

December 2018



INDEPENDENT AUDIT OF CAPITAL ASSET MANAGEMENT IN BC HYDRO

www.bcauditor.com



OFFICE OF THE
Auditor General
of British Columbia

CONTENTS

| | |
|---|----|
| Auditor General's comments | 3 |
| Report highlights | 5 |
| Response from BC Hydro | 6 |
| About the audit | 7 |
| Background | 7 |
| Audit scope | 10 |
| Audit method | 11 |
| Audit objective and conclusion | 12 |
| Audit objective | 12 |
| Audit conclusion | 12 |
| Audit criteria summary | 12 |
| Key findings | 13 |
| Overall, we found that BC Hydro's capital asset management systems and practices reached generally advanced maturity levels | 13 |
| Information collection | 14 |
| Life-cycle management | 15 |
| Systems and practices | 17 |
| Audit quality assurance | 18 |
| Appendix: complete audit criteria | 19 |


623 Fort Street
Victoria, British Columbia
Canada V8W 1G1
P: 250.419.6100
F: 250.387.1230
www.bcauditor.com

The Honourable Darryl Plecas
Speaker of the Legislative Assembly
Province of British Columbia
Parliament Buildings
Victoria, British Columbia
V8V 1X4

Dear Mr. Speaker:

I have the honour to transmit to the Speaker of the Legislative Assembly of British Columbia the report, *Independent Audit of Capital Asset Management in BC Hydro*.

We conducted this audit under the authority of section 11(8), of the *Auditor General Act* and in accordance with the standards for assurance engagements set out by the Chartered Professional Accountants of Canada (CPA) in the CPA Handbook – Canadian Standard on Assurance Engagements (CSAE) 3001 and Value-for-money Auditing in the Public Sector PS 5400.



Carol Bellringer, FCPA, FCA
Auditor General
Victoria, B.C.
December 2018

The Office of the Auditor General of British Columbia would like to acknowledge with respect that we conduct our work on Coast Salish territories. Primarily, this is on the Lkwungen-speaking people's (Esquimalt and Songhees) traditional lands, now known as Victoria, and the WSÁNEĆ people's (Pauquachin, Tsartlip, Tsawout, Tseycum) traditional lands, now known as Saanich.

AUDITOR GENERAL'S COMMENTS

ELECTRICITY IS A NECESSITY IN OUR PROVINCE – to drive our industries and economy, and to keep our hospitals, schools, public institutions and homes functioning. BC Hydro provides more than 90% of the electricity in B.C. through a province-wide generation, transmission and distribution system.

BC Hydro manages about \$25 billion in assets — more than any other government entity. About 80% of these assets are things like dams, generators, power lines and poles, substations, and transformers, which are used to provide reliable electrical service to the people of British Columbia.

BC Hydro's assets are a mix of old and new, with some approaching 100 years of service and others coming on-line this year. To manage these assets economically and efficiently requires sound asset management processes.

Asset management is the purposeful and long-term processes that aim to get the greatest efficiency, for the lowest cost, out of an asset over its lifetime. From April 1, 2017 to March 31, 2018, BC Hydro invested almost \$2.5 billion to renew, repair or replace the assets it manages. For BC Hydro, good asset management practices ensure the supply and flow of electricity in British Columbia.

For this audit, we looked at whether BC Hydro is managing its assets well through appropriate information, practices, processes and systems. We found that it is. BC Hydro has good asset management practices, not by accident, but as a result of a decade-long plan and associated efforts.

Over ten years ago, BC Hydro made asset management an organizational priority. Since then, it has worked to implement international guidelines and good practice standards. It has also had its practices independently verified.



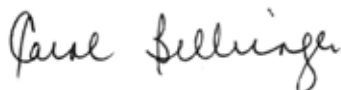
CAROL BELLRINGER, FCPA, FCA
Auditor General

AUDITOR GENERAL'S COMMENTS

I am pleased to say that because BC Hydro is managing its assets well, we made no recommendations in this audit.

Going forward, we will continue to provide legislators and the public with information about BC Hydro's operations and programs through my office's role as BC Hydro's independent financial statement auditor and through the performance audits we plan to carry out on BC Hydro's operations.

My thanks to everyone that we spoke with for their co-operation and support during this audit.



Carol Bellringer, FCPA, FCA
Auditor General
Victoria, B.C.
December 2018

REPORT HIGHLIGHTS

MORE THAN

90%

B.C. electricity

supplied by

BC HYDRO



BC HYDRO
MANAGES

35%

OF GOVERNMENT
CAPITAL ASSETS



BC Hydro
successfully made

**ASSET MANAGEMENT AN
ORGANIZATIONAL PRIORITY**

10+ years ago

ASSET MANAGEMENT:

purposeful and
long-term processes
to get the

greatest efficiency,
for the **lowest cost,**
out of an asset

over
its lifetime



BC Hydro Assets include

**DAMS,
POWER LINES
AND POLES,
GENERATING
STATIONS**



**\$2.47
BILLION
INVESTED**

in fiscal 2018 to

**RENEW, REPAIR
OR REPLACE**

the \$29 billion in assets



NO SIGNIFICANT
DEFICIENCIES SO

**NO
RECOMMENDATIONS**

RESPONSE FROM BC HYDRO

BC HYDRO APPRECIATES the Office of the Auditor General's report on the audit of our Capital Asset Management Practices. The report highlights the progress BC Hydro has made over the past decade to define and develop our asset management processes. We are proud that the Office of the Auditor General recognizes BC Hydro's capital asset management systems and practices have generally reached an advanced level of maturity.

Although no recommendations were made as a result of the audit, BC Hydro is committed to ongoing improvements of our asset management processes to help us continue to deliver clean, reliable, and affordable electricity to our customers. One example is a recent organizational change which merged all of our power system asset management groups into one department to increase alignment and get the highest value from investments in our system. In addition, we have a number of initiatives underway that will further strengthen asset management with a focus on:

- ◆ mitigating high priority safety, environmental and financial risks;
- ◆ managing our assets using a life-cycle approach; and,
- ◆ meeting customer demand growth.

BC Hydro would like to thank the Office of the Auditor General for conducting the audit of our Capital Asset Management Practices. The conclusions of the audit confirm that BC Hydro has taken the right direction in developing its asset management capabilities.

ABOUT THE AUDIT

BACKGROUND

BC HYDRO OPERATES the largest electricity generation, transmission and distribution network in British Columbia ([Exhibit 2](#)). The network largely comprises assets such as dams, electricity generation equipment, transmission lines, transformers and power poles, all of which must be kept under scrutiny, periodically maintained and eventually renewed or replaced.

BC Hydro operates equipment and facilities that range widely in age. Its electricity generation and distribution system was largely established and expanded between 1940 and 1985. Some facilities, such as the Ruskin Dam ([Exhibit 1](#)), near Mission, are even older.

The average age of BC Hydro's generating units is over 40 years, with a number of components in the oldest facilities exceeding 85 years. The older generating, transmission and distribution assets continue to

contribute to the network at or near their full capacity, and an increasing number of assets are reaching the end of their service life. Some have exceeded their life expectancy and require replacement or major investment to extend their service life.

In any aging population of assets, maintenance requirements can be expected to increase and performance to decline because of degradation over time. The oldest parts of BC Hydro's network, including assets such as transmission lines, dams

Exhibit 1: Ruskin Dam and its generating station, which began operating in 1930, are currently being improved and seismically upgraded.

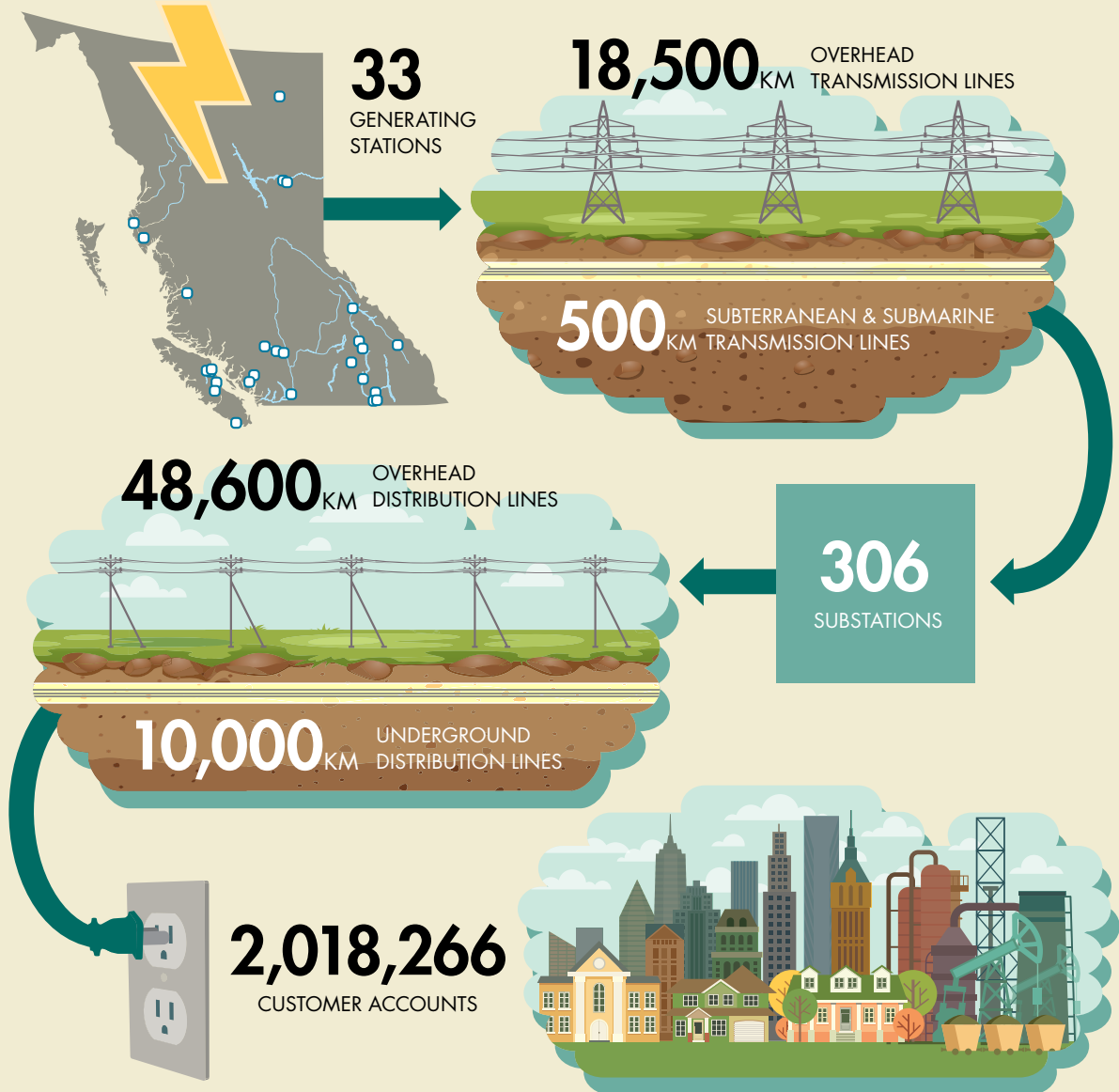


Source: [BC Hydro](#)

ABOUT THE AUDIT

Exhibit 2: BC Hydro generation and distribution network

BC Hydro's large generation assets are situated **considerable distances** from load centres, **requiring significant infrastructure** to deliver electricity to customers.



Source: Office of the Auditor General of British Columbia with information from BC Hydro F2017-F2019 Revenue Requirements Application

ABOUT THE AUDIT

and power generating facilities, are already receiving attention or are due for renewal.

For example, as part of the John Hart Generating Station Replacement Project, BC Hydro is replacing generating facilities from the late 1940s that had a less efficient power output. Exhibit 3 shows the specification plate for a generator at the facility, near Campbell River, that has been in service continuously since 1948.



Source: Office of the Auditor General of British Columbia

BC Hydro's assets are typically costly to renew or replace, even though the return in service life is long. Electricity-generating assets, for example, have average expected lifespans of 40 to 50 years. The Mica Dam facility (Exhibit 4) near Revelstoke has operated for 45 years. Its powerhouse was recently modified to include two new 500-megawatt generating units, which translates into enough power to supply 80,000 homes.

Over the last five years, BC Hydro has completed 493 capital projects at a total cost of \$6.9 billion. For the fiscal year that ended in March 2018, completed capital projects aimed at renewing and expanding the generation, transmission and distribution system totalled \$1.6 billion. For the period 2017 to 2026, BC Hydro has forecast an annual average of approximately \$2.3 billion per year to refurbish, upgrade and expand its existing generation, transmission, distribution, property and technology assets.

This audit focuses on the system BC Hydro uses for looking after its assets. Asset management at BC Hydro, as at any other asset-intensive business in



Source: [BC Hydro](#)

ABOUT THE AUDIT

WHAT IS A CAPITAL ASSET, A CAPITAL PROJECT AND A CAPITAL PROGRAM?

A capital asset includes property of any kind that provides service to an organization for more than one year. Examples are land, buildings and furniture, computers and software, power plants and machinery, vehicles, power poles and towers.

A capital project is an activity that creates a new capital asset or improves the capacity or life span of an existing one. A capital program is a series of capital projects.

the public sector, involves knowing where all assets are located and their condition at a given time. It also involves having a plan in place, and the funding available, to repair, renew or replace assets without interrupting electrical service to the public.

We undertook this audit because good asset management is critical to BC Hydro's success as a reliable energy provider. Our independent assurance work provides BC Hydro with feedback on its self-assessed level of management capability in this area, and also provides the Legislative Assembly of British Columbia with an assessment indicating how well developed BC Hydro's asset management practices are relative to best practices worldwide.

AUDIT SCOPE

We looked at whether BC Hydro has the information, practices, processes and systems needed to support good asset management. We looked specifically at their generation, distribution and transmission assets and not things like vehicles, buildings and computers. In order to assess this, we looked at the following specific elements:

- ◆ information collection:
 - ◆ setting strategic asset management direction
 - ◆ establishing service levels required
 - ◆ forecasting future demand for assets
 - ◆ collecting information and knowledge about assets
 - ◆ monitoring asset performance and condition
- ◆ life-cycle management:
 - ◆ life-cycle decision making
 - ◆ risk management
 - ◆ operational planning
 - ◆ capital investment planning
 - ◆ financial planning
- ◆ systems and practices:
 - ◆ asset management leadership and teams
 - ◆ asset management plans
 - ◆ management systems
 - ◆ asset management information systems and tools
 - ◆ service delivery models
 - ◆ audit and improvement

ABOUT THE AUDIT

Good performance in these elements greatly improves the likelihood of good asset management—but doesn't guarantee it. Other factors, such as the available funding, are also key to success. We did not look at whether capital expenditure levels were sufficient to obtain good asset management results at BC Hydro, as that responsibility lies with BC Hydro and its regulator, the BC Utilities Commission.

We conducted our fieldwork between September 2016 and December 2017. Subsequently, we reviewed our finalized assessments with BC Hydro to determine whether additional evidence was available. Our work was not continuous over this period or afterward, as staff worked on multiple audits at the same time.

AUDIT METHOD

We asked BC Hydro to self-assess its asset management maturity by applying an agreed-upon set of internationally developed asset management maturity criteria. BC Hydro returned its self-assessment results along with documentation supporting its assessment scores.

We considered BC Hydro's assertions and its documentation as part of our own examination. We supported our examination by interviewing BC Hydro professionals on their asset management practices and requesting additional documentation. We followed up on specific issues where we needed clarification. We also made site visits, including visits to the John Hart Generating Station near Campbell River, the G.M. Shrum powerhouse and the W.A.C. Bennett Dam, and BC Hydro's administration offices in Burnaby.

This report is dated November 27, 2018—the date on which we received and accepted BC Hydro's acknowledgement that it had provided all the information we needed in order to conclude on the objective of our audit.

AUDIT OBJECTIVE AND CONCLUSION

AUDIT OBJECTIVE

The objective of this audit was to determine whether BC Hydro has good asset management practices.

AUDIT CONCLUSION

We concluded that BC Hydro had demonstrated good asset management practices.

AUDIT CRITERIA SUMMARY

We derived a set of asset management maturity criteria from the 2015 *International Infrastructure Management Manual* (IIMM). The particular self-assessment grid we used was developed by, and used with the permission of, the New Zealand Tertiary Education Commission (see [Appendix](#)). This New Zealand grid reflects the most recent 2015 edition of the IIMM. This approach provided an international perspective on good asset management practice. BC Hydro accepted the use of these maturity criteria.

We chose this set of criteria with a view to applying them to other asset-intensive public-sector organizations. We hope to thereby promote asset management literacy and continuous development toward best practices in asset management within the B.C. public sector.

KEY FINDINGS

OVERALL, WE FOUND THAT BC HYDRO'S CAPITAL ASSET MANAGEMENT SYSTEMS AND PRACTICES REACHED GENERALLY ADVANCED MATURITY LEVELS

WE FOUND NO SIGNIFICANT deficiencies in BC Hydro's asset management practices. Based on mutually agreed audit criteria, we found that BC Hydro:

- ◆ has collected the information it needs to support good asset management practices
- ◆ has asset life-cycle management processes that meet good practice principles
- ◆ has systems and practices in place that enable good asset management practices

BC Hydro has reached its generally advanced level of asset management maturity as a result of a concerted effort, over at least 10 years, to build its asset management practices (see [Exhibit 5](#)). This included adopting the publicly available specification for the optimal management of physical assets and a variety of internal and external assessments, which

have motivated a range of improvements that are still changing the organization.

Changes to date have included identification and reduction of deficiencies, as well as reduction of barriers between organization units. Many of the good processes and practices that we observed at BC Hydro are a direct result of the efforts of the past decade.

PUBLICLY AVAILABLE SPECIFICATION FOR THE OPTIMAL MANAGEMENT OF PHYSICAL ASSETS (PAS55)

PAS 55 set out the requirements for an asset management system for the management of physical assets and asset systems over their life cycles. The specification was produced in 2004 by the UK firm BSI, in response to demand from industry for a standard for asset management.

At the time BC Hydro used it, the standard applied to any organization where physical assets were a principal means to achieving an organization's goals. PAS55 has now been superseded by international standard ISO 55001 which has similar objectives.

Source: BSI Group, <https://bsigroup.com/>

KEY FINDINGS

Information collection

Asset information is current and reliable

BC Hydro has collected the information it needs to support good asset management practices.

BC Hydro knows the service requirements that its electricity-generating, transmission and distribution capability must meet. This knowledge is informed by information about its assets that is current, comprehensive and routinely updated. Within its asset knowledge base, BC Hydro keeps records of asset condition and monitors asset performance, information that in turn informs decision-making and planning functions.

BC Hydro uses an equipment health rating methodology, which captures in a standardized way the actual performance of equipment, relative to design specifications and operational expectations, as well as maintenance activity and service life estimates. BC Hydro has been working to ensure that these records are all up to date and has put in place monthly inter-unit meetings to discuss emerging equipment issues or unanticipated events that could affect asset performance and trigger needed action.

Load forecasting process is robust

BC Hydro has a load-forecasting capability that compares favourably with industry standards. The process it uses includes three components:

- ♦ projecting what will drive residential and commercial demand at a future date

- ♦ conducting sensitivity analyses to adjust for various demand outcomes
- ♦ producing a set of demand probability scenarios (low, medium and high peak load forecasts) which can be applied to strategic planning

BC Hydro uses electricity load forecasting to estimate the timing, location and size of capital investments needed to meet anticipated electricity demand. Many of the assets BC Hydro uses to meet demand, such as dam facilities, generating stations, transmission lines, and rights of way on land, take many years to plan, permit, construct and commission. This lead time means BC Hydro must act at the right time to ensure that it has the energy capacity its customers will draw from many years from now.

Forecasting future peak demand enables asset managers to evaluate, plan, reconfigure and implement a revised system to supply enough energy to meet the expected load on the electrical grid.

The primary factors that BC Hydro considers in estimating future peak energy demands include forecasts of housing starts, trends in energy use, projections of the province's gross domestic product, and estimates of changes in employment and retail sales. Calculations of future demand also attempt to take into account the impact of commercial expansions or reductions and emerging trends, such as growth in reliance on electrical vehicles and use of LED lighting. For their largest 190 customers, BC Hydro develops individual projections based on information provided by these customers plus government data and third party expert reports.

KEY FINDINGS

Other factors, however, such as unforeseen labour disruptions, recessions, changes in resource commodity prices for timber and minerals, and temporary or permanent closures of businesses that affect voltage at specific locations, create uncertainty. BC Hydro's predictive demand scenario modelling factors in: gross domestic product, likely weather impacts, and external variables, such as commodity prices affecting energy consumption.

Life-cycle management

Life-cycle planning meets expectations

BC Hydro has asset life-cycle management processes that follow good practice principles.

Continual improvement based on lessons learned is built into operational plans. For example, asset maintenance standards and instructions and safety procedures are regularly reviewed. Subject matter experts and engineering reports are used to identify root causes and trends when a failure or incident occurs. Preventive maintenance required to meet regulatory requirements is always funded and resourced to the full extent.

Management has identified the most critical assets and works to sustain them by focusing on the following factors:

- ◆ safety and security of assets
- ◆ current condition of assets
- ◆ asset characteristics and specifications
- ◆ availability of skilled professionals and materials

- ◆ time when assets can be out of service
- ◆ changes in regulation and standards
- ◆ procurement lead times for materials and labour

BC Hydro manages the interaction between these factors and its service delivery objective, which is to produce a reliable supply of energy. For example, some degree of equipment redundancy is built into the network, so that if a component fails the service demand can be met in other ways.

BC Hydro also has a mature and well-documented asset maintenance program that is aligned with its objectives as an organization.

Capital planning balances asset investment with the need to manage cost

The three priorities for expenditure in BC Hydro's current 10-year capital investment plan are managing growth, maintaining and renewing assets, and dam safety. BC Hydro is funding improvement and expansion projects in all three areas within an annual funding cap. That means, for example, changes in foreign currency, trade tariffs or new technologies that drive up costs must be accommodated without exceeding the cap.

Capital investment plans are developed after all of the business units have identified their specific needs; programs and projects are then created to meet those needs as the plans are developed. An annual prioritization process decides which of the many projects will proceed and which will have to wait to keep capital spending caps from being exceeded.

KEY FINDINGS

The prioritization allows certain projects to advance toward completion each year and pushes others further out. Near term focus on capital expenditure by BC Hydro takes precedence over projects that will be funded later.

BC Hydro's ten year plan is made up of projects with different levels of cost certainty. Projects starting in the first three years of the plan have the most accurate cost estimates. Projects starting after year three are rougher forecasts. To compensate for this uncertainty and keep future costs close to the plan, Hydro uses an annual funding target (limit). Given that costs typically rise over time, projects may have to be delayed or scaled back to keep the overall plan within the funding target. Hydro therefore achieves a higher level of certainty about the cost of projects by reducing the level of certainty that projects in the later years of the plan will be built as planned.

BC Hydro explained that it is prohibitively costly to prepare full cost estimates for projects that won't start for several years.

However, it also means that BC Hydro cannot always determine the full cost associated with delaying projects, because it only has detailed costs for the near term. Impacts can include real cost increases, such as labour and equipment, loss of revenue, and increased maintenance and operational costs. Cost changes could also be decreases resulting from new technologies or alternative energy sources. BC Hydro looks at these impacts in its annual project prioritization if a project will be deferred by three years. This means that some cost consequences of delay within the 10-year capital plan are unknown.

However, advanced maturity requires a high level of project cost certainty throughout a 10-year capital plan. This is a higher level of certainty than what is achieved in years 4-10 of Hydro's plan. However, in BC Hydro's case, this is not a deficiency, and as a result we are not making a recommendation.

BC Hydro's practices in this regard make sense. Consider, for example, the needs of BC Hydro compared with those of a school district experiencing declining enrolment. The school district will not need to plan for new assets and can focus on the maintenance and possible retirement of existing facilities. It should therefore be able to cost-effectively meet all the significant indicators of advanced maturity for capital investment planning. By contrast, BC Hydro must make a complex estimation of the need for power and the resulting income from customers available to grow capacity while allocating investments across a wide array of asset types of different ages and manufacture. Additionally, accurately costing the largest projects requires costly professionals like designers, engineers and quantity surveyors to put in significant amounts of time. Greater certainty therefore takes a lot of time and comes at a significant cost.

More specific to BC Hydro's situation is the dynamic environment in which it operates. In planning it must try to estimate the impacts of emerging technologies and energy efficiency gains on electricity demand, while at the same time responding to government policy direction, such as that associated with the *Clean Energy Act*. BC Hydro's regulator, the BC Utilities Commission, looks at this operating environment to the degree which it is allowed to given government direction.

KEY FINDINGS

Systems and practices

Leadership and teams are supported by learning, development and trades training strategies

We expected BC Hydro’s commitment to asset management to be reflected in the leadership roles in the business units. We found there is alignment of asset management objectives, such as reliability, with asset management methodology and responsibilities of professionals involved. The technical capacity in the business units is sufficient to design projects for the 10-year plan of capital investments.

Asset management plans are updated each year

We found that asset performance expectations and future demand forecasts are applied to asset management planning. Significant levels of stakeholder engagement are factored into planning. One example is the facility planning process BC Hydro uses to keep stakeholders informed of known issues and opportunities. Asset management plans are reviewed, improved and updated annually.

Service delivery focus is on best value

BC Hydro has to buy supplies and services from external sources to support its asset management maintenance programs and capital projects. We expected that the risks, benefits and costs of various service delivery options had been considered and that the option with the best value was implemented. In BC Hydro’s capital asset management framework, all projects over \$50M must be assessed for suitability for alternative procurement.

We found there are slightly different procurement plans/policies in place for different departments within BC Hydro. There is a plan to align procurement policies to ensure consistency of practices across the organization.

BC Hydro has a generally advanced level of maturity in asset management, as indicated in Exhibit 5. Its success in this regard is a result of concerted effort over several years by a set of skilled professionals focused on ensuring that a reliable source of electrical power will be supported by a mature asset management practice.

Exhibit 5: BC Hydro’s Asset Management maturity score - out of 100 points

| Understanding and Defining Requirements | |
|--|----|
| Setting the Strategic Direction | 95 |
| Establishing Levels of Service | 95 |
| Forecasting Future Demand | 95 |
| Collecting Asset Information (Asset Knowledge) | 85 |
| Monitoring Asset Performance and Condition | 85 |
| Lifecycle Planning | |
| Lifecycle Decision Making | 90 |
| Risk Management | 80 |
| Operational Planning | 90 |
| Capital Investment Planning | 80 |
| Financial Planning | 90 |
| Asset Management Enablers | |
| AM Leadership and Teams | 90 |
| AM Plans | 85 |
| Management Systems | 80 |
| AM Information Systems and Tools | 85 |
| Service Delivery Models | 90 |
| Audit and Improvement | 85 |

Intermediate maturity Advanced maturity

Source: Office of the Auditor General of British Columbia

AUDIT QUALITY ASSURANCE

WE CONDUCTED THIS audit under the authority of section 11 (8) of the *Auditor General Act* and in accordance with the standards for assurance engagements set out by the Chartered Professional Accountants of Canada (CPA) in the CPA Handbook – Canadian Standard on Assurance Engagements (CSAE) 3001 and Value-for-money Auditing in the Public Sector PS 5400. These standards require that we comply with ethical requirements, and that we conduct the audit to independently express a conclusion on whether or not the subject matter complies in all significant respects to the applicable criteria.

We apply the CPA Canadian Standard on Quality Control 1 (CSQC) and, accordingly, maintain a comprehensive system of quality control, including documented policies and procedures regarding compliance with ethical requirements, professional standards, and applicable legal and regulatory requirements. In this respect, we have complied with

the independence and other requirements of the code of ethics applicable to the practice of public accounting issued by the Chartered Professional Accountants of British Columbia, which are founded on the principles of integrity, objectivity and professional competence, as well as due care, confidentiality and professional behaviour.

APPENDIX: COMPLETE AUDIT CRITERIA

FOR BC HYDRO asset managers, asset planners, operators, maintainers and developers, the IIMM manual offers a reference within which the various components of a system of asset management are situated and interrelated. For those specialists at the periphery, such as regulatory, IT and financial professionals, the manual provides an asset management framework with examples.

Audit Criteria as adapted from the *International Infrastructure Management Manual*

| Maturity Scale | Aware Maturity 0-20 | Basic Maturity 25-40 | Core Maturity 45-60 | Intermediate Maturity 65-80 | Advanced Maturity 85-100 |
|---|---|--|--|---|---|
| Understanding and Defining Requirements | | | | | |
| <p>Setting the Strategic Direction</p> <p>Asset management (AM) policy supports an organization's strategic objectives. It articulates the principles, requirements and responsibilities for AM. It articulates the objectives, practices and action plans for AM improvement, audit and review processes. The AM Policy and Strategy may be incorporated into the AM Plan.</p> | <p>The organization is aware of the need to develop an AM Policy, but hasn't yet completed this work.</p> | <p>Corporate expectations are expressed in relation to the development of AM plans and objectives, such as "all departments must have a current AM plan".</p> | <p>AM policy and objectives are developed and aligned with corporate goals and strategy.</p> | <p>The scope of AM is defined and documented. How AM fits into the wider corporate environment is analyzed and implications for AM are documented in the Strategic AM Plan or AM Strategy. AM policy and objectives are reflected in departmental plans and priorities.</p> | <p>AM Policy and Strategy is fully integrated into the organization's business processes and subject to defined audit, review, and updating procedures.</p> |
| <p>Establishing Levels of Service</p> <p>Levels of service are the cornerstone of asset management and provide the platform for all life-cycle decision making. Levels of service are the outputs a customer receives from the organization. One of the first steps in developing asset management plans or processes is to find out what levels of service customers are prepared to pay for, then understand the organization's capability to deliver the levels of service.</p> | <p>The organization understands level of service requirements but has not documented or quantified them.</p> | <p>The organization has defined how assets contribute to the organizations objectives and levels of service. Customer/user groups have been defined and their needs are informally understood.</p> | <p>Level of service benchmarks are in place for each major client, user or asset group. Customer/user needs have been analyzed.</p> | <p>Customers/users have been consulted on significant service levels and options. The relationship between the level of service and costs is understood by the organization.</p> | <p>Levels of service and benchmarks are integrated into decision making, business planning and performance reporting.</p> |
| <p>Forecasting Future Demand</p> <p>This AM activity involves predicting changes in demand for specific service requirements over the life of the AM plan or the life of the asset pool. The ability to predict demand enables an organization to plan ahead and meet that demand, or manage risks of not meeting demand.</p> | <p>The organization generally understands future demand requirements but they are not documented or quantified.</p> | <p>Demand forecasts are based on predictions by experienced staff, with consideration of known past demands, trends and likely future growth patterns.</p> | <p>Demand forecasts are based on robust projections of a primary demand factor (e.g. population growth) and extrapolation of historic trends. Risks associated with changing demand are broadly understood and documented.</p> | <p>Demand management is considered during long term capital planning. Demand forecasts are based on mathematical analysis of past trends and primary demand factors. A range of demand probability scenarios is developed (e.g. high, med, low) as part of risk management.</p> | <p>Demand management is considered in strategic and project decisions. Risk assessments of different demand scenarios with mitigation actions are in place.</p> |

APPENDIX

| Maturity Scale | Aware Maturity 0-20 | Basic Maturity 25-40 | Core Maturity 45-60 | Intermediate Maturity 65-80 | Advanced Maturity 85-100 |
|--|--|--|---|---|---|
| Understanding and Defining Requirements (continued) | | | | | |
| <p>Collecting Asset Information (Asset Knowledge)</p> <p>Credible asset data is the foundation for enabling most AM functions. Effective planning for asset maintenance, renewal, upgrade, and replacement cannot proceed until organizations know the nature, location, capacity, and reliability of the assets they rely on for service delivery.</p> | <p>The organization has asset information in a variety of formats. There is an awareness of the need for an integrated asset register.</p> | <p>Essential asset information (e.g. type, design size / capacity, age, location) is recorded in spread sheets or data bases, but is based primarily in historical records such as “as-built”. Asset information is updated and verified periodically.</p> | <p>As for Basic, plus there is sufficient information for valuations, replacement costs, asset age, remaining service life. Asset information generally supports planning and prioritization. Asset hierarchy, identification and attribute systems are documented. Asset data is routinely updated and tested for reliability.</p> | <p>As for Core, plus a reliable register of physical, financial and risk attributes recorded in an information system with data analysis and flexible reporting functionality. Systematic and documented data collection process are in place. High level of evidence based confidence in asset data.</p> | <p>As for Intermediate, plus detailed (component level) information on work history, type and cost, condition, performance, etc. is recorded and utilized in data analysis. Systematic and fully optimised data collection program in place with supporting metadata. There is a complete data base for core assets with minimal assumptions for non core assets.</p> |
| <p>Monitoring Asset Performance and Condition</p> <p>Assets are central to service delivery and meeting strategic objectives. Timely and complete performance and condition information is essential for AM and supports life cycle decision making, risk management, and operational, capital and financial planning.</p> | <p>Asset condition and performance data is not formally documented, or is collected in limited quantities.</p> | <p>Asset information and data is adequate to confirm current asset performance against AM objectives.</p> | <p>Asset condition and performance information is suitable to plan maintenance and renewal over the near term (5 years or less).</p> | <p>As for Core, plus asset condition and performance information is modelled to assess whether AM condition and level of service objectives are being met over the long-term (> 5 years). Contextual information such as forecasting demand variances is used to estimate potential performance variances.</p> | <p>As for Intermediate, plus the type, quality and amount of asset data are optimised to the financial and technical decisions being made. Asset performance and condition data is modeled for development and reporting of continuous improvement strategies. The data collection program is adapted to reflect asset lifecycles.</p> |
| Lifecycle Planning | | | | | |
| <p>Lifecycle Decision Making</p> <p>Lifecycle based AM planning is essential to achieve sustainable, appropriate, and affordable levels of services.</p> | <p>The organization recognises the benefits of lifecycle-based decision making but currently bases decisions primarily on staff judgement.</p> | <p>Organizational priorities are reflected in AM decision making.</p> | <p>As for Basic, plus formal decision making analysis/techniques are applied to major projects and programs, where criteria are based on organizational AM objectives.</p> | <p>As for Core, plus formal decision making and prioritization techniques are applied to operational and capital programs at the business unit, asset component level, or budget category. Past assumptions, forecasts, estimates, and decision making methodologies are tested against actual results.</p> | <p>As for Intermediate, plus AM objectives and targets are based on formal decision making techniques and are supported by the estimated cost and benefit or achieving targets. The decision making framework enables projects and programs to be optimized across the organization. Formal risk based sensitivity analysis is carried out and informs subsequent management decision cycles.</p> |

APPENDIX

| Maturity Scale | Aware Maturity 0-20 | Basic Maturity 25-40 | Core Maturity 45-60 | Intermediate Maturity 65-80 | Advanced Maturity 85-100 |
|--|---|--|--|--|---|
| <i>Lifecycle Planning (continued)</i> | | | | | |
| <p>Risk Management</p> <p>Risk management helps identify higher frequency and higher consequence risks, and identifies actions to mitigate those risks. This process reduces the organization's exposure to asset related risks and drives maintenance rehabilitation and renewal programs and decision making.</p> | <p>The organization has identified formal risk management, related to AM, as a future improvement.</p> | <p>Critical service and asset risks are understood and considered by senior staff involved in maintenance and renewal decisions.</p> | <p>A risk framework is developed. Critical assets and high risks are identified. There are documented risk management strategies for critical assets and high risks.</p> | <p>As for Core, plus systematic risk analysis assists key decision-making. The risk register is regularly monitored, updated and reported. Risk is managed consistently across the organization. An infrastructure resilience strategy and program is in place including defined levels of service for resilience.</p> | <p>As for intermediate, plus a formal risk management policy in place. Risk is quantified and risk mitigation options evaluated. Risk and resilience are integrated into all aspects of decision making.</p> |
| <p>Operational Planning</p> <p>Operational plans document how assets will be operated on a day to day basis including activities aimed at keeping assets in service and meeting AM objectives. Operations encompasses both operational and maintenance activities. Effective operational strategies can mitigate risk, defer the need for asset replacement, minimize service downtime, reduce the impact from asset failures, increase service affordability and reduce lifecycle costs.</p> | <p>Operational plans and procedures (operations and maintenance) are based on historical practices (things are largely done the way they always have been).</p> | <p>Operating plans and procedures are available for critical operational processes.</p> | <p>The organizations operational structure is in place, documented and roles are assigned.</p> | <p>As for Core, plus operating plans and procedures (maintenance and operational) are available for all operational processes. Support requirements/ resources are in place and risk and opportunity planning is completed.</p> | <p>As for Intermediate, plus operational objectives and intervention levels are defined and implemented. Operational planning's alignment with organizational objectives can be demonstrated. Continual improvement can be demonstrated for all operational processes.</p> |
| <p>Capital Investment Planning</p> <p>Capital investment includes the upgrade, creation and/or purchase of new assets, typically to address growth or changes in levels of service requirements, or for the periodic renewal of existing assets to maintain service levels. Organizations need to plan for the long term asset requirements relative to forecasted demand and future levels of service.</p> | <p>Capital investment projects are identified during the annual budgeting process.</p> | <p>There is a schedule of proposed capital projects, with associated costs, for the next 3-5 years, based on staff judgement of future requirements.</p> | <p>Proposed projects have been collected from a wide range of sources and collated into a project register. Capital projects for the next three years are fully scoped and estimated. A prioritization framework is in place to rank the importance of capital projects. Asset condition, performance and levels of service are variables used to prioritize projects.</p> | <p>As for Core, plus formal options analysis and business case development has been completed. Priority capital projects proposed in the 3-5 year period are consistent with capital programs, reflecting the requirements of the next 10-20 years. Priority projects and programs have full cost estimates available.</p> | <p>Long term capital investment programs are developed using decision techniques such as predictive modeling. The organization has a reliable and approved 10-year view of its future capital requirements to meet forecast level of service requirements and the strategic choices available to meet changing fiscal or level of service requirements.</p> |
| <p>Financial Planning</p> <p>Poor long term financial management can lead to higher life cycle costs, and financial "shocks". Good collaboration between financial and technical asset managers is important, especially in relation to long term financial forecasts and asset condition and level of service related decisions. Robust financial budgets are a key output of any asset management planning process.</p> | <p>Financial planning is largely an annual budget process but there is intention to develop longer term forecasts.</p> | <p>10-year financial forecasts are based on extrapolation of past trends and broad assumptions about the future.</p> | <p>10 year+ financial forecasts are based on current comprehensive AM plans. Significant assumptions are stated. Expenditures are captured at a level useful for AM analysis.</p> | <p>10 year+ financial forecasts are based on current comprehensive AM plans with detailed supporting assumptions and reliability factors. Significant assumptions are specific and well reasoned. Asset expenditures are easily linked to finance databases.</p> | <p>10 year+ financial forecasts based on comprehensive, advanced AM plans with detailed underlying assumptions and high confidence in accuracy. Advanced financial modeling provides sensitivity analysis, demonstrable whole life costing and cost analysis for level of service options.</p> |

APPENDIX

| Maturity Scale | Aware Maturity 0-20 | Basic Maturity 25-40 | Core Maturity 45-60 | Intermediate Maturity 65-80 | Advanced Maturity 85-100 |
|--|--|--|---|--|---|
| Asset Management Enablers | | | | | |
| AM Leadership and Teams Effective asset management requires a committed and co-ordinated effort across all sections of an organization. | Organization leadership is supportive of AM. | AM functions are carried out by small groups. Position descriptions incorporate AM roles. | AM coordination processes are established. Leadership demonstrates ownership and support for AM. There is an awareness of AM across most of the organization and broad organizational structures that support AM. | There is a consistent approach to AM across the organization and an established internal communication plan. AM is resourced, key AM roles are in place and AM duties are included in position descriptions. | Roles reflect AM requirements and AM is defined in all relevant position descriptions. There is a formal documented assessment of AM capability and capacity requirements needed to achieve AM objectives. There is a demonstrate alignment between AM objectives, AM systems and individual responsibilities. |
| AM Plans An asset management plan is a written representation of intended capital and operational programs for its new and existing infrastructure, based on the organizations understanding of demand, customer requirements and its own network of assets. | The organization has stated an intention to develop AM plans. | AM plans contain basic information on assets, service levels, planned work and financial forecasts (5-10 years) and identifies future AM improvements actions. | AM objectives are defined within the overall strategic context. The AM plan includes basic level attributes plus the following: - the approach to risk and critical assets is described - a top-down condition and performance assessment - future demand forecasts - descriptions of supporting AM processes - 10-year financial forecasts - a 3-year AM improvement plan. | AM strategic context analyzed with risks, issues and responses described. The AM plan includes core attributes plus the following: - analysis of asset condition and performance trends - customer engagement in setting levels of service - optimized decision making and risk techniques applied to major programs. | The AM plan includes intermediate attributes plus the following: - evidence of programs driven by comprehensive optimized decision making techniques - risk management programs and level of service/cost trade off analysis AM plan improvement program is largely complete with focus on ongoing maintenance of current practices. |
| Management Systems Effective management systems allow organizations to improve effectiveness and efficiency, increase customer satisfaction and better manage asset condition, performance, service delivery, risk and other factors. | The organization is aware of the need to formalize AM systems and processes but has yet to document and implement a management system with specific policies, processes, procedures, systems and reporting frameworks. | Simple process documentation in place for service critical AM activities. | A basic quality management system is in place that covers financial and technical activities. Critical AM processes are documented, monitored and subject to review. | As for core plus process documentation is implemented in accordance with AM system to an appropriate level of detail. Internal financial and technical management systems are aligned. | As for intermediate plus strong integration of all management systems within the organization. Ongoing staff training supports the effective and consistent use of management systems. Outcomes are measured and reported to support continuous improvement. |

APPENDIX

| Maturity Scale | Aware Maturity 0-20 | Basic Maturity 25-40 | Core Maturity 45-60 | Intermediate Maturity 65-80 | Advanced Maturity 85-100 |
|---|---|--|--|--|--|
| Asset Management Enablers (continued) | | | | | |
| <p>AM Information Systems and Tools</p> <p>AM systems are an essential tool for the timely and cost effective management of assets in order to affordably meet service obligations. The large amounts of data associated with assets and AM requires information systems and tools in order to effectively deal with the extent of analysis required to fully manage assets.</p> | <p>The organization recognizes the benefits of using asset management information systems (AM IS), but does not have one in place.</p> | <p>The AM IS or asset register can record core asset attributes such as size, material etc. Asset information reports can be manually generated for AM plan input.</p> | <p>The AM IS or asset register enables hierarchical reporting (from component to facility level). Customer request tracking and planned maintenance functionality is enabled. The system enables manual reports to be generated for valuation and renewal forecasting.</p> | <p>As for core plus, there is more automated analysis, forecasting and reporting on a wider range of information including operations, maintenance, condition, performance and financial.</p> | <p>Financial, asset and customer service systems are integrated, interactive and enable advanced AM functions. There is forecasting of AM activity including prioritized expenditures to refurbish and upgrade assets. Asset optimization analysis can be completed.</p> |
| <p>Service Delivery Models</p> <p>The cost effectiveness of asset management planning is proven in the efficient and effective delivery of services at an operational level.</p> | <p>The organization has clearly allocated service delivery roles (internal and external) and generally follows historic approaches.</p> | <p>Service delivery roles are clearly allocated internally and externally and generally follow historic approaches or industry customs and practices.</p> | <p>Core functions are defined. A procurement strategy/policy is in place. Internal service level agreements are in place with primary internal service providers and contracts for primary external service providers.</p> | <p>Risks, benefits and costs of various outsourcing options are determined and considered. Competitive tendering practices are applied with integrity and accountability. Periodic reviews are conducted to identify the best value delivery mechanism for each major AM activity.</p> | <p>All potential service delivery mechanisms have been reviewed and formal analysis carried out. Risks, benefits and costs of various service delivery options have been considered and the best value arrangement has been identified and is being implemented.</p> |
| <p>Audit and Improvement</p> <p>Well performing organizations recognize the value that can be obtained from continuously improving AM policies, processes, systems and capabilities. The focus is on ensuring AM practices are appropriate to the current and long term business objectives.</p> | <p>The organization recognizes the need to improve AM processes and practises, but has yet to develop an improvement plan.</p> | <p>Improvement actions have been identified and responsibility has been allocated to appropriate staff.</p> | <p>Current and future AM performance is assessed and identified gaps are used to drive improvement actions. Improvement plans identify objectives, timeframes, deliverables, resource requirements and responsibilities.</p> | <p>As for Core, plus formal monitoring and reporting on the improvement program to the Executive Team. Project briefs have been developed for all key improvement actions. Resources have been allocated to the improvement actions.</p> | <p>As for Intermediate, plus improvement plans specify key performance indicators (KPIs) for monitoring AM improvement. Improvement plan key performance indicators are routinely reported.</p> |



OFFICE OF THE
Auditor General
of British Columbia

Location

623 Fort Street
Victoria, British Columbia
Canada V8W 1G1

Office Hours

Monday to Friday
8:30 am – 4:30 pm

Telephone: 250-419-6100

Toll free through Enquiry BC at: 1-800-663-7867

In Vancouver dial: 604-660-2421

Fax: 250-387-1230

Email: bcauditor@bcauditor.com

Website: www.bcauditor.com

This report and others are available at our website, which also contains further information about the office.

Reproducing

Information presented here is the intellectual property of the Auditor General of British Columbia and is copyright protected in right of the Crown. We invite readers to reproduce any material, asking only that they credit our office with authorship when any information, results or recommendations are used.



AUDIT TEAM

Morris Sydor,
Deputy Auditor General

Bill Gilhooly,
Assistant Auditor General

Christopher Thomas,
Senior Manager

Denver Wigg,
Senior Manager

Ken Ryan-Lloyd,
Manager

Patrick Bustard,
Senior Auditor

Amanda Rees,
Auditor



OFFICE OF THE
Auditor General
of British Columbia