I	I	I	I	I
Construction Permitting	C						I	I	R/A								C
Environmental Permitting							I	I	A				R	R			C
Resource Management	C	C					C	C	R/A	C							
Day-to-Day Construction Scheduling		C					R/C	R/C	C/A								
Create Bill of Material (BOM) / Work Order			R	R	R	R	C	C	A								
Warehousing Materials Management							C	C	A	C	R/A						
Construction							R ¹	R ¹	A	I	I	C	C	C	C	C	C
Construction Management (Outside Contractors)									R/A	C							
Management of in-house crews							R	R	A	C							
Cost and Schedule Forecasting	C	I	C	C	C	C	C	C	A	R	C	C	C	C	C	C	C
Cost and Schedule Tracking	C	I	C	C	C	C	C	C	A	R	C	C	C	C	C	C	C
Stakeholder Engagement & Management			C	C	C	C	C	C	R/A ²	R	I	R/A ²		C		C	C
Clearance Scheduling & Management							I	I	A							R	
Scope Change Management	C	I	C	C	C	C	I	I	R/A	I	I	I	I	I	I	I	I
Schedule Management	R	C	C	C	C	C	C	C	A	R							
Project Reporting			C	C	C	C	C	C	A	R							
Risk Management									A	R/A			C	C	C		C
Maintain Action Item List									R/A								
Closeout	R	I							A	R							
Performance Management	R ³ /A	I	C	C	C	C	C	C	R ³	R ³	C	C	C	C	C	C	C

¹ Inside plant for SPT construction v/s outside plant for OH/UG construction

² PM/R/A for internal and external affairs for external stakeholders

³ AM responsible for portfolio/program level, PM/controls for project level

Responsible: The person who does the work to achieve the task. They have responsibility for getting the work done or decision made. As a rule this is one person; examples might be a business analyst, application developer or technical architect.

Accountable: The person who is accountable for the correct and thorough completion of the task. This must be one person and is often the project executive or project sponsor. This is the role that responsible is accountable to and approves their work.

Consulted: The people who provide information for the project and with whom there is two-way communication. This is usually several people, often subject matter experts.

Informed: The people who are kept informed about progress and with whom there is one-way communication. These are people that are affected by the outcome of the tasks so need to be kept up-to-date.

CLOSING THE GAPS

Benefits from Closing the Gaps

UMS Group has identified a series of recommendation to close the gaps identified in the report. While all of these recommendations are intended to assist Hydro in improving its Asset Management capabilities, some will have a greater impact than others. The table below lists all recommendations and summarizes the benefits that Hydro can expect to achieve from each.

Number	Area	Recommendation	Benefit
1	Leadership	Decide on and declare the Operating Model for Asset Management	Drive alignment on roles and set expectations for achieving progress on improving Asset Management capabilities
2	Leadership	Formally acknowledge the CAM EC's role as the Asset Owner	Provide clarity on who is responsible for setting the parameters for Asset Management, as well as set the specific limits to bound decision-making
3	Leadership	Change the focus of decision-making away from "being the best" towards cost efficient satisfaction of objectives	Re-align culture to focus on understanding the parameters around optimization and making decisions to meet, but not exceed those parameters
4	Leadership	Develop a formal Asset Management roadmap and Asset Management Strategy	Create alignment around and provide direction to personnel on improving AM competency, as well as accelerating development of capabilities through a timetable and defined plan
5	Leadership	Transition to a more competitive process for capital across the Business Units	Maximize corporate value by increasing optimization of capital spend
6	Leadership	Develop and deliver a road show to communicate changes	Signify to the organization the importance of asset management and demonstrate Leadership's commitment to it
7	Risk	Define a risk tolerance level and establish a formal process to regularly review risks	Provide direction to the Business Units to enable them to optimize on meeting risk tolerance levels, rather than overinvesting in risk avoidance
8	Risk	Implement a risk assessment methodology and a risk register	Provide Leadership with the ability to measure and manage risk and provide the Business Units with direction to guide their decision-making
9	Roles and Responsibilities	Formalize the Asset Manager and Service Provider roles within each business unit and clarify accountabilities	Create understanding and alignment on accountability for asset and risk management decisions. Assists in building organizational alignment - vertically and horizontally for shifts in traditional roles and authorities.
10	Consolidation of Functions	Develop an organizational structure which consolidates asset management functions	Reduce duplication of effort, eliminate inefficiencies, and drive a more consistent application of processes and tools

Number	Area	Recommendation	Benefit
11	Consolidation of Functions	Group the functions focused on asset management under a single group	Enhance ability to implement a life-cycle orientation and clarify responsibility for decision-making.
12	Lifecycle Optimization	Develop and document Life-cycle Strategy Plans for the key asset classes	Provide platform for addressing and optimizing costs across the asset's life-cycle. Ensure all parts of the organization understand the strategy for the asset.
13	Lifecycle Optimization	Review existing design specifications and maintenance plans with an eye towards life-cycle optimization.	Target spending to achieve the greatest impact on meeting objectives and avoid overspending outside risk tolerance
14	Lifecycle Optimization	Create an Asset Strategist role with overall responsibility for the integrated Asset Life-Cycle Strategy	Provide a single point of accountability for asset life-cycle decisions and ensure a coordinated approach to optimizing across the various life-cycle components
15	Lifecycle Optimization	Develop processes and implement tools to address O&M spend and the trade-off between O&M and Capital.	Provide capability to optimize O&M spend (both life-cycle cost and trade-off with Capital) and ensure clarity around role of Asset Management in making maintenance decisions
16	Lifecycle Optimization	Integrate O&M into the existing processes used for optimizing Capital spend	Optimize O&M spend in terms of efficiency and effectiveness.
17	Lifecycle Optimization	Improve processes and tools to enable assessment of assets as a group	Allow for programmatic analysis above the individual asset level and support optimization at a unit, station or system level
18	Lifecycle Optimization	Establish AHIs for all key assets and transition to economic life to drive decisions	Enable application of monetized risk assessment to large volumes of assets in a consistent and programmatic manner
19	Performance Management	Develop controls and an internal review function for the asset management system	Provide assurance to Leadership on the performance of the asset management system and identify need for corrective action
20	Performance Management	Refine the current Performance Management framework	Focus performance management on continuous improvement to enable increasing efficiency and better asset and asset management performance
21	Performance Management	Create a Resource Optimization capability	Assure workforce operational effectiveness, efficiency, and productivity and identify improvement opportunities
22	Performance Management	Create an Investment Delivery Assurance process	Ensure that approved investments are delivering the benefits that they are expected to provide and drive continuous improvement
23	Performance Management	Define a corporate-wide process for identifying and sharing best practices	Accelerate the Asset Management maturation process and increase the efficiency with which practices and processes are implemented
24	Data and Technology	Develop a robust data governance structure to ensure data integrity and validity	Ensure data integrity and validity and enable effective data analysis for making asset-related decisions
25	Data and Technology	Perform a Data Inventory and Gap Assessment	Provide a framework for developing and applying data standards, as well as for resolving data issues

Number	Area	Recommendation	Benefit
26	Data and Technology	Improve AHI algorithms to be more objective	Make decisions more data-driven improving transparency and accuracy of forecasts
27	Data and Technology	Develop a plan/roadmap for improving Operational Analytic capabilities	Improve decision-making by leveraging big data to get a more granular understanding of condition, failures, and system drivers
28	Data and Technology	Improve data quality through better communication with the Field/Plant	Improve data quality at the source to increase accuracy of data-driven decisions

Prioritizing the Recommendations

At the highest level, the recommendations fit into one of four categories along a continuum of driving performance improvement. There is a logical flow along the continuum, and while exceptions can be made, careful thought should be given to the impact of skipping a step. The categories are as follows:

- Create the Right Environment – These are recommendations which set the tone for the business and signal to the corporation the direction which Leadership wants to go and the importance of the initiative. Recommendations in this category include development of a Vision, Strategy, Objective, or similar corporate policy; declarations around roles, accountability, and controls; and communications from Leadership about the importance of the initiative.
- Design the Change – These are recommendations which focus on the design/development of new processes, structures, or technology to provide new capabilities. Recommendations in this category include organizational structure, roles and responsibilities, governance and oversight, and plans/roadmaps.
- Implement the Change and Work the New Processes - These are recommendations in which the “Design the Change” recommendations are implemented. Recommendations in this category include implementing new processes, undertaking activities to improve existing processes, and making incremental changes.
- Get Excellent – These are recommendations focused on improving already established processes or capabilities to exceed Competence in an area.

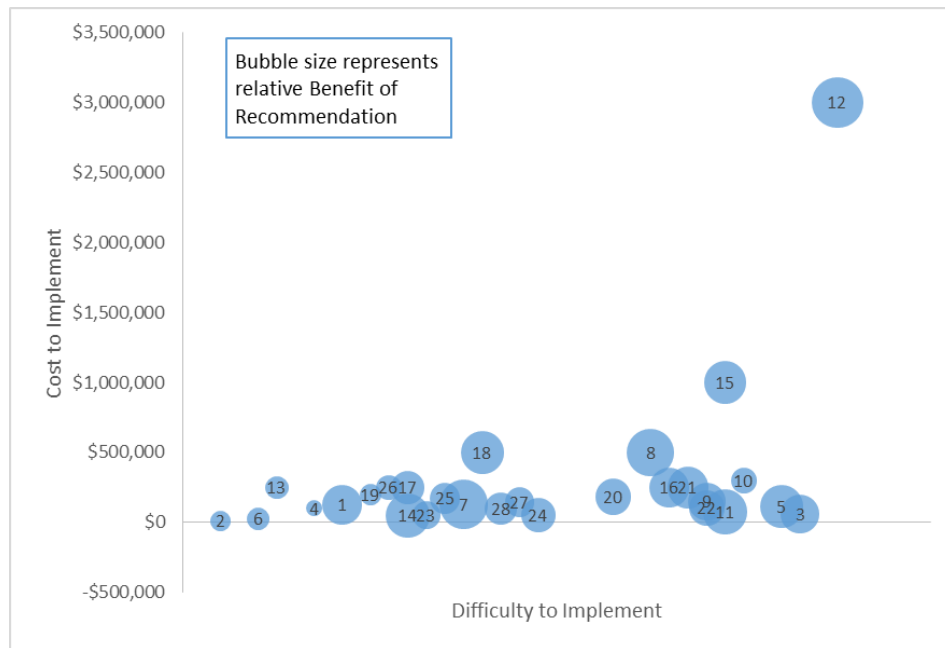
For the 29 recommendations made in the Assessment, UMS Group has designated the category for each on the following pages:

Number	Area	Recommendation	Create the Right Environment	Design the Change	Implement the Change and Work the New Processes	Get Excellent
1	Leadership	Decide on and declare the Operating Model for Asset Management	X			
2	Leadership	Formally acknowledge the CAM EC's role as the Asset Owner	X			
6	Leadership	Develop and deliver a road show to communicate changes	X			
4	Leadership	Develop a formal Asset Management roadmap and Asset Management Strategy	X			
19	Performance Management	Develop controls and an internal review function for the asset management system	X			
3	Leadership	Change the focus of decision-making away from "being the best" towards cost efficient satisfaction of objectives		X		
7	Risk	Define a risk tolerance level and establish a formal process to regularly review risks		X		
9	Roles and Responsibilities	Formalize the Asset Manager and Service Provider roles within each business unit and clarify accountabilities		X		
10	Consolidation of Functions	Develop an organizational structure which consolidates asset management functions		X		
11	Consolidation of Functions	Group the functions focused on asset management under a single group		X		
20	Performance Management	Refine the current Performance Management framework		X		
21	Performance Management	Create a Resource Optimization capability		X		

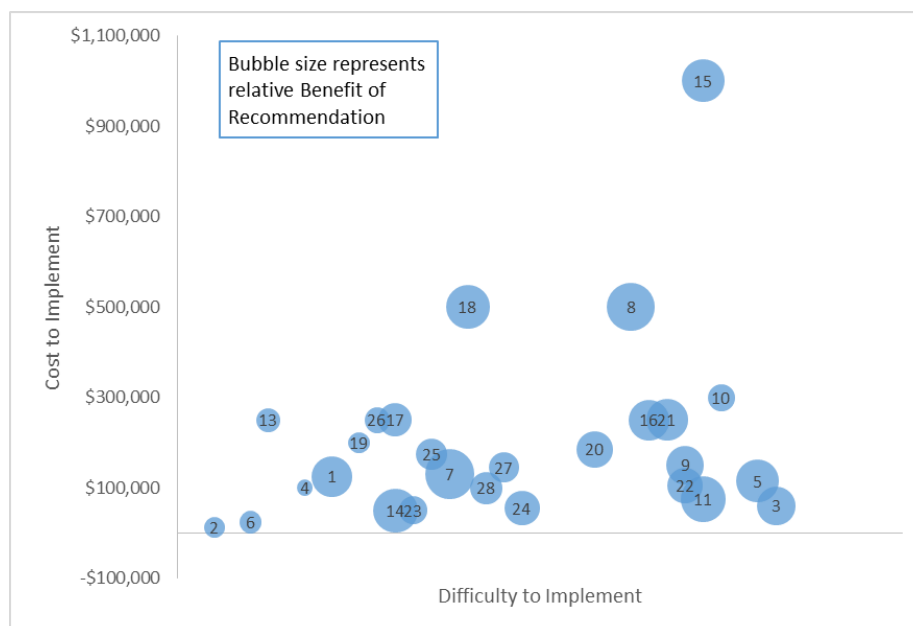
Number	Area	Recommendation	Create the Right Environment	Design the Change	Implement the Change and Work the New Processes	Get Excellent
22	Performance Management	Create an Investment Delivery Assurance process		X		
23	Performance Management	Define a corporate-wide process for identifying and sharing best practices		X		
24	Data and Technology	Develop a robust data governance structure to ensure data integrity and validity		X		
27	Data and Technology	Develop a plan/roadmap for improving Operational Analytic capabilities		X		
5	Leadership	Transition to a more competitive process for capital across the Business Units			X	
8	Risk	Implement a risk assessment methodology and a risk register			X	
14	Lifecycle Optimization	Create an Asset Strategist role with overall responsibility for the integrated Asset Life-Cycle Strategy			X	
15	Lifecycle Optimization	Develop processes and implement tools to address O&M spend and the trade-off between O&M and Capital.			X	
16	Lifecycle Optimization	Integrate O&M into the existing processes used for optimizing Capital spend			X	
17	Lifecycle Optimization	Improve processes and tools to enable assessment of assets as a group			X	
18	Lifecycle Optimization	Establish AHIs for all key assets and transition to economic life to drive decisions			X	

Number	Area	Recommendation	Create the Right Environment	Design the Change	Implement the Change and Work the New Processes	Get Excellent
25	Data and Technology	Perform a Data Inventory and Gap Assessment			X	
12	Lifecycle Optimization	Develop and document Life-cycle Strategy Plans for the key asset classes				X
13	Lifecycle Optimization	Review existing design specifications and maintenance plans with an eye towards life-cycle optimization.				X
26	Data and Technology	Improve AHI algorithms to be more objective				X
28	Data and Technology	Improve data quality through better communication with the Field/Plant				X

While this categorization provides an indication of prioritization in a logical manner, some organizations do not choose to implement all recommendations or may desire to focus in certain areas first. As the recommendations have varying levels of costs, benefits, and difficulty to implement, this decision can be made based either on implementing the “easiest / least expensive” or the “most impactful”. To aid in making this decision, UMS Group has assessed each of the recommendations on these factors and created the chart below to provide a relative comparison between them (note the number can be linked to the recommendation in the table above).



The table below has recommendation “12” removed to make it easier to distinguish among the lower cost recommendations.



Potential Issues/Challenges

Asset Management is often difficult to implement and requires tackling specific barriers. These challenges include:

- Silo Thinking - Departmental, functional or regional barriers exist preventing collaboration and shared solutions. This is usually due to strong local management personalities, non-aligned performance/reward mechanisms or organization size and hierarchy
- Short Term Thinking – The total lifecycle is not taken into account, especially where success is often measured as ‘on time’ and ‘on budget’, irrespective of subsequent asset performance and value of the work
- Conflicting Performance Measures - Capital and operational spending is usually budgeted separately rather than integrated in terms of asset needs. Even ‘balanced scorecards’ can reinforce such competing priorities
- Business Focus - Engineers and operational management do not traditionally speak the same language as finance, executives and external stakeholders
- Risk Management - There is limited comprehension of the need for rational and consistent identification, quantification and management of commercial, technical, safety, customer/public perception and other infrastructure risks
- Data/Technology – There is not enough data or it is of inadequate quality or the wrong sort. IT software and hardware infrastructure is not aligned with the business requirements

In addition, organizational capabilities at three levels are critical for achieving world class business performance. At the Leadership level, there is a need for a clearly understood vision, agreed priorities and a well-articulated strategy on how to be a successful organization in an increasingly challenging market. At the organizational level, there is need to have effective processes, information technology, and infrastructure to support business goals. At the individual level, employees need to be able to co-ordinate work effectively, acquire new business, leadership and team practices and skills, and replace old practices and ways of working.

Finally, to fully succeed in building Asset Management competencies, Hydro needs to make changes to its culture. This will require development and implementation of a Change Management Plan designed to address the often forgotten “soft” people issues (leadership, skills, culture, etc.) related to a major business transformation. This plan (likely multiple plans to go along with different initiatives) will need to be executed in parallel with other planned implementation activities (e.g. new processes, systems, organization redesign, etc.). Key elements of the Change Management Plan should include a Vision which lays out the case for changes, an Organizational Readiness and Impact Assessment which identifies the potential enablers and barriers to change, and a Communication and Stakeholder Management plan to ensure a consistent message is put forth.

Monitoring Progress

Performance measures should be put into place in order to ensure that the recommendations are implemented effectively and that Asset Management capabilities are in fact improving. These measures should include ones to track overall progress on implementing Asset Management transformation initiatives, as well as ones to track success in performing Asset Management. Below are examples of the types of metrics that should be tracked. Specific metrics should be developed during the implementation planning phase.

Asset Management Transformation Initiative Metrics:

- Number of tasks completed on schedule
- Number of tasks completed on budget
- Number of communications to employees on Asset Management
- Number of asset life-cycle strategies completed

Asset Management Performance Metrics:

- Equipment outage rate (number of forced and fault outages as % of total asset class)
- Equipment failure rate (number of major failures as % of total asset class)
- Equipment maintenance spend rate (avg. \$ of maintenance per asset – by asset class)
- Downtime as a proportion of total operating time (%)
- Number of service interruption per month (by asset class)
- % of AHI distribution good or fair (trend)
- Unplanned capital expenditure/total capital expenditures
- Corrective Maintenance cost / Preventive Maintenance cost (by asset class)
- Emergency maintenance cost / Total maintenance cost (by asset class)
- Maintenance Backlog (cost of maintenance due / average annual maintenance expenditure)
- Preventive Maintenance Compliance %
- Asset Sustainability Ratio (sustainment capital expenditure / depreciation expense)
- Asset Consumption Ratio (current value of asset class / current replacement cost of asset class)
- Percent of Assets with complete, correct demographic data in Asset Register
- Percent of Work Orders with correct failure codes entered by Field

APPENDIX A – GAP ASSESSMENT METHODOLOGY

Basis for the Assessment

The assessment of Hydro's asset management maturity was performed against both international standards for asset management systems (ISO 55000 and PAS 55) and industry best practice. The international standards are focused on the requirements for an asset management system and provide guidelines for the application of the specified requirements.

While these standards provide guidance on what is needed to set-up, operate and maintain the asset management system, they do not provide much insight or detail on how to do so. Therefore, UMS Group has also assessed Manitoba Hydro against its own proprietary Strategic Asset Management (SAM) framework which is aligned with industry best practice in application. The SAM framework is fully compliant with both ISO 55000 and PAS 55, but is more focused on the "how" of asset management, while the standards are focused in the "what." It is also focused specifically on the utility industry.

Combined, these two approaches were intended to provide a holistic view of Hydro's current level of asset management maturity and inform the gap analysis to ensure that actionable recommendations are provided to enable implementation of significant improvement opportunities

Interviews

UMS Group held initial interviews with Hydro Leadership to gain some historical context on the development of asset management in the organization, understand their view on perceived gaps/issues, and ascertain their objectives for the engagement. Subsequent to the Executive Interviews, UMS held individual interviews with key personnel in the Generation Operations, Transmission, and Customer Service and Distribution business units. These interviews were designed to understand the current asset management system in terms of processes, tools, and practices. Roles and responsibilities for key asset management functions were also explored.

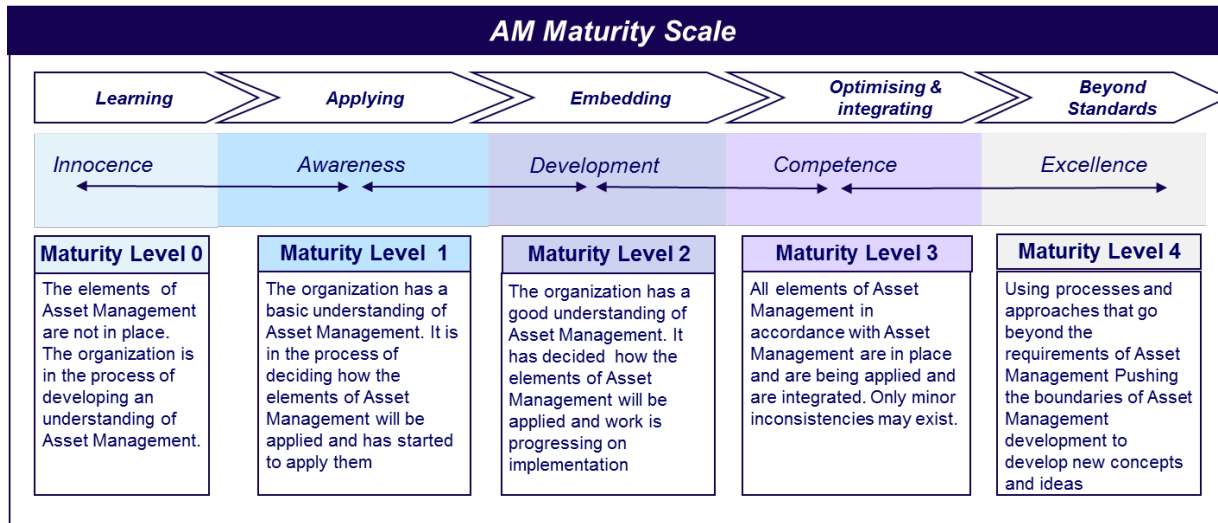
Workshops

UMS Group facilitated separate workshops with personnel in each of the Generation Operations, Transmission, and Customer Service and Distribution business units (25 personnel in total participated) to perform a self-assessment of Asset Management maturity. The workshops had two objectives:

- Educate personnel on the principles of best practice Asset Management per international standards
- Gain alignment around the current maturity level of Manitoba Hydro with regard to these principles

The main body of the workshop comprised of an explanation of the key requirement of an Asset Management System (per ISO 55000 and PAS 55), as well as the key Asset Management Processes. Discussion was then held with the participants on what maturity

in that area meant and where the participants thought the business unit should be rated today versus the maturity standard. The scoring was based on the current level of maturity on a scale where 0=innocence and 4=excellence. Compliance with the Standard is at a competence maturity level of 3 and there is no upper limit to excellence.



The workshops were designed to provide a better understanding by the participants of not only what best practice asset management looks like, but where there is agreement (or disagreement) over where gaps exists and the size of those gaps.

- Context of the Organization** – When establishing or reviewing the Asset Management System, the organization should take into account its internal and external contexts. External context includes social, cultural, economic and physical environments, as well as regulatory, financial and other constraints. The internal context includes organizational culture and environment, mission, vision and values of the organization.
- Leadership** – Top leadership is responsible for developing the asset management Policy and asset management Objectives and for aligning them with the organizational objectives. Top management should create the vision and values that guide policy and promote these policies inside and outside of the organization.
- Planning** – The organizational objectives provide the overarching context and direction to the organization's activities, including its asset management activities. They are generally produced from the organization's strategic level planning activities and are documented in an organizational plan. The principals by which AM is applied should be set out in an asset management Policy and implementation documented in a Strategic Asset Management Plan (SAMP).
- Support** – Collaboration of resources is a critical component in an asset management System. Asset IT Systems can be extremely complex and it is vital for an organization to create, control and document the necessary information and data as a critical function.

- **Operation** – The asset management System can enable the directing, implementation and control of its asset management activities, including those that have been outsourced. Functional policies, technical standards, plans and processes for implementation of the asset management plans should be fed back into the design and operation of the asset management System. Planning changes to asset management processes or procedures are required and will introduce additional risk and must be continually evaluated.
- **Performance Evaluation** – The organization should evaluate the performance of its assets, its asset management and its asset management system. Performance measures can be direct or indirect, financial or non-financial. Asset performance evaluation is often indirect and complex and the transformation of data into information is a critical component. Monitoring, analysis and evaluation of this information should be a continuous process and the results of performance evaluations should be used as inputs into management reviews for continual improvement.
- **Improvement** – An organization's asset management system is likely to be complex and continually evolving to match its context, organizational objectives and its changing asset portfolio. Continual improvement is a concept that is applicable to the assets, the asset management activities and the asset management system, including those activities or processes which are outsourced.
- **Asset & Risk Strategy** - The decision making process that determines how assets are to be added, removed, and maintained. System Planning, Standards, and Maintenance Optimization (Condition Based Maintenance, Reliability Centered Maintenance, Economic End of Life), and Risk Assessment are all critical elements of the Asset Strategy process. Life Cycle Planning is included in this process.
- **Investment Planning** - The analysis and optimization of all capital and O&M spending. All work and investments are prioritized in this process through an evaluation of business drivers and risk (financial, technical, and socio-political) in order to ensure that projects are selected that provide the greatest financial and customer returns.
- **Performance Management** - The Performance Management framework measures the performance of assets, processes, and people, analyzes identified performance gaps and points to possible gap closure solutions.
- **Resourcing Strategy** - The activities necessary to add, remove and manage service providers, whether they be internal or external.
- **Industry Intelligence** – An organized process to identify, assess, and utilize industry best practices to continually assess and modify policies/procedures/processes to ensure improvement remains a priority throughout the organization.

UMS Group also performed a workshop with each of the Business Units which comprised a comparative walkthrough of their Asset Lifecycle and Risk Strategy

process against best practice standards. Through a review of the steps in a model process and a group discussion on how the process matched up to Manitoba Hydro, areas of agreement and areas in contention regarding the current and future state of the process were identified.

APPENDIX B – LIST OF PERSONNEL INVOLVED (INTERVIEWS AND WORKSHOPS)

<i>Corporate, HR and IT Interviews</i>		
Kelvin Shepherd	Darren Rainkie	Lorne Midford
Shane Mailey	Brent Reed	Bryan Luce
Siobhan Vinnish	Sandy Bauerlein	Rob Lanyon
Brad Ireland	Domenic Pellegrino	
<i>Generation Operations Interviews</i>		
Joel Wortley	Val Yereniuk	Rejan Sayak
Hal Turner	Gary Bishop	Terry Miles
Kathy Allard	Karla Skulmoski	John Kreml
Reed Winstone	Don Ans	Krista Halayko
Dave Bowen	Brian Fox	Bob Dandenault
<i>Transmission Interviews</i>		
Gerald Neufeld	Derek Acres	Scott Simons
Rajitha Perera	Kyle Zevena	Joe Petaski
Kerry Walker	Bagen Bagen	David Swatek
Brent Jorowski	Dave Osmond	Glenn Penner
Mark Adamkowicz	John McNichol	Michelle Rheault
<i>Distribution Interviews</i>		
Mark Prydun	Owen Preston	Ken Hamilton
Corey Senkow	Dave Petursson	Jeff Shabaga
Rob Isaac	Kristin Braid	Chuck Steele
David Dudar	Graham Eason	Jesse Perry
Jared Waddell		

<i>Generation Operations Workshop Participants</i>		
Joel Wortley	Don Ans	Rejan Sayak
Hal Turner	Gary Bishop	Kathy Allard
Krista Halayko	Karla Skulmoski	
<i>Transmission Workshop Participants</i>		
Brent Jorowski	Kelvin Kent	Scott Simons
Rajitha Perera	Greg Parent	Gary Lussier
Kerry Walker	Treffe Aussant	
<i>Distribution Workshop Participants</i>		
Jared Waddell	Rob Issac	Dave Petursson
Graham Eason	Chuck Steele	Corey Senkow
Owen Preston	Jeff Shabaga	Ken Hamilton