



December 1, 2014

LDC ASSET RENEWAL SERIES

Part 3: Asset Upkeep & Renewal

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1.0 Executive Summary

A significant portion of the province's distribution assets are reaching the end of their useful life. Increased investment is required to replace these assets while concurrently building the smart grid. Infrastructure and equipment expenditures must be examined within the context of contemporary challenges: replacing aging infrastructure, integrating digital equipment, new processes and tools that facilitate cost-effective maintenance and refurbishment, rate pressures, and increasing risk of obsolescence as innovation accelerates.

LDCs use comprehensive asset management and capital planning processes in an effort to optimize the value of their investments. The OEB scrutinizes these plans when LDCs file their Distribution System Plans (DSP). Evidence suggests that LDCs show maturity in asset and capital planning, while new OEB filing requirements are more efficient. Nevertheless, there is room for growth: LDCs could follow international standards, consider uniform risk measurements across the sector, and continuously improve on maintenance regimes, while the OEB should seek third-party evaluations and determine a benchmark for asset planning prior to 2018.

The LDC workforce also requires renewal. With a significant portion of the sector's employees set to retire in the coming decades, LDCs will have to use new tools to recruit a new generation of workers, adjust to their worldview, and capture the knowledge of those departing.

1.1 Glossary

ACA – Asset Condition Assessment
ADMS – Advanced Distribution Management System
AMI – Advanced Metering Infrastructure
CBM – Condition-based maintenance
CEA – Canadian Electricity Association
DSP – Distribution System Plan
FIM – Feeder Investment Model
GDP – Gross Domestic Product
IEA – International Energy Agency
LDC – Local distribution company
OEB – Ontario Energy Board
OM&A - Operations, Maintenance and Administration
PBM – Performance-based maintenance
RCM – Reliability-centred maintenance
RRFE - Renewed Regulatory Framework
SCADA - Supervisory control and data acquisition
WPF – Worst Performing Feeder

2.0 The State of the Grid

A significant portion of Ontario's distribution assets need to be replaced. The CEA estimates that Canada will need to invest approximately \$240 billion in its electricity sector by 2030 (CEA, *How Will We Power 3*). The Conference Board predicts that Canada requires distribution asset investments of \$62 billion (2010 dollars) between 2011 and 2031. Ontario's share is \$21 billion, nearly three-quarters of which is required to sustain current service levels. This projection excludes investments in smart grid and distributed generation (Baker et. al. 23). The Conference Board estimates that for every \$100 million of these investments, real GDP rises by \$85.6 million and 1,200 jobs are created (Coad, Crawford & Macdonald i). The need for this investment comes at a time of declining consumption intensity, slowing economic growth, rising rates, and pressure on public sector spending.

Ontario's LDCs are facing the challenges of aging infrastructure in ways that reflect their customer base and asset portfolios. To consider the state of Ontario's distribution asset stock, we selected the three largest LDCs in the province. Combined, they serve over 2 million customers, more than the other LDCs combined (Ontario Distribution Sector Review Panel 7). There are also selected statistics from other, smaller distributors.

In 2012, 28% of Toronto Hydro's assets were past their end-of-life, representing a replacement value of \$3.2 billion. An additional 20% of their assets will reach end-of-life within a decade, requiring another \$2.4 billion in sustaining investments (Toronto Hydro, *2012 Corporate Responsibility Report 44*). The company must also contend with considerable load growth, particularly with Toronto's "high-rise boom." Recently, Toronto Hydro invested \$190 million in the new Copeland TS to address growth in the downtown core. Windsor TS currently serves the area. Due to its advanced age, the utility must manufacture its own parts to keep it in service. Even with continuing maintenance at Windsor TS, the station will reach full capacity within a few years. A major failure at Windsor could interrupt power to the financial district, Rogers Centre, CN Tower, and Union Station (Toronto Hydro, *Reliability for the Core 1-2*).

In a 2012 study of Toronto Hydro's asset base, Kinectrics found that:

- Nearly 7% of station power transformers were in "poor" or "very poor" condition, while 40% were in "fair" condition. Only half of these transformers are in "good" or "very good" condition;
- 35% of station switchgear was in fair condition, while over 28% of switchgears were in "poor" or "very poor" condition;
- Approximately 60% of air magnetic, 74% of Oil KSO, 88% of air blast, and 93% of oil breakers were either in "fair" condition or worse; and,
- Over half of their 125,000 wood poles were "fair" or worse ("2012 Asset Condition Assessment" 24, 26, 30, 32, 34, 53).

PowerStream serves a smaller urban and suburban customer base. On average, the assets PowerStream inherited from its predecessors in York Region and Barrie are younger than Toronto Hydro's. Yet, much of its equipment is around 30 to 40 years old and soon requires renewal. Further, a greater proportion of PowerStream's assets are buried, including over

7,800km of wire. To address their aging assets, the company intends to increase its replacement rate from 8.5km per year in 2012 to 47km each year until 2031. Between 2012 and 2016, spending in both overhead and underground plant asset replacements will rise from about \$3 million to \$3.7 million and \$6.5 million to \$20 million (*2013 Electricity Distribution Rates Application* B1.1.4.4, B1.2.2.45, 54, 57, 110).

Hydro One – excluding its Brampton subsidiary – serves rural Ontario. In their most recent OEB filing, Hydro One notes that 19% of their transformer population is beyond its expected service life, with an additional 10% to reach this threshold in the next five years. They propose to move from replacing seven transformers a year to 36. They also seek to double the rate that they replace their reclosers, breakers, switches, and fuses. Of its 1.5 million wood poles, over 300,000 will be 62 years or older by 2019. Accordingly, they intend to increase their annual pole replacement rate from 11,000 in 2013 to 15,200 (D1.2.1.3-4, 8, 12, 14-15, 20-21, 24).

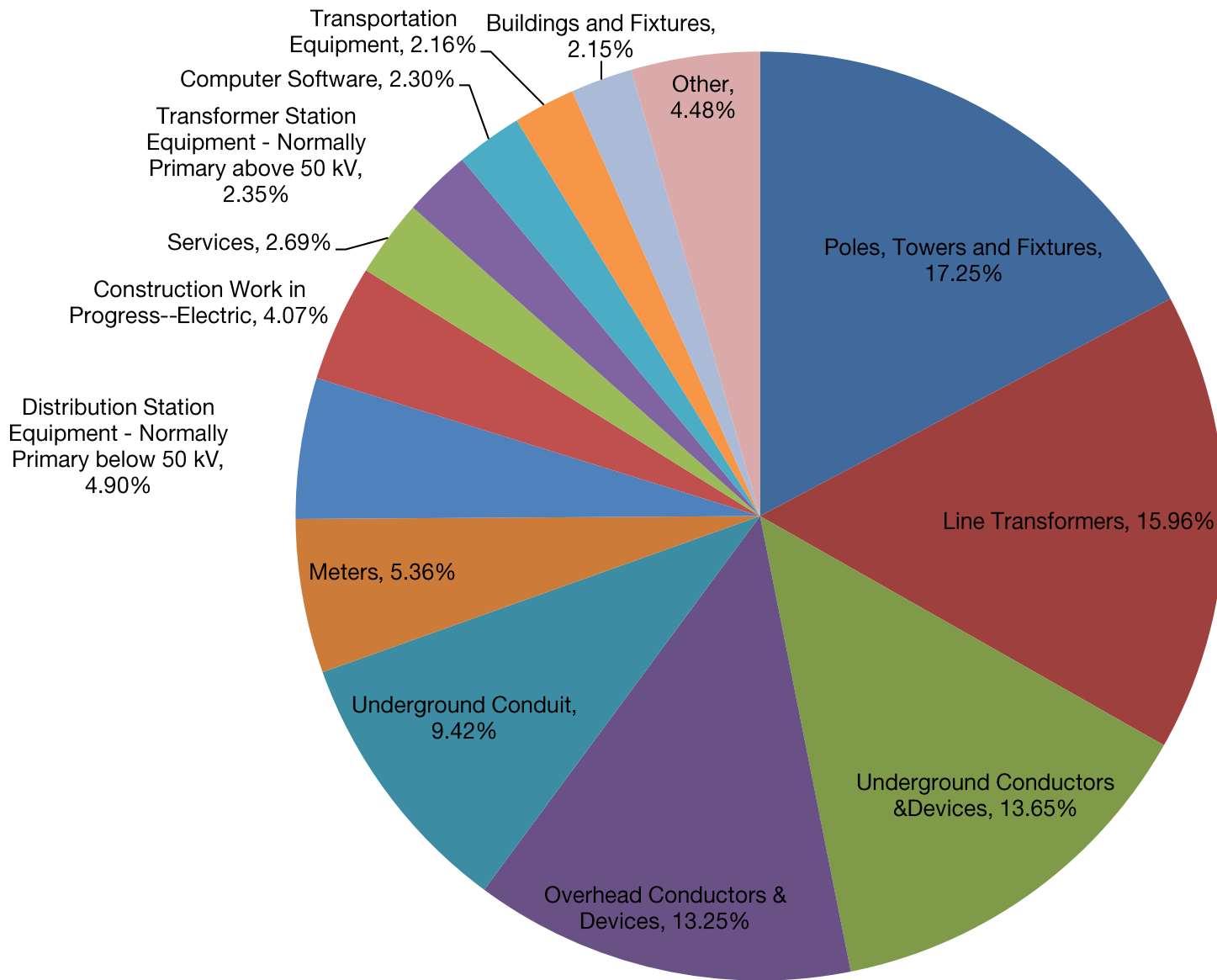
The problem of aging assets is not limited to the largest LDCs:

- Horizon is beginning to replace its underground residential cables, some as old as 60 years. Of the \$900 million in investment scheduled by that company in the next two decades, \$700 million is dedicated to system renewal (*2013 Sustainability-based Annual Report* 14, 27). Further, they maintain that they have “...some of the oldest distribution assets in the province,” and that its reliability indices “...have been trending negatively since 2006, representing a decrease in service ... consistent with an aging distribution system. As such, significant capital investment to address infrastructure renewal is an immediate, necessary requirement” (*Five Year Custom IR* 1.2.6.9).
- Veridian has characterized their aging asset infrastructure base as a “serious issue.” For example, 21.3% of their substation transformers and 34.8% of their overhead line switches were in “poor” or “very poor” condition (*Cost-of-Service Application* 1.1.2.19, 2.3.6.1. 23);
- Fort Frances Power Corporation is moving from “a ‘Maintenance’ mode... and is entering a ‘Rebuild’ mode...” (1.1.2-3).
- On Waterloo North Hydro’s plans, CEO Rene Gatien has remarked that his LDC is “...replacing assets that were installed when Diefenbaker and Pearson were prime minister... even some assets that were put in the air when Louis St. Laurent was prime minister” (Testimony 20-21).

Failure to invest in system renewal leads to less reliability and greater customer interruption costs. The ESA notes other risks associated with aging assets and equipment failures:

- Safety hazards to employees and the general public;
- Increased spending on emergency services and crews;
- Increased liability exposure and insurance premiums;
- In the event of a catastrophic failure, significant injuries, or continuing interruptions, pressure from the public for the government to increase regulation (2).

2012 Ontario LDC Asset Mix



Derived from (OEB, *Gross Plant*)

3.0 Distribution Asset Management

During this period of renewal, effective management of LDCs assets is critical for operational stability, financial security, and customer service. An effective asset management regime can enhance reliability, while encouraging cost-effective decision making.

For the purposes of this paper, an asset management process is:

“the systematic approach a distributor uses to collect, tabulate and assess information on physical assets, current and future system operating conditions and the distributor’s business and customer service goals and objectives to plan, prioritize and optimize expenditures on system-related modifications, renewal and operations and maintenance, and on general plant facilities, systems and apparatus...”(OEB, *Filing Requirements* 1).

Such processes seek to:

- Ensure system reliability, safety, and capacity for future growth;
- Consider all inputs, costs, risks, and externalities, both direct and indirect, and based where possible on hard data;
- Align with shareholder and/or government priorities;
- Provide for short and long-term planning; and,
- Allow LDCs to reach their preferred asset portfolio by weighing risk versus return, corporate, regulatory, budgetary, and above all, the customer (Al-Batayneh and Al-Mehairi 3-4; Brown and Humphrey 40; KEMA 2-2).

The challenges in managing these assets vary:

- They are generally completely depreciated or stranded by the LDC at end-of-life;
- The resale market for distribution assets is negligible; and,
- There is an indirect, social component to asset returns. Unreliable assets or planning can cause significant social, political, regulatory, and corporate reputational costs;

Asset management processes vary across LDCs. Some general concepts that are shared are:

- An asset register containing information on the characteristics of assets, such as age, condition, service history, utilization, load, performance, and the environment;
- An Asset Condition Assessment (ACA) regime that defines, collects and analyzes the condition of any given asset or class;
- A life-cycle management model refined from historical data that appropriately calculates determines and quantifies risk and determines the optimum time for intervention, such as Toronto Hydro’s Feeder Investment Model (FIM);
- Using the ACA, register, and modelling together to determine investment priorities; and,
- A program that addresses the weakest parts of the system, like Worst Performing Feeders (KEMA 2-16-17; OEB, *Filing Requirements* 15).

3.1 Maintenance Regimes

Renewing the grid will require LDCs to make effective capital decisions that ensure reliability while minimizing cost to the customer. Since outright capital replacement can increase costs 10-fold over ongoing maintenance, LDCs should maximize their maintenance processes to emphasize life-cycle extension over run-to-failure replacement where possible (Venkatesh).

In recent years, technology and experience have allowed for maintenance practices to evolve and mature. The most basic regime is *periodic* or *time-based maintenance* (TBM), where inspections are carried out on fixed cycles (NERC 14). The schedule is determined by manufacturer guidelines and/or regulatory requirements. *Corrective* or *reactive* maintenance can address component failures during these inspections. *Preventive* maintenance can also take place: maintenance on assets or components that demonstrate a potential risk of failure.

TBM can result in unnecessary costs, since inspection intervals provided by manufacturers or regulators are generally conservative. Assets also experience different environmental and loading conditions that may render existing inspection intervals suboptimal. *Predictive* maintenance incorporates these variables to determine appropriate inspection intervals. Many of Ontario's LDCs have moved to *performance-based* maintenance (PBM) and *condition-based* maintenance (CBM), where *predictive* maintenance practices, statistical analysis, and data provided by inspections or digital telemetry allow for intervention only when required (NERC 14-15, 19; Cozzens; Brown and Willis 40-41).

Utilities are beginning to adopt *reliability-centered* maintenance (RCM). RCM goes further than PBM/CBM by contextualizing a maintenance regime. RCM practices place greater importance on assets that would produce greater consequences in the event of failure. It dictates a program that seeks the greatest reliability possible within a budget constraint in an attempt to maximize system up-time at the lowest of costs (Brown and Willis 41-42).

3.2 Technology

Smart meters, SCADA, ADMS, and like tools provide greater access to information on system conditions for CBM, PBM, and RCM. Software and smart meters account for less than 8% of Ontario's LDCs holdings..

Digital equipment presents new challenges to asset managers:

- Some digital assets have a shorter lifespan than their mechanical counterparts. For instance, the life expectancy of Ontario's first-generation smart meters is half that of traditional meters (Kinectrics, *Asset Depreciation* 19);
- Overall, the cost to replace digital assets like-for-like is cheaper in future years as technology progresses, yet new functionality may increase the price of these assets;
- The useful life of firmware and software is only a few years (Kinectrics, *Asset Depreciation* 19). In the case of a privacy or security breach, updates or replacement may be required immediately and system-wide;
- Dependence on third party communications networks could pose a significant risk should those networks be decommissioned;

- Considering the rapid pace at which LDCs installed smart meters, the replacement cycle will likely follow a peak and trough function, with significant replacements required beginning around 2030; and,
- We do not have the same level of experience with these assets as we do with historical ones.

3.3 To Replace or Renew

Eventually, continued maintenance on an asset becomes less advantageous than other options, owing to factors such as new technology, remaining life, failure, or poor performance. Depending on the asset, an LDC can choose to refurbish or replace. In making this decision, asset managers must balance the performance and budgetary tradeoffs between life-extension and its increased maintenance costs but capital savings, and replacement with its higher expenditures on capital (KEMA 2-15). A strong maintenance regime encourages less costly life-extension programs (Brown and Willis 40).

LDCs have a range of choices in addressing their failing or aging assets, including:

- Run-to-failure;
- Life-extension refurbishment;
- One-for-one replacement; and,
- Replacement with new technology (Brown and Willis 41).

All assets eventually need to be replaced. This process is expensive and disruptive for large assets, while for non-critical equipment, replacement after failure may be the best choice (Brown and Willis 41). An LDC may consider replacing other, still-reliable assets near a piece being replaced to save future mobilization costs by already having staff and equipment onsite, while minimizing future interruptions and disruptions to the community.

3.4 Relationship with Capital Planning

Asset management informs capital planning and vice versa; data from asset management allows planners to forecast upcoming expenditures; while budget constraints are considered in the asset management process. To be analogous, asset management produces a prioritized “wish list,” the capital planning process determines which items on the list are purchased.

Generally, LDCs have five to ten-year plans, updated yearly (*Renewed Regulatory Framework* 28). They are based on corporate goals and values, including financial performance, customer satisfaction, business model changes, and human resources. Planners make a set of economic assumptions— like interest rates and load growth – that inform these plans.

LDC budgets generally contain three components:

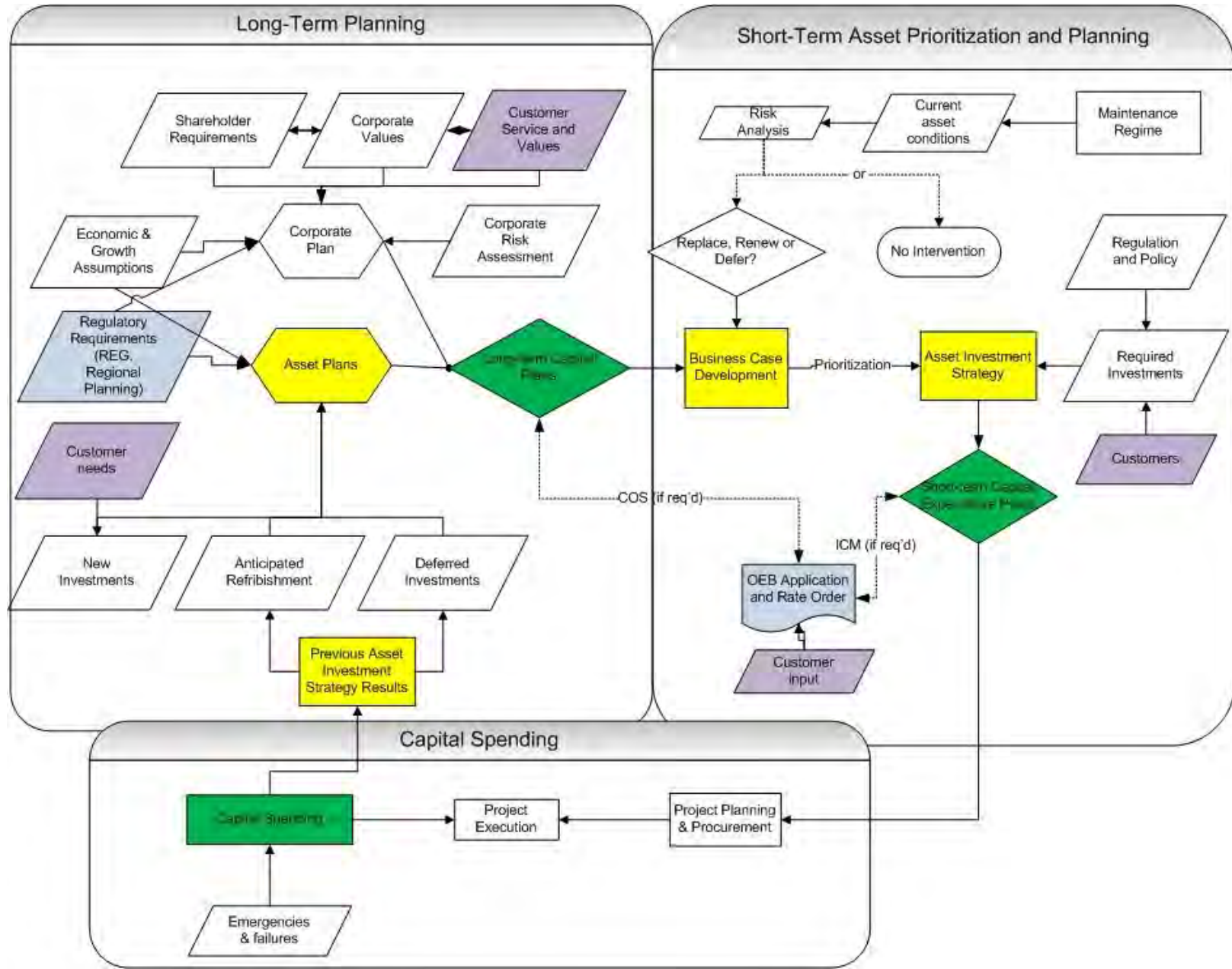
- Operations, maintenance and administration (OM&A): The cost of running and maintaining the system, including:
 - Maintenance activity;
 - Payroll not attributable to capital projects;

- Stores and warehouse;
- Capital: New equipment that can include:
 - Sustaining investments that replace or enhance assets to maintain the system;
 - Development investments that meet new demand;
 - Operations investments in physical assets that support business processes (tools, buildings, IT); and,
- Expenditures on non-distribution assets, such as subsidiary companies.

Once a long-term plan is in place, short-term planning begins. Business cases are prepared for potential capital expenditures. LDCs weigh projects based on many factors, such as corporate values, financial impact, risk, asset condition, health and safety, the environment, and regulatory requirements. At the end of this process, the short-term capital process is completed and projects are budgeted, approved, and executed.

The flowchart on the next page provides a *general* example of the integration of asset management and capital planning.

Chart 2: An Example Asset and Capital Planning Cycle



3.5 LDC Performance

At filing, both an LDC's capital expenditure and asset management plans are reviewed by the OEB as part of a rate application and condition of license. In addition to OEB considerations, intervenors can provide additional oversight of asset management practices.

The last external review of asset management policies within the sector was completed in 2009 by KPMG. Asset management proficiency comes with time and experience; the audit sought to determine the "maturity" of the asset and capital processes at LDCs. KMPG was:

"... generally satisfied that the asset management practices by distributors are at the 'expected' level of maturity. In general, while there is variability in practices, distributors are applying appropriate care and diligence in their asset management practices. While we noted areas for improvement, management... focused on the right issues with respect to their assets and had identified and were working towards enhancements in key areas. We do not have any concern that the utilities visited are failing to address important safety or reliability issues. The results... provide comfort with respect to the state of asset management practices at Ontario distributors" (1-2).

On maintenance practices, the firm noted:

"Among the utilities visited, we were generally very impressed with the quality of maintenance processes. One utility clearly ranked as a 'leading' utility in this area. While the remaining utilities also incorporated elements of leading practices, we ranked their overall performance at the high end of 'expected'... Based on the results of the survey questionnaire, there is good evidence that respondents in this broader group also incorporate many of the maintenance practices of leading utilities. More generally, it appears that survey participants conduct maintenance activities with appropriate diligence and care" (8).

A York University study noted that after the price freeze of 2003, LDC innovation "[was] evident largely in the area of efficiency-oriented asset management..." It was around this time that some LDCs began to adopt advanced maintenance and asset management practices, and that these routines continue to mature and be adopted by additional LDCs (Barrows et. al. 60-61, 65).

Nevertheless, there is room for distributors to improve on their practices:

- Not all LDCs fully employ advanced maintenance regimes;
- LDCs do not need to adhere to international standards for asset management, despite the existence of two benchmarks: PAS 55 and ISO 5001 (Institution for Asset Management 2). There may be merit in adopting an asset management standard for all LDCs for regulatory oversight and benchmarking purposes;
- The decision on replacement or renewal is often based on a risk assessment. Although the risk profiles may vary according to geography, size, customers, and assets, the

sector should consider establishing a uniform set of risk categories and sharing their experience in weighing these risks; and,

- With improvements in asset management practices, one should expect maintenance costs to rise at a greater rate than new capital spending. A review of the last three years of data from the OEB *Yearbook of Electricity Distributors* indicates no clear trend towards increased maintenance costs vis-à-vis new capital spending when corrected for customer growth. This may be due to the pressing need to replace many assets, along with declining maintenance costs through efficiencies. Nevertheless, we believe that a performance goal for LDCs in the coming years should be increasing maintenance spending vis-à-vis capital costs.

Toronto Hydro, Hydro One, and PowerStream all have comprehensive asset management plans, outlined in their latest OEB filings. At Veridian, a recently completed asset condition assessment has given that utility the ability to prioritize equipment for their asset renewal program, which is part of their “commitment to developing a formal asset management plan, which establishes a logical, quantifiable rationale for prudent planning and capital investment through identifying priorities for system renewal over the next 30 years” (2013 *Annual Report* 15).

4.0: The Distribution System Plan

Upon the release of the 2012 *Renewed Regulatory Framework*, the OEB sought “an integrated approach to distribution network planning” (27). Previous filing requirements called for LDCs to provide three year system plans, and five year *Green Energy Act* plans (*Renewed Regulatory Framework* 27-28; *Requirements: Distribution* 12-13). The Board concluded that:

“...in order to have distribution plans that support the Board’s performance outcomes approach to rate-setting, an integrated approach to infrastructure planning is required. Under an integrated approach, all categories of network investments will be planned together... An integrated approach to planning will provide a foundation for the setting of distribution rates and lead to optimized investments that support the achievement of the outcomes identified by the Board” (31).

To “...ensure that distributor investment plans are demonstrably economically efficient and cost-effective, and paced so as to match required expenditures with fair and reasonable rate adjustments and predictable changes to the elements of customer bills affected by the plans...” (OEB, *Staff Discussion Paper* i), eleven groups participated in a consultation towards new system plan requirements, including several LDCs (OEB, *Distribution Network Investment Planning* 4). Stakeholders generally supported an integrated approach to network planning, along with a longer-term projection period and simplified reporting and regulatory requirements, while the OEB sought a process that optimizes “consumer value”, was “integrated and holistic”, adaptable, clear, and increased regulatory efficiency (*Staff Discussion Paper* 5-7). Accordingly, the new Distribution System Plan (DSP) Filing Requirements were released in March 2013. Key principles espoused in the requirements include:

- A five year planning horizon, along with a ten-year historical/projection review;
- Evaluation against the OEB’s core outcomes: customer focus, operational effectiveness, public policy responsiveness, and financial performance, along with a focus on regional planning;
- Ensuring holistic investments by making no differentiation between smart grid, regional planning, and LDC capital needs; yet,
- LDC plans must show that they have considered policy directives such as smart grid implementation in their planning; and,
- Utilizing a template that easily conforms to different LDC planning processes and provides the regulator with a comprehensive view of the LDC’s plans without significant additional formatting or costs (*Supplemental Report on Smart Grid 4. Filing Requirements ii, 1-3; Cain 9-10*).

To begin, LDCs are expected to provide a high-level overview of their DSP, describe any coordinated planning processes with third-parties, and include mandatory OPA commentary on regional planning and renewable generation considerations. The applicant then proposes metrics to measure their performance on the OEB scorecard. These metrics provide measurements for success for the two major components of the DSP: the asset management plan and capital expenditure plan (*Performance Measurement 22-24; Cain 15*).

The asset management plan describes the LDC’s current capital, planning for new assets, and the management of these assets through their lifecycle. The OEB requires that LDCs describe their current physical asset stock. Applicants are required to express how they determine product lifecycles and how they address assets as they reach either state of “high risk” or at end-of-life. Here, LDCs describe their risk modeling, asset monitoring strategies, and what influences their decision to maintain, refurbish, or replace assets (*Filing Requirements 12-14*).

Applicants then propose the capital expenditure that they seek to recover through the rate base. After a high-level summary, applicants must describe how they plan their capital expenditures and provide evidence that the system will have the capacity to incorporate new renewables into their grid (*Filing Requirements 14-15*).

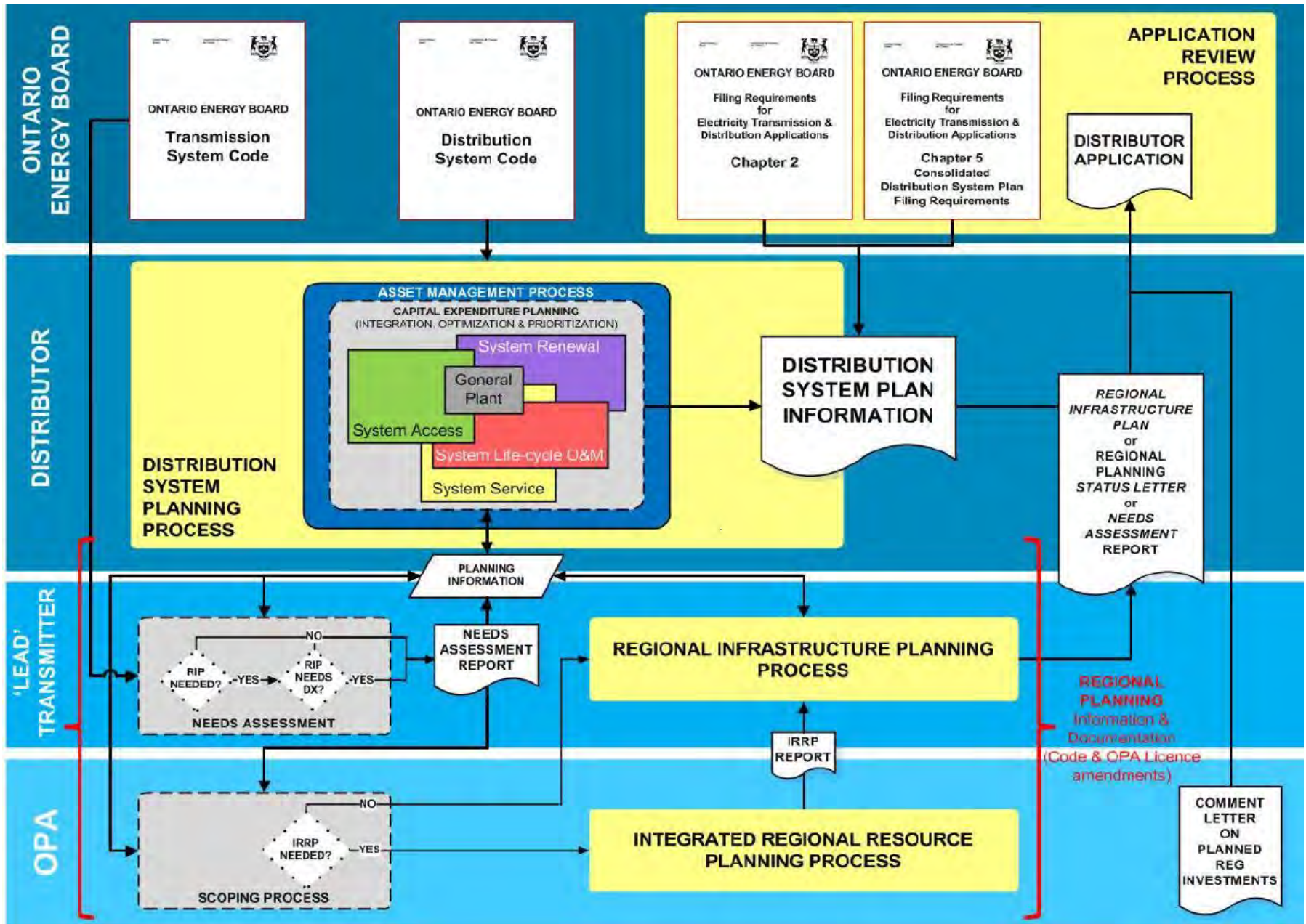
The OEB categorizes investment cost drivers in one of four categories:

- *System access investments* are required to connect new customers to the grid;
- *System renewal investments* involve refurbishing or replacing assets;
- *System service investments* include spending that anticipates new growth and enhances system performance; and,
- *General plant* covers spending on non-network assets: buildings, vehicles, and tools, for example (*Filing Requirements 7*).

Although a project may encompass several of these categories, LDCs must select one for each project based on its “cost driver.” To provide a longer-term perspective on capital spending, LDCs are directed to provide historical capital expenditure variances for five years and their forecast for the next five (OEB, *Filing Requirements ii, 7; Cain 18*).

For capital projects over a materiality threshold, a comprehensive business case must be presented, including the characteristics of the investment (cost driver, expenses, timelines, etc.), how the investment aligns with RRFE outcomes, and other evaluation categories such as safety, security, economic development, and environmental benefits. There are also reporting requirements unique to each cost driver (*Filing Requirements 19-25*).

The overall DSP process is visualized in the next chart.



4.1 Regulation Paradigm

The new DSP requirements are flexible for LDCs, while providing a common and simple template that improves regulatory efficiency. The EDA is optimistic about the process:

“The outcomes remain to be fully tested, but we like what’s taking shape, particularly relating to capital approvals and rate setting. The OEB has established new rate-application processes, with the potential to better enable long-term capital planning and investment, while smoothing out rate increases for customers. In particular, this is meant to address the need some LDCs have for large or variable capital investments that exceed historic norms” (Gatien, “Vision to Action” 4).

The OEB provides minimum inspection requirements for LDC assets: generally three years for urban assets and six years for rural equipment. Here too, the OEB provides flexibility: LDCs can apply to adhere to a different cycle when they have demonstrated a good record of maintenance, inspection, and reliability-maintaining practices (*Distribution System Code 5-6*).

The OEB lacks effective metrics to measure asset management. The regulator has left it to LDCs to determine appropriate benchmarks to measure the success of their plans. The Board has stated “that it is premature to set a target for this new measure” on its scorecard, owing to a lack of consensus among the members of the Distribution Network Investment Plan Working Group (*Performance Measurement 22-24*). LDCs will provide both the measure and the results of how successful they are in implementing their DSP. By allowing LDCs to set their own measurement standards, a state of information asymmetry exists that favours the distributor.

The OEB has shifted focus from inputs, activities, and costs to outcomes, results, and value for money (Leclair 4). Asset management is a continuous, evolving process; a constant feedback loop that informs incremental changes in strategy. As such, the OEB may consider evaluating the asset management process during its implementation and execution. For instance, third parties – such as the ESA – could conduct field inspections to ensure that maintenance regimes reflect those outlined in a submission. The OEB could review yearly changes to an LDC’s plans to ensure continuous improvement. The regulator may also consider conducting another sector-wide evaluation of asset management processes to provide LDCs an opportunity to understand where their processes stand versus other LDCs and to, perhaps, set a benchmark.

Even with a scorecard metric, an asset management strategy is a complex and multidisciplinary process. In seeking clarity and brevity in filings, the process simplifies complex accounting, economic, engineering, and risk assessment considerations. Further, with so many entities filing plans for OEB review, each with their own nuances, outcomes, and measurements, does the OEB have the capability needed to effectively evaluate each DSP? As noted in the 2009 KEMA report, inserting expert third party asset management experts and consultants from multiple disciplines into the evaluation process would provide the OEB with a clearer picture of the feasibility and strength of an asset management regime during a hearing (3-5 – 3-6, 5-9).

In the context of a changing energy paradigm, New York State is undergoing a review of its distribution sector and regulatory model. They broadly claim that:

“While the bulk power system has seen major regulatory changes in recent decades, the basic cost-of-service paradigm for regulating distribution utilities remains in place. Current ratemaking provides few incentives for utilities to innovate or to support third-party innovation, to address the current challenges in ways that promote a more efficient system and benefit consumers. Programs to encourage efficiency and clean energy are funded through surcharges and programs that are not directly integrated with utility business models. Although the existing paradigm served adequately for many years, it now falls short of the pace of technology development that defines many parts of our economy”
(*Reforming the Energy Vision 2*).

Accordingly, State intends to incorporate the following “lessons” into future rate making plans:

- “Rate plans should have pre-established means to determine whether a utility is spending adequate levels on necessary investments and maintenance of its system, so that later catch-up spending is not needed. There should also be upside protections on [capital expenditure] spending to prevent unnecessary inflation of the rate base.
- Performance metrics need pre-established trigger points for re-evaluation, especially when the incentive includes both upward and downward reconciliations. Plans should have provisions to review and assess the long-term effect of the incentives and to modify them, as necessary
- Despite the level of competition and incentives in the marketplace, continued monitoring of performance is essential.
- Revenue adjustments should be sized so that companies will perform to standards rather than finding it economic simply to pay penalties. In addition, Staff must have access to all underlying performance data for auditing purposes.
- Innovative performance plans should be developed through participation by all market providers.
- Utilities should have the ability to make incremental investments that represent modest calculated risks without fear of penalty, allowing the trial and error process that enables larger investments to be made with more confidence”
(49-50).

Ontario’s LDCs earn a regulated return on equity. Although the new regulatory requirements for asset management plans encourage life cycle planning focused on customer needs, there nevertheless remains an incentive for LDCs to invest more in short-lived capital to maximize returns on capital as opposed to managing longer-term assets through increased maintenance costs. Utilities can spread capital costs over many years, while maintenance costs affect the bottom line that quarter. This works well during a period of high growth, but not during periods of rebuilding, increasing maintenance costs, and potentially shrinking LDC asset bases.

New York also subscribes to rate of return ratemaking. In their current review, they are considering changes to the rate structure in a period of asset renewal:

“The reforms described above have mitigated but not eliminated the way in which ROR ratemaking can present barriers to the achievement of policy objectives. In the long term, utilities still have an incentive to maximize their capital expenditures, and little incentive to optimize system efficiency to reduce capital needs. With respect to operating expenses, utilities can earn money for shareholders by "beating" the operating expense allowances provided for in a rate case; this contributes to contentious ratemaking processes and, more importantly, gives utilities no financial incentive to manage operating resources positively toward the achievement of policy objectives. Revenue decoupling mechanisms also provide no positive incentive; at best they make utilities indifferent to efficiency and distributed generation. Because RDMs spread the lost revenues across all remaining sales, they leave utilities and remaining customers vulnerable to the long-term implications of widespread revenue loss...

Traditional rate-of-return ("ROR") regulation, using an annual rate case cycle, provides very little incentive to the utilities to improve performance. Benefits of any efficiency gains are reflected in the next year's rate case. ROR regulation may also encourage the utility to over-invest in capital spending, because earnings are directly tied to rate base. For the same reason, utilities are rewarded for the inefficiencies in the bulk and distribution systems that require capital spending to build for unmanaged peak loads" (47).

“...One of the values of [review], however, is to reduce utilities' need for capital expenditures. Another objective – reducing peak demand on the bulk system – may have the incidental effect of reducing utility investment. Under conventional ratemaking, a utility will have no incentive to pursue these measures that would reduce its rate base. If utility rates approach levels where they can no longer be increased without exacerbating customer migration, then utilities would lose the incentive to invest in rate base; but that scenario carries even greater concerns and should be avoided. The Commission should consider ratemaking approaches that encourage the most efficient allocation between capital and operating expenses to advance Commission objectives.” (53)

Their report then cites a model developed by the Office of Gas and Electricity Markets in the United Kingdom. They use a “Revenue set to deliver strong Incentives, Innovation and Outputs,” or RIIO model. Among the benefits:

Another innovative aspect of RIIO is the use of a “totex” approach to setting rates. This aims to remove utility bias in favor of capital costs by attempting to make utilities indifferent to capital vs. expense treatment of costs. Also, the RIIO approach uses some semi-symmetrical incentives with a larger

potential upside than downside, which may sharpen focus on desired outcomes. (55)

5.0 Human Capital

Asset renewal relies entirely on the people behind it: planners, administrators, engineers, and line workers. LDCs face another challenge in the immediate need to replace human capital.

5.1 The Challenge Ahead

Ontario's LDCs employed just over 10,000 people in 2012. In 2008, it was estimated that 45% of these employees were between 45 and 54 years old, or 51 to 60 today (EDA 1). As these groups are beginning to retire, the labour market supply to replace them is beginning to drop (ESC, *Powering Up the Future 2*). Hydro One's latest application to the OEB notes:

"Hydro One faces the prospect of unprecedented challenges in the years ahead associated with the availability of skilled and professional staff to operate, sustain and develop its transmission and distribution systems. Hydro One's greatest corporate risk with respect to its human resources continues to be an aging workforce and, with a world-wide scarcity of core skills in the electricity industry, a highly competitive labour market.

This issue and associated risks are not unique to Hydro One, but apply to the Canadian electricity sector as a whole. In its 2008 study of the Canadian electricity industry... the Electricity Sector Council (ESC) states, "The Canadian electricity sector is about to enter into the eye of the perfect storm, whereby the supply of trained workers is decreasing just at the same time that a significant proportion of the current workforce is retiring, and the demand for electricity and investment in new capital and infrastructure projects is increasing" (*Application for 2013 and 2014 C1.5.1.1*).

Amongst Ontario's LDCs:

- 23% and 41% of Horizon's workforce will be eligible to retire in the next five to ten years respectively, mostly from their skilled trade and technical areas; (*Five Year Custom IR 1.2.1-7.35*)
- Veridian "has a significant number of employees close to retirement eligibility," many of whom are in the trades. "Succession planning will be critical" for their metering workforce (*Cost-of-Service Application 4.2.2.21, 4.3.1.14*); and,
- 45% of Toronto Hydro's workforce will or have retired between 2011 and 2020. THESL's employee distribution is such that 69% of employees are 45 and over, and 23% are age 55, the minimum age for a full pension (*Distribution Rate Change Application C2.1.5.2*);

Many employees will require extensive apprenticeship and training and cannot immediately replace a departing worker. In addition, the CEA notes that with the rapid pace of technological

growth in the sector “...new, skilled employees will be increasingly crucial as the sector continues to evolve and transition to new ways of producing and delivering electricity” (*Innovating for a Sustainable Future* 28). Raising human capital will occur within the context of the compensation restraint with the broader public sector and the pressures of highly unionized environments.

5.2 New Workers: Generational Attitudes, Labour Markets and Recruitment

Different generations often bring new perspectives and attitudes to the workplace, owing to the differing circumstances of their childhood and upbringing. Over the coming years, “Millennials” (born roughly 1980-2000) are entering the workforce. Millennials have been described as having:

- An attitude of entitlement and looking for a degree of “glamour” in their work;
- A desire for meaningful and interesting work within a compatible corporate value structure;
- A greater emphasis on work-life balance than their predecessors;
- A significant need for feedback, clarity, structure, and mentorship,;
- A willingness – considering the current economic context – to accept lower compensation to begin their careers, coupled with expectations of rapid promotion, pay increases, and other methods of compensation;
- A willingness to make horizontal moves within corporate bodies to gain a breadth of experience;
- Increased emphasis on teamwork, collaboration, diversity, and the social aspect of work;
- Preference towards short, ‘just-in-time’ bursts of information;
- Trust in institutions while rejecting corporate hierarchies;
- Technological savviness, but less concerned about corporate and individual privacy; and,
- A higher probability of holding many careers in several fields throughout their life (Ng, Schweitzer and Lyons 282-283, 288-291; ESC, *Knowledge Management* 23-24; Hershatter and Epstein 212-215, 217, 220; Shaw and Fairhurst 368-370, 373-375).

More women than men attend postsecondary institutions at any given time, but women – along with minorities – remain grossly under-represented in the applied sciences (Yoder 13). While undergraduate engineering students as a whole prefer studying mechanical, civil, electrical and computer engineering, women tend towards environmental, chemical, and biological disciplines. In fact, mechanical and electrical engineering are among the least popular disciplines among women (Engineers Canada 4; Yoder 12).

In terms of gross enrollment, the number of students in electrical engineering fell in every province except British Columbia (ESC, *Powering Up the Future* 2), while enrolment in relevant disciplines is increasing at the college level (ESC, *Powering Up the Future* 9-10). The Electricity Sector Council also notes that electrical engineering facilities are facing challenges addressing programs costs and insufficient numbers of instructors (ESC, *Powering Up the Future* 75-76).

Women, Aboriginals, minorities and immigrants represent untapped labour pools for LDCs (ESC, *Knowledge Management* 9). New Canadians represent only 13% of the total labour force in Canada's utilities, below the national average of 21% (ESC *Powering Up the Future* 41). Aboriginal people are a fast growing but under-represented group in this sector; the CEA has made engaging with Canada's First Nations a priority. The Association also noted that "as of the end of 2012, only about 25 percent of senior company executives were female, and 9 percent were from minority groups," and that "83 percent of members indicated that they have a commitment to workforce diversity, although only 43 percent have a formal diversity program (*Innovating for a Sustainable Future* 28,33)."

LDCs are actively seeking out ways to attract new talent. Initiatives include:

- Hydro One is partnering with universities and colleges to develop curricula, supporting programs in power systems, and providing scholarships and co-ops, and participates in Career Bridge which helps new Canadians and immigrants with foreign qualifications enter the sector (C1.5.1.6)
- Toronto Hydro offers its own Ministry-accredited power line technician program. It is also helping to shape electrical discipline curricula at Georgian College (C2.1.5.8; *2012 Corporate Responsibility Report* 12, 55);
- PowerStream has committed over \$2 million to several postsecondary institutions to help build facilities, provide scholarships, and advance research in areas such as sustainable energy. They also donated a bucket truck to Conestoga College's power line technician program (*Annual Report* 27);
- Horizon has a formalized apprentice orientation program and encourages experienced workers to act as mentors for new hires. They also recruit engineering graduates right after graduation (*2013 Sustainability-based Annual Report* 15); and,
- Many LDCs offer internships and co-op placements, and support cutting-edge research, such as the work done at Ryerson's Centre for Urban Energy.

These efforts are encouraged by the CEA: "Apprenticeship programs, workshops, online learning, tuition reimbursement programs, partnerships with educational institutions, and other training and development initiatives will continue to be critical for ensuring employees have the right skills and knowledge (*Innovating for a Sustainable Future* 28)."

Other recruitment options to consider include:

- Market working in the distribution sector as stimulating, attractive, and well paying;
- Provide opportunities for K-12 students to explore the sector through co-ops or school trips;
- Free books or internships for scholars in relevant fields (Lave, Ashworth, and Gellings 74-76);
- Encouraging face-to-face contact between the company and potential recruits;
- Developing interesting and robust web presences, including social media and "inspirational videos" on YouTube;
- Holding engineering competitions;

- Reaching out to teachers and guidance counsellors (Ray 22-27);
- Marketing campaigns on both traditional and social media;
- Continue to work with postsecondary institutions to ensure that curricula reflects the rapidly changing landscape that the sector faces;
- Target under-represented and growing communities; and,
- In light of changing economic and generational paradigms, consider new incentives, such as contributions to student debt in return for a mandatory employment period.

5.3 Institutional Knowledge and Knowledge Management

Much of the work on LDCs assets is highly technical; nearly every position requires rigorous training. Even after a lengthy training process, experience and mentorship helps build the confidence, efficiency and skill set of younger workers.

A cycle of older workers passing on unwritten best practices to their younger colleagues creates a collective body of knowledge. Some of this institutional knowledge may be lost in the coming years as a wave of retirements approach. Capturing institutional knowledge should become a human resources goal. As Hydro One notes, changes in the composition of their workforce makes this goal a priority: "...the need for structured information transfer is particularly acute because our demographic composition involves marked segmentation between staff that have more than 20 years of experience, and staff with less than 5 years of experience" (C1.2.9.5).

Processes should be in place to identify those with critical experience and capture their tacit knowledge. Options available to LDCs include:

- Networking opportunities or 'lunch and learns;'
- Oral histories, exit interviews, or other means to use technology to capture knowledge;
- Mentorship programs; and,
- Phased retirement (ESC, *Knowledge Management* 31-32; University of Minnesota 1).

Although passing along expertise is critical to continuity of efficient operations, it is also important to remember that the next generation of LDC worker is entering a much different business (ESC, *Knowledge Management* 14). Retiring boomers were primarily the builders of the centralized, mechanical grid; the next generation will be concerned with renewal, maintenance, incorporating new technologies, and connecting renewable generation.

The Future of the Distribution Sector: Asset Upkeep and Renewal

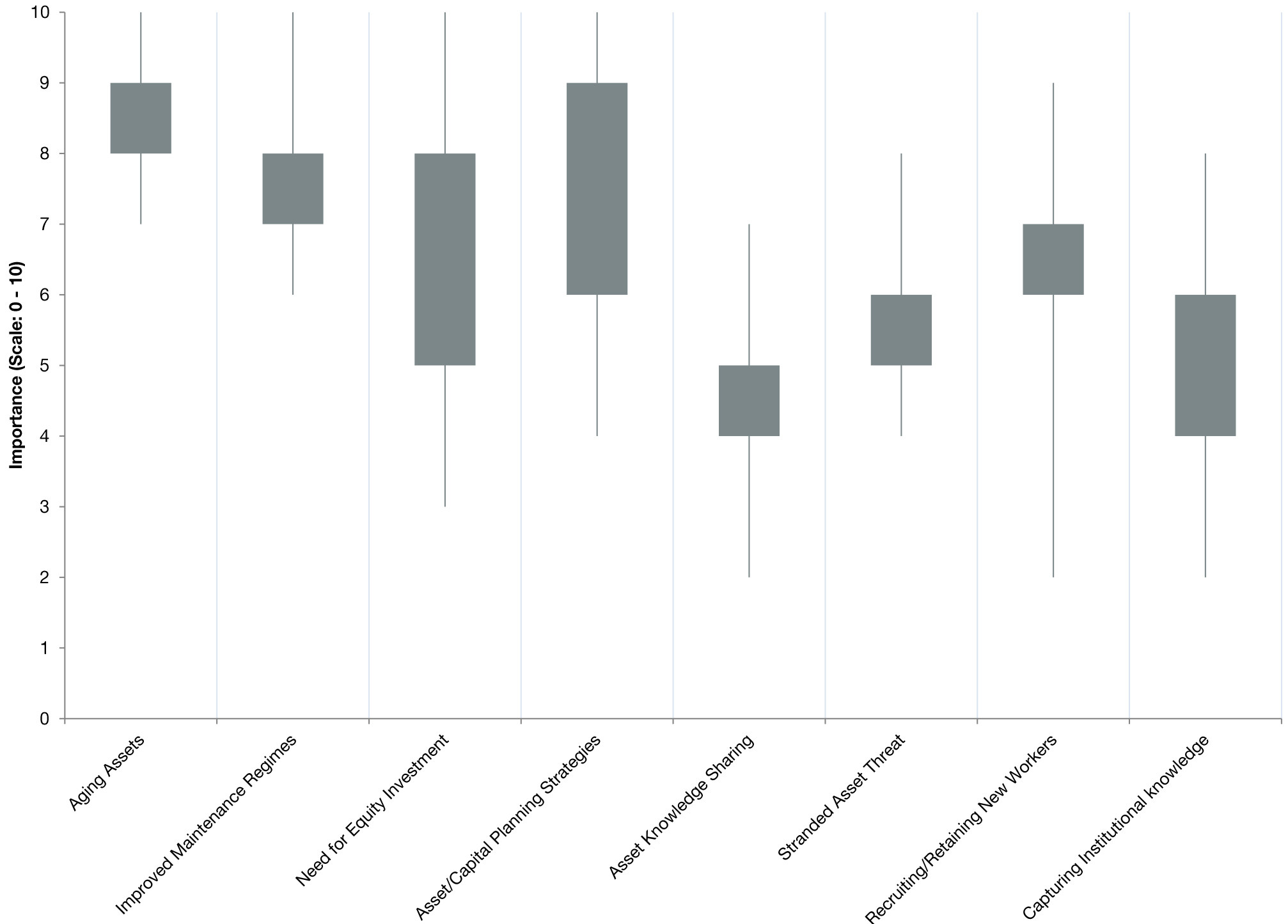
Visual:

An analysis of asset management issues in the LDC sector. Projected importance is ranked from one to ten on the vertical axis. Each topic on the horizontal axis includes a “bar and line.” The line represents the possible range of the topic’s importance, while the bar represents our predicted importance.

Observations

- Maintenance practices are maturing from time-based towards condition-based and reliability-centered regimes through asset analytics, extending asset lives and increasing reliability. Nevertheless, there remains an age bulge of LDC assets that require replacement;
- LDC asset and capital planning processes are mature and well informed. Further, OEB asset and capital plan requirements are easier to understand and streamlined for LDCs, encourage life cycle planning, and focus on the customer;
- The OEB requires that LDCs set their own scorecard metric to measure their asset management success. A lack of a uniform measure recognizes differences among LDCs, but the practice of self-measurement lacks the *gravitas* that regulator-imposed and evaluated metrics would hold;
- Asset renewal will need to be informed by the future LDC business model, which is a function of much uncertainty: changing customer needs, new technology, regulatory structure, economic growth, and government policy;
- LDCs must invest in assets that balance cost with performance, not just the newest technology;
- LDCs are incented to invest in short-lived capital to maximize returns as opposed to longer-term assets;
- Some LDCs would benefit from equity investment, having nearly exhausted their debt financing options. Public owners (if they are able) could provide equity to their LDCs, and/or the government could eliminate barriers to mergers and new investors.
- Larger LDCs are generally more sophisticated in their asset and capital planning processes;
- There is no forum for distributors to coordinate and share information on experience with new assets;
- Although co-ops, mentorships, and partnerships with postsecondary institutions are helping, graduates of engineering programs lack specific skills required by the sector;
- LDCs will need to find ways to capture and transfer the relevant knowledge and experience of their retirees to the next generation of power workers; and,
- LDCs have an opportunity to increase the representation of women, Aboriginals, and immigrants within their staff.

Asset Renewal Importance Predictions





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