Tab 5

Index

May 12, 2017

MANITOBA HYDRO

2017/18 & 2018/19 GENERAL RATE APPLICATION

ASSET MANAGEMENT & CAPITAL EXPENDITURE FORECAST

INDEX

Appendices

MANITOBA HYDRO

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5.0 OVERVIEW

Tab 5 provides a summary of Manitoba Hydro's asset investment processes and the resulting investment requirements necessary to meet the regionally growing energy needs of Manitoba, replace aging utility assets and pursue energy conservation and efficiency activities designed to manage the demand for energy.

Section 5.1 describes the corporation's asset management practices and various initiatives underway to improve its capital planning and portfolio management. Section 5.2 provides a summary of the Capital Expenditure & DSM Forecast (CEF16). This section includes further information on Major New Generation and Transmission (MNG&T) capital expenditures, including changes in the cost estimates for the Bipole III Reliability and Keeyask Generation projects, as well as details on the capital expenditure requirements for Electric Business Operations capital and a summary of program information related to Electric Demand Side Management (DSM) expenditures.

5.1 ASSET MANAGEMENT

Manitoba Hydro is an asset intensive organization that has been managing assets for generations and embraces the need to mature its asset management practices to maximize value from scarce funding.

In mature asset management organizations, asset processes are integrated and aligned to achieve a prescribed balance of asset performance, cost and risk that supports business objectives. Asset management is thereby the framework of processes and metrics used to make asset life cycle decisions, including operating context (duty cycle), maintenance schedules, and replacements/upgrades in accordance with corporate priorities and risk tolerances to maximize value creation within established constraints. In other words, asset management translates organizational objectives into asset-related decisions, plans and activities that balance cost, performance and risk.

A Corporate Asset Management initiative was launched in 2016 to foster mature and consistent asset management practices across the Corporation, as discussed in Section 5.1.1, below.

Core to this initiative is asset investment planning in consideration of the long and near term asset requirements. Section 5.1.2 describes how long term investment requirements are developed into near term portfolios of potential investments, from which projects are advanced for execution. Investment requirements for generation, transmission and distribution assets are also discussed in Section 5.1.2 and are enumerated in the Capital Expenditures Forecast, Section 5.2. Several specific asset management improvement initiatives are underway in support of the Corporate Asset Management initiative. These are discussed in Section 5.1.3.

5.1.1 Corporate Asset Management Initiative

The corporation's asset management initiative consists of centralizing asset management governance and developing a Corporate Asset Management Framework to foster mature and consistent asset management practices across the Corporation.

Centralized Asset Management Governance

Centralized asset management governance was instituted in 2016 through the creation of the Corporate Asset Management ("CAM") Executive Council and the CAM Steering Committee.

The CAM Executive Council is a Vice-President level committee chaired by the corporation's Chief Finance & Strategy Officer. The CAM Executive Council provides a centralized vision and direction for asset management at Manitoba Hydro and embodies the role of Asset Owner to set business objectives, risk tolerance and budgets.

The CAM Steering Committee is a Director level committee chaired by the Director of Strategic Business Integration, responsible for executing the corporation's asset management development strategy.

The Director of Strategic Business Integration is a new position created within the Finance & Strategy Corporate group with specific asset management responsibilities that integrate with Manitoba Hydro's financial planning processes.

Corporate Asset Management Framework

An external asset management consultant was retained to assist in development of a corporate asset management framework in three separate phases:

1. Assessment of current asset management practices;
2. Development of asset management policies and strategies; and
3. Development of a detailed roadmap for the implementation of a corporate asset management framework at Manitoba Hydro.

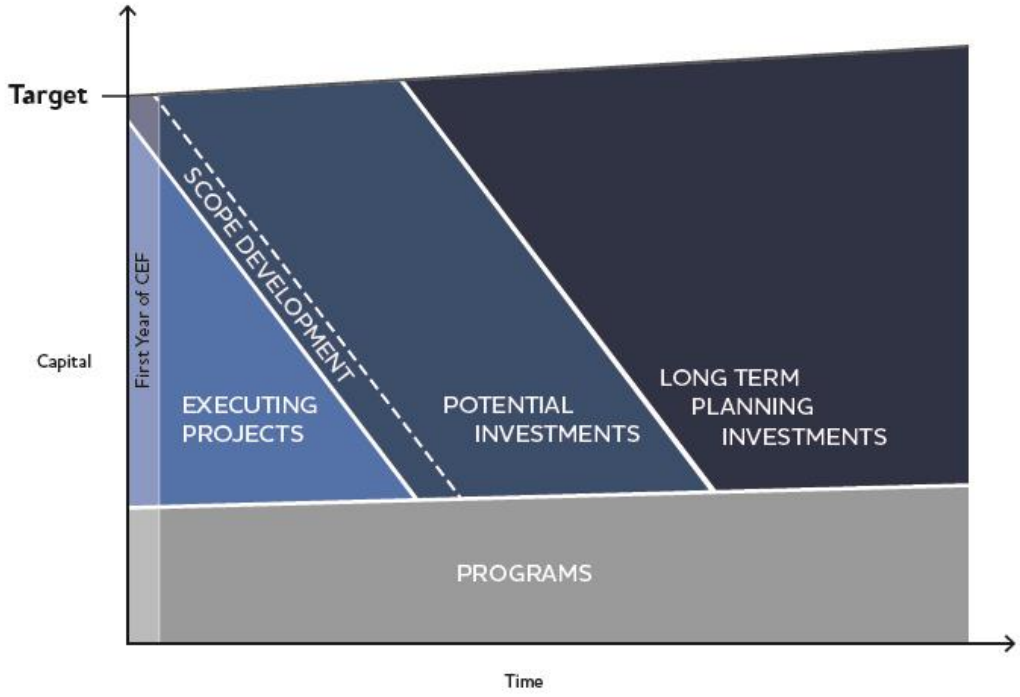
The UMS Group was selected through a competitive request for proposal process to provide expert asset management advice in 2016. The UMS Group is an international leader in asset management in the utility sector and has over 20 years of experience guiding utilities through the development of asset management systems and programs. They have recently worked with other Canadian utilities such as SaskPower, BC Hydro and Hydro One and are proficient in the application and use of asset management industry standards such as ISO 55000 and PAS55.

The first phase of Manitoba Hydro's engagement with UMS was an assessment of Manitoba Hydro's current asset management practices and comparing them to industry best practices as well as the ISO 55000 and PAS55 standards. The Asset Management Gap Assessment report can be found in Appendix 5.1.

5.1.2 Asset Investment Planning

Manitoba Hydro's capital planning model is depicted in **Figure 5.1** and is also the basis for the Corporation's investment requirements detailed in the Capital Expenditures Forecast (CEF). Certainty in the capital plan is highest in year one where projects have a defined scope, schedule and budget, as well as a start date. Plans become more uncertain and more likely to change the further they are out in time. Long term planning investments have only a notional definition of scope, schedule and budget.

Figure 5.1 Capital Planning Model



As depicted in **Figure 5.1**, *Programs* are a collection of asset classes requiring renewal that are not planned on a specific asset basis, but rather as a fleet. Examples include large populations of comparatively inexpensive assets that require annual replacement for sustainability (e.g. wood poles), ongoing fleet life extension works (e.g. cable injection) and run to failure assets, such as pole top transformers.

To understand the concept of run-to-failure, consider the example of pole top transformers. Manitoba Hydro runs pole top transformers to failure to utilize the full potential of the asset life cycle. Pole top transformers are low cost and common stock items which can be replaced in a short time frame (1-2 hours) once they fail. As they are not a critical asset, the benefit of avoiding in-service failure does not justify the cost of preventive monitoring and replacement.

Capital expenditures for programs are forecasted based on anticipated failure rates and necessary investment rates to keep asset populations healthy. Specific works within a program are scoped year to year according to immediate need and efficiency.

Long term planning investments reflect general requirements to maintain a sustainable balance of asset risk and performance for capital intensive assets. These are typically larger, more expensive assets that are monitored and maintained to avoid in-service failures. Examples include station transformers and generating unit components.

As assets are identified as having undesirable operating costs, performance or risks, specific *potential investments* are developed to explore potential remedial alternatives. Potential investments are also developed for system expansion needed to meet customer demand. A tentative start date may be associated to a potential investment to facilitate portfolio evaluation, but is fluid until a decision is made to execute.

The potential investments are considered on an annual basis for advancement to *scope development or project execution*, based on the urgency of the work and limiting constraints of capital funds and available staff resources. Scope development is used to advance the understanding of the costs, benefits and risks of an investment to allow for a more informed decision about advancing to execution.

Investments selected to begin execution in the next year (the first year of the CEF) join projects already in execution to form the portfolio of executing projects.

Decisions to proceed with project execution (i.e. plan the project to begin in year 1 of the CEF) are based on a consideration of multiple risk and economic factors reviewed in the context of the specific project relative to other potential investments. Factors include public and employee safety, asset condition and performance, regulatory compliance and asset life cycle costs. Advancement or deferral of potential investments is actively managed on an ongoing basis

throughout the year to address changing conditions and priorities while managing within funding and resource constraints.

The CEF depicts the corporation's projected investment requirements at a point in time, to which the only committed investments and those projects already in execution and those planned to begin in year 1. Potential investments included within the CEF are subject to change with changes in circumstances and priorities. **Figure 5.3** in Section 5.2 summarizes CEF16 forecasted requirements over the 10 year period from 2018 to 2027.

System Assets and Investments

Manitoba Hydro's electric system consists of the generation, transmission and distribution assets used to deliver electricity to customers.

In general, the status of the system and need for investment can be summarized as follows:

- The highest need for investment is in the distribution system. Aging populations of assets, expansion required to service regional growth and condition and capacity concerns on the existing system are expected to put pressure on long term funding levels.
- The transmission system also needs to expand to meet regional load growth in the near term with overall acceptable system reliability once Bipole III is in service. Long term funding levels included in the CEF are expected to be sufficient to sustain the system.
- The generation system has sufficient capacity to meet domestic and export customer commitments for the foreseeable future. Re-investment in some older generation assets is being reviewed. Near term funding levels are sufficient to sustain the system and long term requirements for the large northern stations are being examined.

Distribution System Assets

Both the substations and major asset classes making up Manitoba Hydro's distribution system require significant investment to address deteriorating condition. System renewal and expansion are also required to meet regional growth in customer load.

Manitoba Hydro has 280 distribution substations across rural Manitoba and 101 substations within the City of Winnipeg. Of the 101 city substations, 29 are above their firm capacity and 25 more are approaching firm capacity. A smaller number of rural stations are also approaching or beyond firm capacity.

This presents a major risk of customer outage as the likelihood of equipment failure increases significantly as substation capacity is exceeded. Limited substation capacity challenges Manitoba Hydro's ability to address new customer connections in a timely manner in regions that are capacity constrained. Customer connections are prioritized ahead of sustainment projects as Manitoba Hydro is mandated to serve customer growth.

In addition to capacity limitations, substation assets are deteriorating. Power transformers and substation breakers represent the highest value assets on the system and the highest risks. While a number of the assets in poorest condition will be addressed through planned substation capacity enhancement projects, the condition of substation breakers remains a particular concern. Many of these breakers were installed between the 1940s and 1960s and have deteriorated to a state where their continued operation presents operational and safety risks. These risks as well as the risk of extended customer outages due to equipment failure are being mitigated through spare and repair strategies but this strategy is becoming more difficult as spare parts are no longer being manufactured and replacement requires expensive retrofitting.

Major distribution asset classes include underground cables, manholes, duct lines, transformers, substation breakers, wood poles, and street light standards. These assets have relatively low per unit costs but there are millions of separate components spread across the province.. A significant portion of the assets are

approaching the end of their expected lives and will require acceleration in replacement rates to maintain distribution system performance over the next twenty years.

The four most concerning classes of distribution assets are substation breakers, underground cables, wood poles, and street light standards. Many of the assets within these classes have exceeded their life expectancy and as their condition continues to deteriorate they present a growing risk of equipment failure with potential impacts to electrical outages and public safety. Wood poles are particularly concerning as they were installed in waves as part of rural electrification in the 1940's and 1950's and are therefore also approaching end of life in waves.

CEF16 includes investments to address only the most concerning substation condition and capacity issues in the near term (approximately 5 years), as well as growth and expansion investments to meet customer service requirements. To pace the level of investment, significant investment in the major asset classes has been deferred beyond this horizon, causing degradation to pace ahead of renewal in the population.

Greater levels of investment may be required in future years to sustain the major asset classes and avoid building an overwhelming asset condition deficit. Asset management practices are being developed to model the investments needed to balance cost, performance and risks within the distribution system and plan sustainable levels of investment.

Transmission System Assets

Manitoba Hydro's major transmission system assets include overhead conductor & hardware, wood pole structures and steel structures, and transmission station equipment such as breakers, protection relays and transformers, as well as highly sophisticated apparatus at the HVDC converter stations.

The overhead conductor, hardware, wood pole structures and steel structures that constitute the transmission lines connecting the electrical system across the Province are generally serviceable, with the exception of some of the oldest lines

which do not meet modern standards and require replacement or decommissioning. Transmission line assets have long life expectancies and require little maintenance to sustain their condition. Annual programs are in place to replace transmission line components based on condition, such as tilting northern tower foundations flagged through inspection and wood pole structures assessed through the Integrated Pole Maintenance program.

The majority of transmission station assets are also serviceable. Some station breakers and protection relays will be replaced in the coming years due to obsolescence, and condition and performance issues; however, most condition-based proactive replacements are expected to occur five or more years from now. The reliability risk of running these assets to failure is being managed through spare and repair strategies when possible. This strategy is only effective so long as spare parts are available and failure rates remain manageable.

Assets within the HVDC system are very complex and expensive to replace and usually require long lead times. Significant maintenance is performed to sustain and extend the asset lifetimes, and these efforts have so far been successful in keeping the assets serviceable. Of major concern is the condition of the Bipole II valve groups, which rank among the oldest in the world. A significant replacement project for this equipment is included in CEF16, currently planned to occur beyond the five-year window. The completion of Bipole III will improve the reliability of the HVDC system and create redundancy which takes the immediate pressure off of Bipoles I and II.

Capacity constraints remain the largest risk associated with the transmission system. Rapid load growth in areas such as Winnipeg, Steinbach, Portage la Prairie, Winkler, Morden and the east side of Lake Winnipeg require that the transmission system in these areas be upgraded. CEF16 includes major investment projects to address these capacity concerns over the next five years.

The main driver for future transmission system projects will be the risks associated with system load growth, the location of new customer load additions on the system and the ongoing degradation of long serving assets. A single large customer could

potentially trigger the need for capacity investment dependent on the location within the province and existing capacity levels.

Generation System Assets

Manitoba Hydro's generation system assets include water retaining structures, water control equipment, generation drive train assets and associated station infrastructure, as well as support infrastructure such as airports and town sites at remote locations.

The majority of generation system assets are generally serviceable; however, some of the generating facilities on the Winnipeg River were built more than 100 years ago and will require significant renewal to remain operational beyond the near term. These facilities represent a small portion of Manitoba Hydro's production capacity. The remainder of Manitoba Hydro's generating system also requires care and attention to meet operational requirements as asset condition deteriorates.

Dam safety and the maintenance of water retaining structures and control equipment are of paramount importance due to the high consequences of uncontrolled water release. Also, generation equipment is carefully managed as downtime results in lost revenue and could threaten energy delivery to customers. These and other critical and expensive assets are monitored for performance and condition, are subject to regular maintenance and when appropriate are replaced or refurbished to avoid in-service failures.

Investment plans within CEF16 have been reduced significantly as compared to CEF15 by deferring asset renewal projects at the Point de Bois Generating Station. Pointe du Bois is Manitoba Hydro's oldest generating station built circa 1911. Assets at the site have significantly deteriorated over time and much of the equipment is obsolete and no longer serviceable. The spillway and water retaining structures were replaced in 2015 to address dam and public safety concerns and assure control of the river. Plans were also in place to repower the power house by replacing some of the generating units and modernizing station equipment to improve safety and reduce maintenance/operating requirements. Due to declining export power prices, the business case for reinvestment in the Pointe du Bois power house is being re-

evaluated to assess the viability of the facility as a generating station investment; decommissioning of the power house is under consideration.

The current levels of sustaining investment in generation system assets are adequate to maintain the serviceability of the existing generating fleet within the near term (3 to 5 years). It is suspected that additional investment may be required beyond this horizon to sustain the large Lower Nelson River assets as their condition deteriorates. These investments will be proactively planned and paced within cost, resource and timing constraints to meet operational requirements and manage risks. Options for renewal and decommissioning are also being studied at aging generating facilities that may not be sustainable.

Section 5.4 of this Tab provides a breakdown of the forecast capital expenditures by investment category, including expenditures required to address capacity and load growth, sustainment of infrastructure and to support business operations.

5.1.3 Asset Investment Process Improvements

Manitoba Hydro's objectives for future asset investment practice are to:

1. Optimize timing of investments to maximize value; and
2. Forecast long term corporate capital requirements

Optimizing the timing of investments to maximize value refers to the near term portfolio of potential investments and their advancement to scope development and execution.

Forecasting long term corporate capital requirements refers to the long term planning of significant investments, including investments needed to sustain the existing system of assets and investments needed to expand the system to meet customer demands.

A roadmap is currently under development for achieving these objectives. The roadmap will detail the steps needed to deploy corporate tools and processes, build supporting sub-processes and data structures, populate asset inventories and collect

data, and build proficiency in the user groups. The anticipated timeline to achieving the objectives is three to five years.

Foundational corporate level initiatives currently underway include the Corporate Value Framework to assess the value of investments, and the Capital Portfolio Management Program to deploy a suite of processes and tools to anchor capital planning and portfolio management. Improving Asset Health Index methodologies as a key capital planning input is also underway for transmission and distribution asset classes. These are discussed below.

Corporate Value Framework

Manitoba Hydro engaged Copperleaf Technologies Inc. ("Copperleaf") to assist in the development of a Corporate Value Framework (sometimes referred to as "CVF") methodology. A Corporate Value Framework is a systematic framework to understand the value of all investments in an organization. The CVF helps identify the optimal set of investments that deliver the greatest value (or mitigates risk) to the organization, within funding, resource and timing constraints. This tool will be used to assess the value of capital investments across all areas of the corporation in support of allocating funds to projects and assets that optimize strategic value or mitigate risk.

Initial development of the Corporate Value Framework is complete and the tool is being piloted in the Generation & Wholesale Business Group while being rolled out in other groups as part of the Capital Portfolio Management Program (see below). As the user base grows, the measures making up the value streams in the Corporate Value Framework continue to be refined and the value streams calibrated to business objectives. Associated business processes will also need to mature to fully utilize the Corporate Value Framework.

Manitoba Hydro is seeking consent of Copperleaf Technologies to file its proprietary report.

Capital Portfolio Management Program

The Capital Portfolio Management (sometimes referred to as CPM) Program will standardize capital investment planning processes through the implementation of Copperleaf's C55 asset investment planning software. The Terms of Reference for the Capital Portfolio Management Program can be found in Appendix 5.2.

Copperleaf's C55 is an enterprise wide platform that supports a risk-informed and value-based approach to investment decision making. The Capital Portfolio Management Program provides a consistent set of processes and methods for investment portfolio management and optimization, as well as asset and program analytics to support investment planning.

Asset Health Indices

Asset condition and health, indices and scores, methodologies and assessments are some of the terms used somewhat interchangeably in industry without an accepted industry convention or definition. As referred to in this Application and its supporting materials, asset health and asset condition are synonymous in describing the state or degradation of an asset. Asset health indices and asset condition scores are equally synonymous in describing a relative quantification of degradation useful in comparing assets to each other and to larger experience databases. Methodology refers to how the assets are to be assessed to calculate the asset health index or asset condition score. And finally, asset condition assessment is the act of performing the assessment to determine the index or score.

Asset Health Indices are used to link asset condition to probability of failure and thus can be used as an indicator of future investment requirements. The methodology used varies by asset according to the cost to upgrade/replace, consequences of in-service failure and performance characteristics.

For instance, assets with a long life expectancy and whose condition does not change quickly are monitored infrequently. Faster changing assets are monitored more frequently. Digital equipment that does not deteriorate, but rather simply stops working with no measurable warning is not monitored. Complex equipment can have multiple measurement points and assessment parameters, whereas simple

equipment may have only one. Assets with significant consequence of in-service failure are monitored closely whereas others are run to failure without monitoring.

Thus, the refresh rate and depth of routine condition data varies significantly by asset, described as asset condition assessment methodology.

It is not possible to predict the timing of asset failure with sufficient confidence to plan specific asset replacements/upgrades using Asset Health Indices methodology alone, even for assets near end of life. Assets with pending upgrade/replacement requirements are subject to a more extensive risk informed economic end-of-life analysis that goes well beyond AHI, particularly for larger scale, more complex assets. This assessment is used to optimize the timing of executing capital projects in the near term. The results of the detailed assessments are used to justify specific investments and will be used in the future for project valuation through the Corporate Value Framework.

Kinectrics Inc. (Kinectrics), an independent company that is recognized worldwide for outstanding technical and business excellence in the energy sector, was retained to assist with several AHI improvement initiatives in support of asset management, including:

- An asset condition assessment for key distribution system assets (this report is in preparation and will be filed when available).
- An asset condition assessment audit for transmission, HVDC and distribution system assets (Appendix 5.3).
- Development of condition degradation curves (estimate/forecast of how condition degrades over time) for some transmission system assets (this report is in preparation and will be filed when available).

Updated asset condition assessments and the revised degradation curves are being configured in Copperleaf C55 as part of the Capital Portfolio Management Program.

5.2 CEF16 SUMMARY

The Capital Expenditure & Demand Side Management Forecast (CEF16) is a projection of Manitoba Hydro's capital expenditures for new and replacement facilities to meet the electricity and natural gas service requirements in the Province of Manitoba as well as expenditures required to meet firm sale commitments outside the province. Expenditures included in CEF16 will provide for an ongoing safe and reliable supply of energy in the most efficient and environmentally sensitive manner. CEF16 also includes a projection of Manitoba Hydro's DSM programs which provide education, incentives and expertise to achieve energy savings to offset growing demand. A copy of CEF16 is included as Appendix 5.4.

Capital Expenditures are categorized between Major New Generation and Transmission (MNG&T) projects and Business Operations capital. MNG&T projects provide significant new generation and transmission capacity and include projects of a substantial cost. Business Operations capital addresses requirements to sustain electricity and natural gas service through replacement of aging or obsolete assets, capacity enhancements as well as system expansion due to load growth. Included are expenditures which support business operations such as fleet, administrative buildings and information technology hardware and software. **Figure 5.2** provides a 10 year summary of Electric Capital & DSM.

Figure 5.2 Summary of Electric Capital & DSM

($ Millions)	2017 Outlook	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2018-2027 10 Year Total
Major New Generation & Transmission	2 355	2 476	2 126	1 274	1 066	746	358	75	4	4	5	**8 134**
Electric Business Operations Capital	574	526	517	516	511	499	521	544	616	640	659	**5 549**
Total Electric Capital	**2 929**	**3 002**	**2 643**	**1 790**	**1 578**	**1 246**	**879**	**619**	**620**	**644**	**664**	**13 683**
Year End Outlook Adjustment	(45)	-	-	-	-	-	-	-	-	-	-	**-**
Total Revised Electric Capital	**2 884**	**3 002**	**2 643**	**1 790**	**1 578**	**1 246**	**879**	**619**	**620**	**644**	**664**	**13 683**
Electric Demand Side Management	50	56	99	94	89	87	67	60	62	67	71	**752**
Total Electric Capital & Demand Side Management	**2 934**	**3 058**	**2 742**	**1 884**	**1 666**	**1 332**	**945**	**679**	**682**	**711**	**734**	**14 435**

CEF16 for electric operations totals $14 435 million for the ten year period from 2017/18 through 2026/27. Expenditures for MNG&T total $8 134 million, and $5 549 million for Business Operations capital. DSM programs total $752 million for the same period.

Figure 5.3 summarizes the annual forecast over the 2016/17 to 2018/19 timeframe and the 10 year forecast period by executing projects, potential investments, programs and planning investments.

Figure 5.3 Summary of Electric Capital & Demand Side Management

($ Millions)	Total Project Cost	2017 Outlook	2018 Forecast	2019 Forecast	2018 - 2027 10 Year
MNGT					
Executing Projects	17 796	2 355	2 476	2 126	8 134
Electric Business Operations Capital					
Executing Projects	3 016	394	325	211	991
Potential Investments	425	-	-	6	391
Programs	NA	242	265	290	3 089
Planning Investments	NA	-	-	26	1 426
Portfolio Adjustments	NA	(63)	(64)	(16)	(303)
Unallocated Year End Outlook Adjustment - Electric		(45)			(45)
		529	526	517	5 549
DSM					
Electric Demand Side Management		50	56	99	752
Total Electric Capital & Demand Side Management	**21 236**	**2 934**	**3 058**	**2 742**	**14 435**

Investment Categories

Manitoba Hydro has incorporated the use of investment categories, which are commonly used within the industry to provide a better understanding of the primary driver for the investment. The primary investment categories are further broken down into sub-categories.

The primary investment categories are Capacity & Growth, Sustainment and Business Operations Support. Capacity & Growth investments provide for future load growth or address existing capacity constraints in key geographic areas on the transmission and distribution system. Sustainment investments are required to ensure the continued and future performance capability of the electricity system and address the issue of aging or obsolete assets. Business Operations Support investments support corporate operations including IT investments, fleet and administrative buildings. Further information on the investment categories can be found in Appendix D of the Capital Expenditure & Demand Side Management Forecast (CEF16).

Figure 5.4 below provides a breakdown of Electric Capital & DSM by Investment Category over the 2016/17 to 2018/19 timeframe and the 10 year forecast period.

Figure 5.4 Summary of Electric Capital & DSM by Investment Category

($ Millions)	2017 Outlook	2018	2019	2018-2027 10 Year Total
Major New Generation & Transmission				
Capacity & Growth	2 308	2 410	2 073	7 864
Sustainment	29	18	7	24
Business Operations Support	18	49	46	246
Business Operations				-
Capacity & Growth	195	183	170	1 341
Sustainment	303	280	284	3 549
Business Operations Support	75	63	62	659
Unallocated Year End Outlook Adjustment - Electric	(45)	-	-	-
Electric Demand Side Management	50	56	99	752
Total Electric	**2 934**	**3 058**	**2 742**	**14 435**

CEF Comparison

CEF16 for electric operations over the ten year period to 2027 totals $14 435 million compared to $11 918 for the same 10 year period in CEF15. The increase of $2 516 million is primarily due to revised estimates for the Keeyask Generation and Bipole III Reliability projects. **Figures 5.5** and **5.6** provide a summary of the changes over the 10 year period.

Figure 5.5 Change in Cost Flow from CEF15 to CEF16

Electric Only ($ Millions)	2017 Outlook	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2018-2027 10 Year Total
CEF15	3,356	2,923	2,008	1,443	1,033	880	714	680	730	739	767	**11,918**
Incr (Decr)	(422)	134	734	441	633	453	231	(1)	(48)	(29)	(33)	**2,516**
CEF16	**2,934**	**3,058**	**2,742**	**1,884**	**1,666**	**1,332**	**945**	**679**	**682**	**711**	**734**	**14,435**

Figure 5.6 Breakdown of 10 Year Cost Flow Change from CEF15 to CEF16

Electric Only ($ Millions)	Total Projected Cost	10 Year Increase (Decrease) 2018 to 2027
Keeyask - Generation	8 726	2 505
Bipole III Reliability	5 042	835
Manitoba-Minnesota Transmission Project	453	113
Generating Station Improvements & Upgrades	NA	(256)
Target Adjustment for MNG&T	NA	(293)
Other MNG&T Projects	NA	(59)
Electric Business Operations Capital	NA	(237)
Electric Demand Side Management	NA	(90)
		2 516

5.2.1 Major New Generation & Transmission

Expenditures for MNG&T total $8 134 million over the 10 year forecast period to 2027. **Figure 5.7** provides a breakdown by investment category of the MNG&T forecast over the 10 year period. Of the $8 134 million, $5 474 million is for New Energy (primarily for Keeyask Generation) and a further $1 906 million is required to address System Load Capacity (Bipole III Reliability project).

Figure 5.7 MNG&T 10 Year Forecast by Investment Category

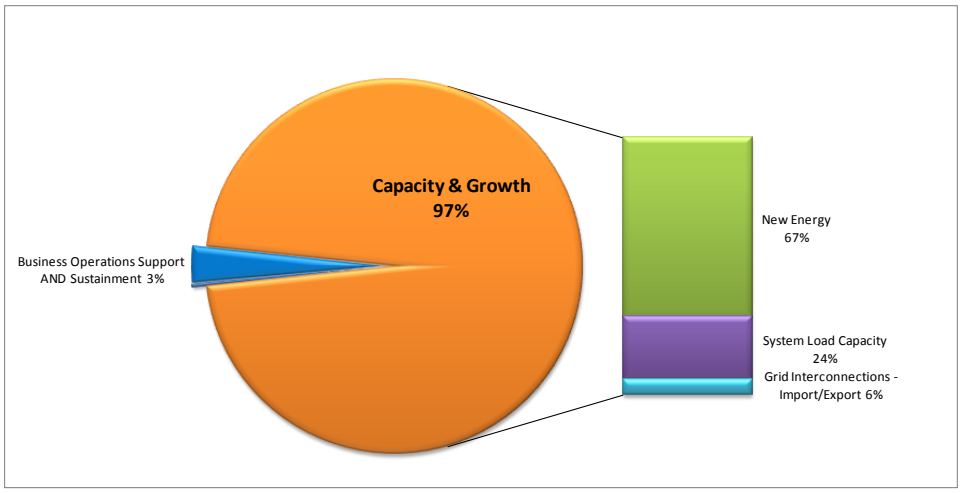


Figure 5.8 provides the annual forecast for each MNG&T project by investment category over the test year period (2016/17 to 2018/19) as well as the cumulative forecast over the 10 years to 2027.

Figure 5.8 MNG&T Forecast - CEF16

($ Millions)	2017 Outlook	2018	2019	2018-2027 10 Year Total
Capacity & Growth				
New Energy				
Keeyask - Generation	914	1,077	1,290	5,453
Kelsey Improvements & Upgrades	4	7	9	16
Wuskwatim - Generation	4	5	-	5
Conawapa - Generation	18	-	-	-
System Load Capacity				
Bipole III Reliability:				
Bipole III - Transmission Line	477	511	346	868
Bipole III - Converter Stations	822	679	286	974
Bipole III - Collector Lines	55	36	24	61
Bipole III - Community Development Initiative	3	3	1	4
Bipole III Total	1,356	1,229	657	1,906
Riel 230/500kV Station	1	-	-	-
Grid Interconnections- Import/Export				
Manitoba-Minnesota Transmission Project	7	87	114	431
Manitoba-Saskatchewan Transmission Project	3	4	2	53
Sustainment				
System Renewal				
Kettle Improvements & Upgrades	19	13	1	14
Pointe du Bois Spillway Replacement	7	5	6	11
Pointe du Bois - Transmission	4	0	-	0
Business Operations & Support				
Townsite Infrastructure				
Gillam Redevelopment and Expansion Program (GREP)	15	37	40	226
Corporate Facilities				
Grand Rapids Fish Hatchery Upgrade & Expansion	3	12	6	19
Total Major New Generation & Transmission	**2,355**	**2,476**	**2,126**	**8,134**

Compared to CEF15, the total project forecast has increased by $2 531 million. The following section provides a summary of cost updates for the MNG&T projects for CEF16 as compared to CEF15 and revision reasons.

Figure 5.9 MNG&T CEF16 as compared to CEF15

($ millions)	Total Project CEF16	Total Project CEF15	Change in Total Project Inc/(Dec)	Reasons for Revision
Keeyask - Generation	8,726.0	6,496.1	2,230.0	Refer to Section 5.3.1 Keeyask Generating Station
Bipole III Transmission Reliability Project	5,041.7	4,652.6	389.1	Refer to Section 5.3.2 Bipole Reliability Project
Wuskwatim - Generation	1,421.6	1,448.6	(27.0)	The decrease of $27 million reflects a revision in scope for the staffhouse from a three level 60 room hotel style building to 11 ready-to-move duplex homes consisting of 22 full suites. In addition, estimates on the generating station plant deficiencies and project close-out costs have been lowered through reduced potential risk on direct contract costs through favourable market conditions. The final in-service date for the staffhouse has been advanced by four months to September 2017 and final project close-out is anticipated to be completed in March 2018.
Pointe du Bois Spillway Replacement	575.7	594.8	(19.1)	The project decrease of $19.1 million reflects planned contract risks not materializing, better than expected contractor performance and reduced costs. The forecast includes costs for remaining site restoration, general civil contract commercial settlement and project contingency.
Manitoba-Minnesota Transmission Project	453.2	353.6	99.6	Refer to Section 5.3.3 Manitoba-Minnesota Transmission Project.
Conawapa - Generation	379.8	404.7	(24.9)	The decrease of $24.9 million reflects less enironmental studies and field work, as well as lower than anticipated costs for agreements related to Aboriginal Traditional Knowledge. Capitalized interest is suspended effective December 2016.
Kelsey Improvements & Upgrades	336.9	338.8	(1.9)	The project decrease of $1.9 million is due to inner hedcover deficiency costs lower than expected. In service date deferred thirteen months from November 2016.
Riel 230/500kV Station	319.9	319.9	0.0	No change.
Gillam Redevelopment and Expansion Program (GREP)	266.5	266.5	(0.0)	No change.
Kettle Improvements & Upgrades	112.2	190.9	(78.7)	The project decrease of $78.7 million reflects the cancellation of the Units 5-12 stator rewinds. A planning item was identified in the 1990's for the stator rewind of Units 5 to 12 at Kettle GS. This planning item was never formalized into a capital project and has been removed pending further study and analysis. In addition, estimates for work on units 1-3 have been reduced to reflect the awarding of mechanical contracts at a significantly lower cost and lower than expected internal resource requirements. In-service date on units 1-4 are advanced one month from December 2017.
Pointe du Bois - Transmission	82.4	118.1	(35.7)	The project decrease of $35.7 million is primarily due to the transfer of forecasted costs to a planning item of potential future work involving a new 115kV transmission line from Pointe du Bois to Whiteshell and associated terminations, the Bank 8 addition and the salvage of the Pointe du Bois to Rover 66kV lines. Partially offset by an increase associated with the Stafford Station Rebuild and the Slave Falls Switchyard Protection Upgrades. Final in-service advanced 40 months from March 2020.
Manitoba-Saskatchewan Transmission Project	56.5	57.0	(0.6)	No Change.
Grand Rapids Fish Hatchery Upgrade & Expansion	23.5	23.5	(0.0)	No Change.
Sub-Total	**17,795.7**	**15,265.0**	**2,530.7**	

Keeyask Generating Station

Keeyask is located upstream of the Kettle Generating Station on the Nelson River with a design rating of 695 MW under ideal operating conditions and a winter peak rating of 630 MW which is utilized for planning purposes. Subsequent to the events described in Tab 2, a review by the Boston Consulting Group and Manitoba Hydro found the potential for delay in the Keeyask Generation Project. Upon further review, a revised estimate was submitted and approved by the Manitoba Hydro-Electric Board (MHEB) for the Keeyask project from $6 496 million to $8 726 million and a corresponding 21-month extension to the schedule. The increased estimate incorporates a revised budget and schedule as a result of a schedule delay with the General Civil contract.

Leading up to spring 2016, the project remained within budget and on schedule. However, as the ramp-up into the first concrete work on the principal structures took place, the contractor fell progressively further behind as the summer construction season unfolded. Around the same time, progress on the earthworks began to slip as a number of geotechnical challenges were realized. At the conclusion of 2016, the first full year of civil works (first year of concrete construction of the principle structures), progress of the concrete structures was roughly 40 percent and progress of the earthworks was roughly 60 percent of the plan for the year. As a result, a recovery plan was developed and implemented for the General Civil Works contract and the overall Keeyask project. The recovery plan includes a comprehensive amendment to the General Civil contract, a re-organization of the project execution team and the development of strategies to increase production rates. All other components of the project remain on track but have been affected due to a longer schedule and increased work force to accommodate the recovery plan.

Bipole III Reliability Project

The Manitoba Hydro-Electric Board (MHEB) approved a revised estimate for the Bipole III Reliability project from $4 653 million to $5 042 million with no change to schedule.

The revised estimate incorporates increases in actual costs and awarded contracts to date as a result of higher than planned market rates for anchors and foundation construction and tower assembly, erection and stringing contracts. Other increases include: delay claims (weather and material) experienced to date, construction schedule compression and resultant costs, increased equipment and vehicle costs to support construction, additional materials required for southern route changes, property costs for finalized southern route, greater material management costs, relationship management costs, environmental monitoring costs, inclusion of additional provincial road upgrades and contingency to address project risks.

Manitoba – Minnesota Transmission Project

The Manitoba – Minnesota Transmission Project is a 500 kV AC transmission line in southeastern Manitoba, connecting at the border with Minnesota Power's proposed Great Northern Transmission Line. The Manitoba – Minnesota Transmission Project will enable power to be exported to the United States based on current sales agreements, improve reliability and import capacity in emergency and drought situations, and increase access to markets in the U.S. The projected in-service date is 2020/21. The Great Northern Transmission Line has received all key U.S. regulatory approvals, including a Certificate of Need on June 30, 2015 and a Route Permit on April 11, 2016 both from the Minnesota Public Utilities Commission and a Presidential Permit PP-398 from the U.S. Department of Energy on November 15, 2016. Manitoba Hydro filed an Application to construct and operate an international power line for the Manitoba – Minnesota Transmission project with the National Energy Board on December 16, 2016.

The Manitoba Hydro-Electric Board (MHEB) approved a revised estimate for the Manitoba - Minnesota Transmission Project from $354 million to $453 million to reflect updated costs for transmission line construction, licensing, and environmental assessment work, station improvements and contingency including management reserve and funding for Indigenous opportunities.

5.2.2 Business Operations Capital

Expenditures for Electric Business Operations capital total $5 549 million over the 10 year forecast period to 2027. **Figure 5.10** provides a breakdown of the forecast by investment category over the 10 year period. Of the $5 549 million, $3 062 million is for System Renewal (e.g. HVDC Transformer Replacement program), $890 million to address System Load Capacity on the transmission and distribution systems (e.g. Dawson Road Station) and a further $451 million is required for Customer Connections (residential, commercial and industrial).

Figure 5.10 Electric Business Operations Capital 10 Year Forecast by Investment Category

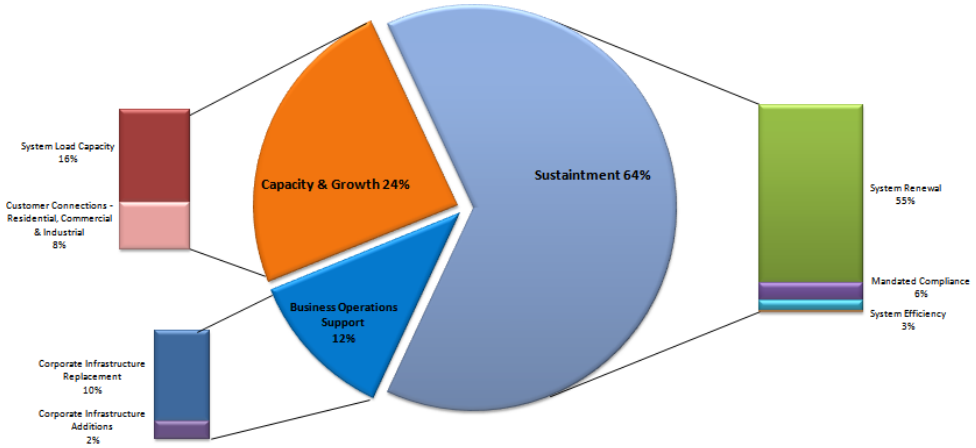


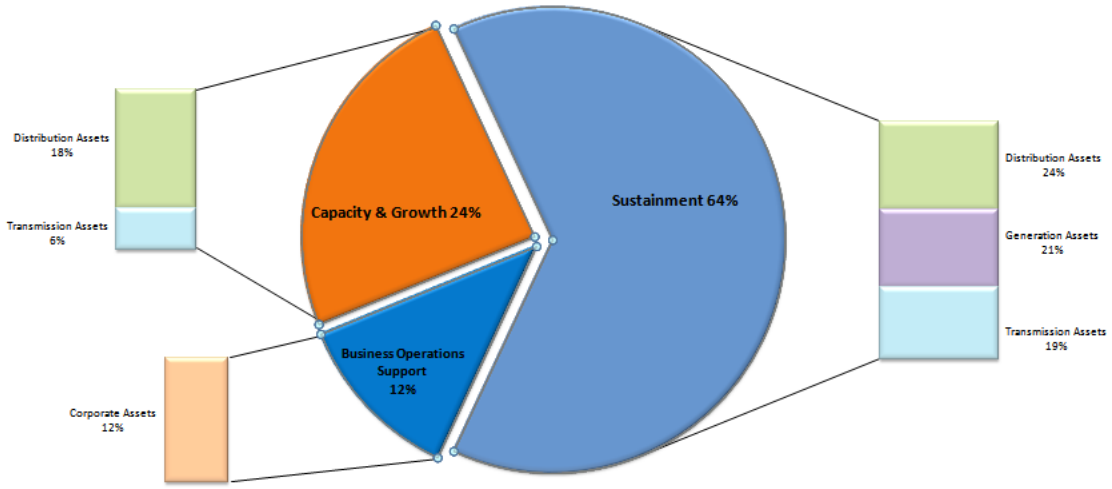
Figure 5.11 provides the annual forecast by investment category over the test year period (2016/17 to 2018/19) as well as the cumulative forecast over the 10 years to 2027.

Figure 5.11 Electric Business Operations Capital by Investment Category

($ Millions)	2017 Outlook	2018	2019	2018-2027 10 Year Total
Capacity & Growth				
System Load Capacity	159	144	128	890
Customer Connections - Residential, Commercial & Indus	37	40	43	454
Grid Interconnections - Independent Power Producer	(0)	(0)	(0)	(3)
Total Capacity & Growth- Electric	**195**	**183**	**170**	**1 341**
Sustainment				
System Renewal	225	217	230	3 062
Mandated Compliance	56	39	37	302
System Efficiency	22	23	17	178
Decommissioning	0	0	0	6
Total Sustainment- Electric	**303**	**280**	**284**	**3 549**
Business Operations Support				
Information Technology	25	27	27	263
Fleet	17	15	15	157
Corporate Facilities	25	12	12	138
Tools and Equipment	5	5	5	52
Town site Infrastructure	3	4	1	16
Generation Buildings and Grounds	-	-	1	32
Total Business Operations Support- Electric	**75**	**63**	**62**	**659**
Unallocated Year End Outlook Adjustment -Electric	(45)	-	-	-
Total Unallocated Target Adjustment- Electric	**(45)**	**-**	**-**	**-**
Total Electric Business Operations Capital	**529**	**526**	**517**	**5 549**

Figure 5.12 provides a breakdown by major asset type (i.e. generation, transmission, distribution and corporate assets) within each of the primary investment categories.

Figure 5.12 Electric Business Operations Capital by Investment Category



Business Operations capital targets have decreased by $237 million over the same 10 year period as compared to CEF15 reflecting projected labour and sourcing savings identified as part of the plan to improve the corporation's financial position. **Figure 5.13** provides the annual cost flow changes between CEF16 and CEF15.

Figure 5.13 Change in Cost Flow from CEF15 to CEF16

Electric Business Operations Capital ($ Millions)	2017 Outlook	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2018-2027 10 Year Total
CEF15	610	547	547	548	573	555	563	571	621	624	637	**5,786**
Incr (Decr)	(81)	(22)	(31)	(32)	(61)	(55)	(42)	(27)	(6)	16	22	**(237)**
CEF16	**529**	**526**	**517**	**516**	**511**	**499**	**521**	**544**	**616**	**640**	**659**	**5,549**

5.2.3 Demand Side Management

Manitoba Hydro's Electric DSM Program targets the achievement of 945 MW and 3,271 GW.h of savings over the next 10 years based upon a capital investment of $752 million dollars and will be relied upon to meet approximately 90% of projected load growth during this period. This is a reduction of $90 million as compared to CEF15.

Figure 5.14 Change in Cost Flow from CEF15 to CEF16

Electric Only ($ Millions)	2017 Outlook	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2018-2027 10 Year Total
CEF15 Demand Side Management	58	99	95	90	92	97	72	67	71	77	82	**842**
Incr (Decr)	(8)	(43)	5	4	(4)	(10)	(6)	(7)	(9)	(10)	(11)	**(90)**
CEF16 Demand Side Management	**50**	**56**	**99**	**94**	**89**	**87**	**67**	**60**	**62**	**67**	**71**	**752**

Figure 5.15 provides an explanation of the major changes over the 10 year forecast period associated with the updated DSM plan.

Figure 5.15 DSM 10 Year Cost Flow Update

Sector	CEF 16 (millions) (2017/18 to 2026/27)	CEF 15 (millions) (2017/18 to 2026/27)	Increase (Decrease)	Explanation
Residential Energy Efficiency	$64.4	$70.5	-$6.1	Decrease due to a change in proposed eligible measures to be offered under the Affordable Energy Program based upon updated market information.
Commercial Energy Efficiency	$198.1	$196.2	$1.9	N/A
Industrial Energy Efficiency	$77.3	$96.3	-$19.0	Decrease in forecast participation levels for the Industrial Performance Optimization Program based on updated market information.
Load Management Program	$68.6	$69.9	-$1.3	N/A
Load Displacement & Alternative Energy Program	$105.2	$128.5	-$23.3	Decrease in the forecast load displacement projects based on updated market information.
Conservation Rates	$24.1	$28.7	-$4.6	Program launch delayed to future years.
Fuel Choice Program	$43.4	$56.0	-$12.6	Reflects removal of the Fuel Choice Program activity in 2017/18.
Other Emerging Technologies	$143.1	$159.9	-$16.7	Decrease in forecast participation levels for the Residential Solar Photovoltaics Program based on updated market information.
Support & Contingency	$27.3	$35.6	-$8.3	Change in allocation of financial loan activity between electric and natural gas DSM, resulting in the overall decrease.
Demand Side Management	**$751.6**	**$841.7**	**-$90.1**	

The DSM Program targets a 814 MW reduction in peak load and a 3,527 GWh reduction in annual energy consumption by 2030/31, which is similar to 2015 projections, which included 824 MW and 3,498 GWh achieved by 2029/30. Incremental DSM excludes savings already achieved to date, savings achieved through codes and standards which are included in the Load Forecast, and savings from curtailable rates programming beyond existing contracts that do not qualify as winter peak capacity as these are short-term resources.