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BY COURIER

June 18, 2018

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
Suite 2700, 2300 Yonge Street
P.O. Box 2319
Toronto, ON M4P 1E4

Dear Ms. Walli,

EB-2017-0049 – Oral Hearing Undertakings for Hydro One Networks Inc.'s 2018-2022 Distribution Custom IR Application (the "Application")

Please find enclosed the responses to undertakings J 1.5 and J 2.4 from the Oral Hearing held on June 11 and 12, 2018 in regards to the above noted proceeding.

This filing has been submitted electronically using the Board's Regulatory Electronic Submission System and two (2) hard copies will be sent via courier.

Sincerely,

ORIGINAL SIGNED BY FRANK D'ANDREA

Frank D'Andrea

Encls.
cc. EB-2017-0049 parties (electronic)

UNDERTAKING – J 1.5

Reference

I-18-SEC-029

K1.6

Undertaking

To advise what caused the change in cost per customer from 2014 to 2015.

Response

The *Total Cost per Customer* measure in the Electricity Distributor Scorecard is calculated by the Pacific Economics Group, LLC (PEG), based on the annual Reporting and Record-keeping Requirements (RRR) filings to the Ontario Energy Board.

Table 1 below illustrates the inputs used in the 2017 PEG Benchmarking Update Calculations[1] (the "PEG model") for the years 2014 and 2015.

Table 1 – Inputs to the PEG Model for Total Cost per Customer

in dollars, u.o.s.	**2014**	**2015**	**Variance**	
Total Actual Cost	1,304,202,201	1,236,083,718	(68,118,483)	**(A)**
Total Customer Count	1,219,670	1,257,467	37,797	**(B)**
Total Cost per Customer	**1,069**	**983**	**(86)**	**(A) ÷ (B)**

The decrease of about 8 per cent, or $86 in the *Total Cost per Customer* in 2015 was primarily due to lower *Total Actual Costs* resulting from lower *Total OM&A* and *Capital Costs*, and a slightly higher *Total Customer Count*.

[1] Pacific Economics Group LLC. (2017, August 17). *Total cost benchmarking - updates, Benchmarking Update Calculations.* Retrieved June 11, 2018, from Audit and Performance Assessment: https://www.oeb.ca/industry/rules-codes-and-requirements/audit-and-performance-assessment

The lower *Total OM&A* expense was mainly due to:

- A decrease of $70.1 million in OM&A from:
    - Lower costs related to remediating the Company's customer information system and lower customer support expenses
    - Lower preventative maintenance related to vegetation management

The lower *Capital Cost* was mainly due to:

- A decrease of $12.9 million in Capital Costs, which were partially offset by $7.8 million stemming from the inclusion of Norfolk Power Inc.

Capital Costs are subject to various PEG-based adjustments, which cannot be directly attributed to the operations and capital work of Hydro One, but which can be explored in further detail within the PEG model.

The higher *Total Customer Count* was mainly due to:

- An increase of 37,797 customers, with 19,564 customers attributable to the merger with Norfolk Power Inc.

For RRR purposes, Hydro One was required to report the impact of the Norfolk acquisition in its 2015 RRR annual filing. For the purposes of Hydro One's rate application (EB-2017-0049), the impact of the mergers & acquisitions (i.e. Norfolk Power Inc., Haldimand County Hydro Inc., and Woodstock Hydro Services Inc., are only recognized starting in 2021.

UNDERTAKING – J 2.4

Reference

I-38-CCC-044-01

Undertaking

To provide in advance of the appearance of panel 5 material created by Boston Consulting Group.

Response

The Boston Consulting Group conducted an initial review of Hydro One's vegetation management program and prepared a draft PowerPoint presentation of their findings, provided as Attachment 1. The presentation was never finalized.

Hydro One did not consider the Boston Consulting Group's draft presentation when it developed its vegetation strategy in this application.

To develop its vegetation strategy in this application, Hydro One retained Clear Path Utility Solutions LLC, an expert in utility vegetation and shared the Boston Consulting Group's draft presentation with them for that purpose.

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Executive summary

Effectiveness of Hydro One's existing VM programs on par with other utilities

- $/ACI for cyclic and strategic trim in line with BCG benchmarks

Under existing grid technology/design, opportunity to improve reliability through better VM practices appears limited

- Based on historical data, trimming every year would only drive a SAIFI improvement of 0.09 (18%)
- Consistent with observation that ~80% of tree-related outages come from off-ROW

Hydro One's VM program can deliver maximum value to customers by focusing on two areas

- Ensuring that existing VM program is optimized for cost effectiveness
- Delivering expected reliability outcomes (e.g. ensuring high reliability to LDAs while maintaining performance for rural customers)

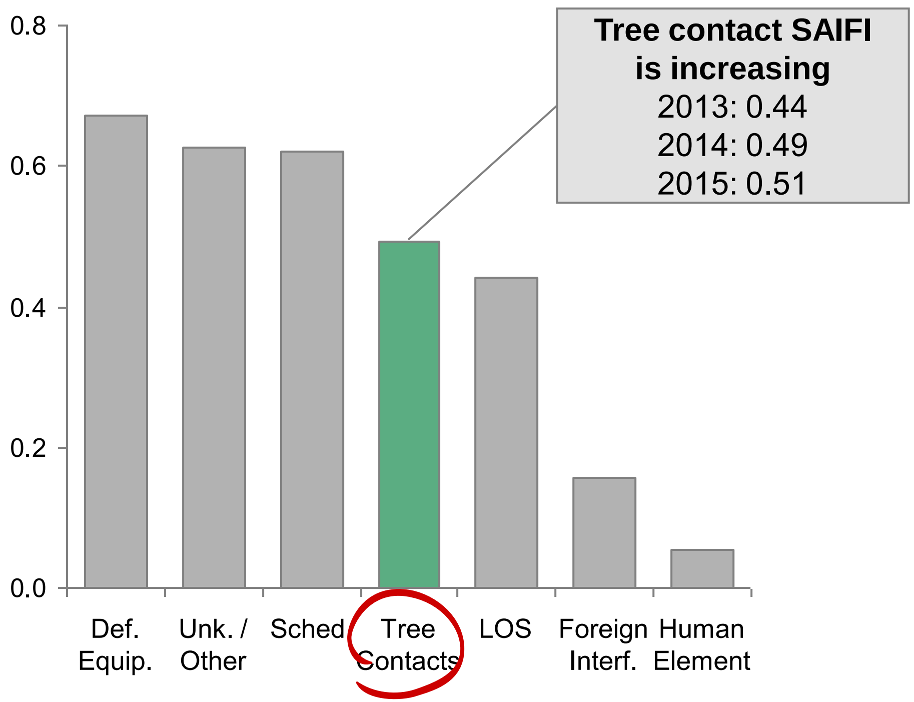
3 potential opportunities for reducing VM spend while meeting customer segment expectations

1. Cyclical trim: reduce trim cycle for highest priority feeders (M-class, LDA-serving, 3-phase, etc.)
   – Shorter trim cycle reduces total O&M costs but likely not feasible/optimal for all feeders
2. Strategic trim: optimize around cost effectiveness of spend
3. Deployment of new design standards (e.g. Hendrix cables) in high risk areas to reduce customer impacts from tree outages

Tree contacts are a large and growing driver of outages in the distribution system

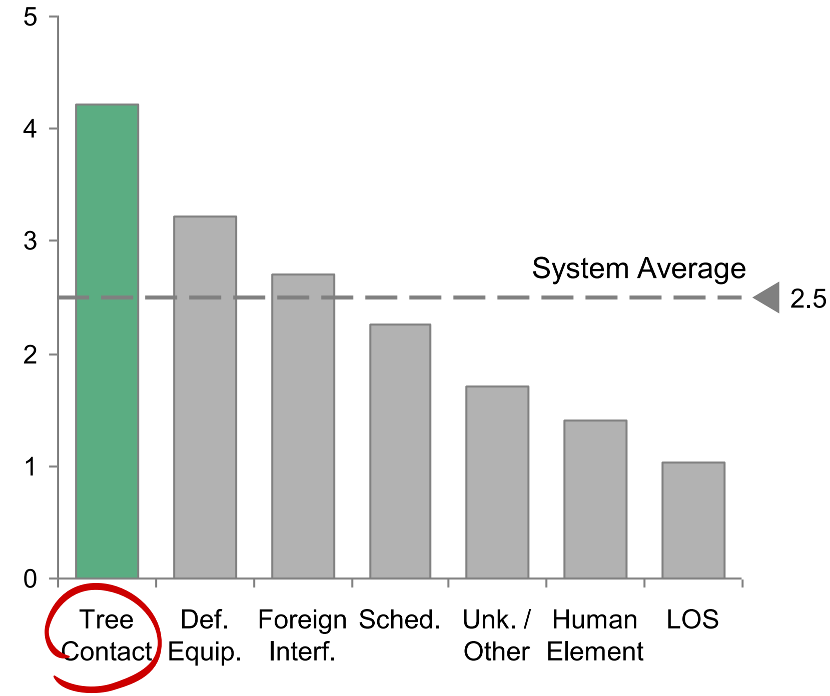
Tree contacts remain major driver of SAIFI, increasing in the past 3 years

SAIFI (2011-2015 avg.)



Tree contact outages have highest CAIDI, reflecting high cost of response

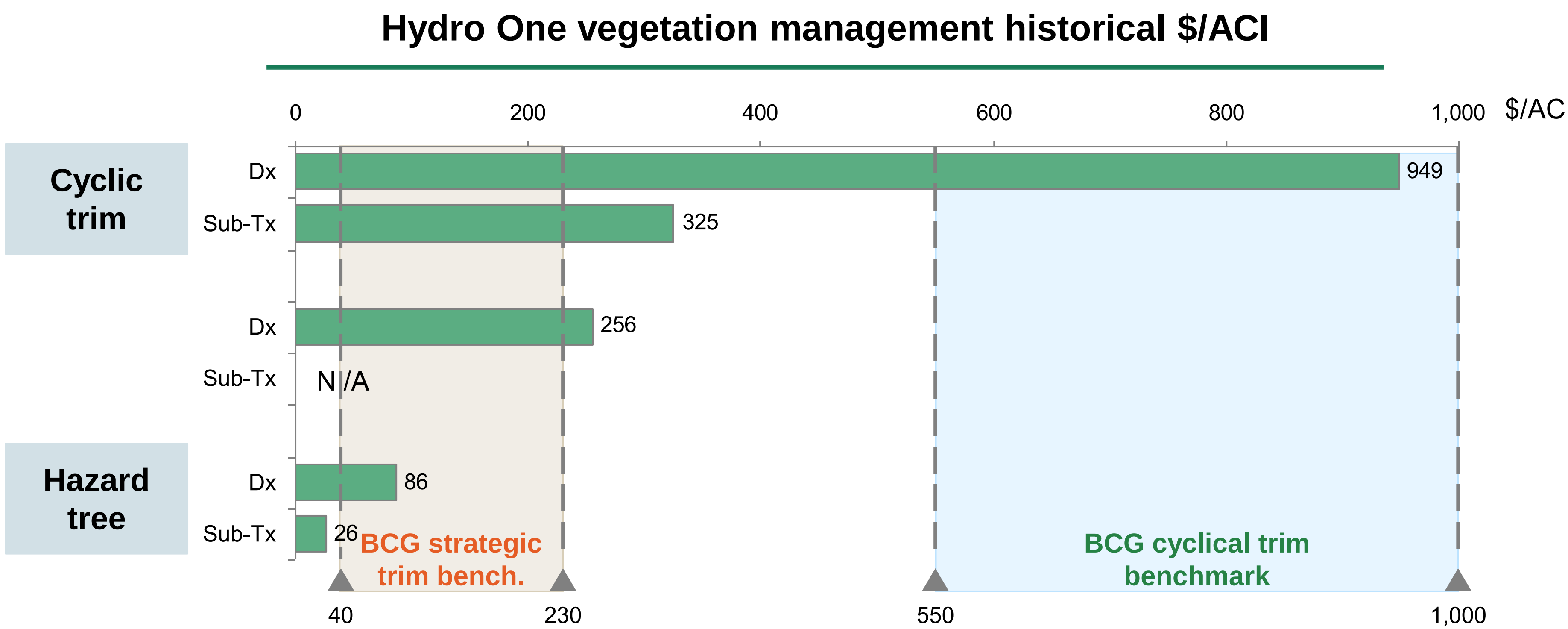
CAIDI (2011-2015 avg.)



Tree contracts account for 16% of system SAIFI and 28% of overall SAIDI

Note: Data includes LOS and excludes FM; data follows the Hydro One standard defining a sustained outage as greater than 1 minute; FM events calculated using 10% methodology
Source: H1 OMS Data

H1's historical vegetation management cost effectiveness on par with other utilities



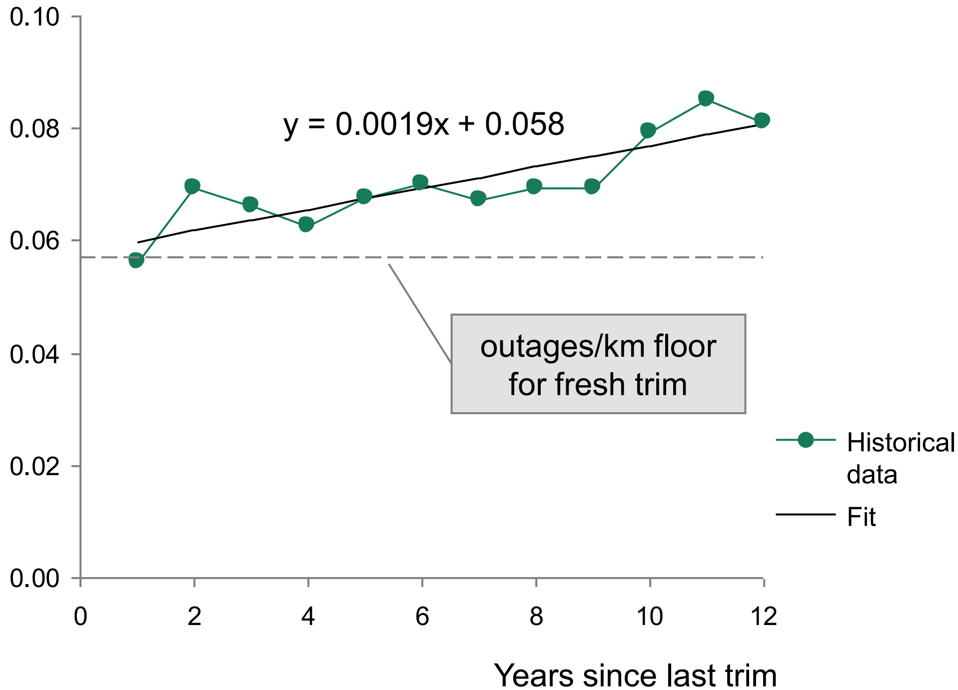
Initial observations

1. Hydro One's veg mgmt program effectiveness in line with BCG benchmarks
2. Sub-Tx cyclic trim more cost effective than Dx trim
3. Hazard tree program is effective but represents limited spend (~$250k /yr)

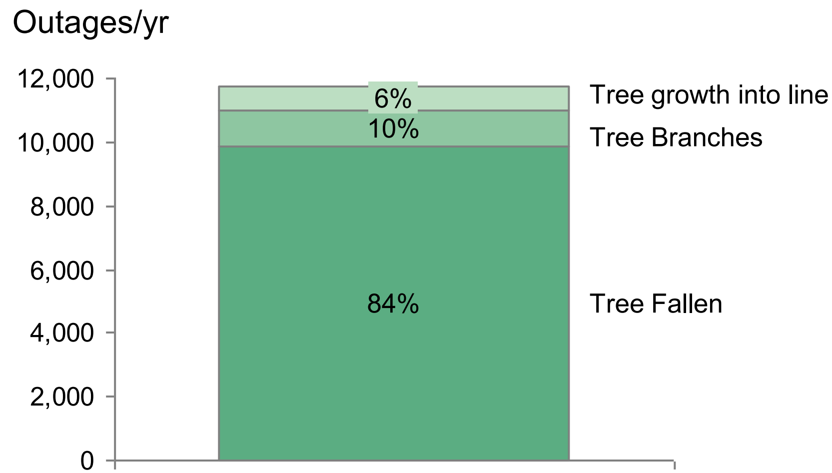
Note: Data includes LOS and excludes FM; FM events calculated using 10% methodology
Source: BCG Analysis, BCG experience with other utilities

Outages increase with time since last trim – but base level of outages likely due to fall-ins

Recently trimmed feeders still suffer from number of tree-related outages



Majority of tree-related outages caused by trees falling from off ROW



Utilities report 80-90% of fallen-tree outages are caused by trees outside managed ROW

- Challenging to identify hazard trees outside maintenance zone

Outage/km floor suggests trimming on 1-year cycle reduces tree-related SAIFI by 18%, from 0.51 to 0.42

Note: Outages/km data includes LOS and excludes FM; outages/yr data includes FM events; data follows the Hydro One standard defining a sustained outage as greater than 1 minute; FM events calculated using 10% methodology. Source: H1 OMS Data

Several potential levers identified to improve vegetation management program

Historic

Current H1 programs	$/ACI
1 Cyclic trim	Dx: $949 Sub-Tx: $325
2 Off-cycle requests	Dx: $256 Sub-Tx: N/A
3 Hazard tree program	Dx: $86 Sub-Tx: $26

= suggested approach

= in progress

( ) = negative

$/ACI reflects cost per avoided customer interruption on a 10-year timeframe

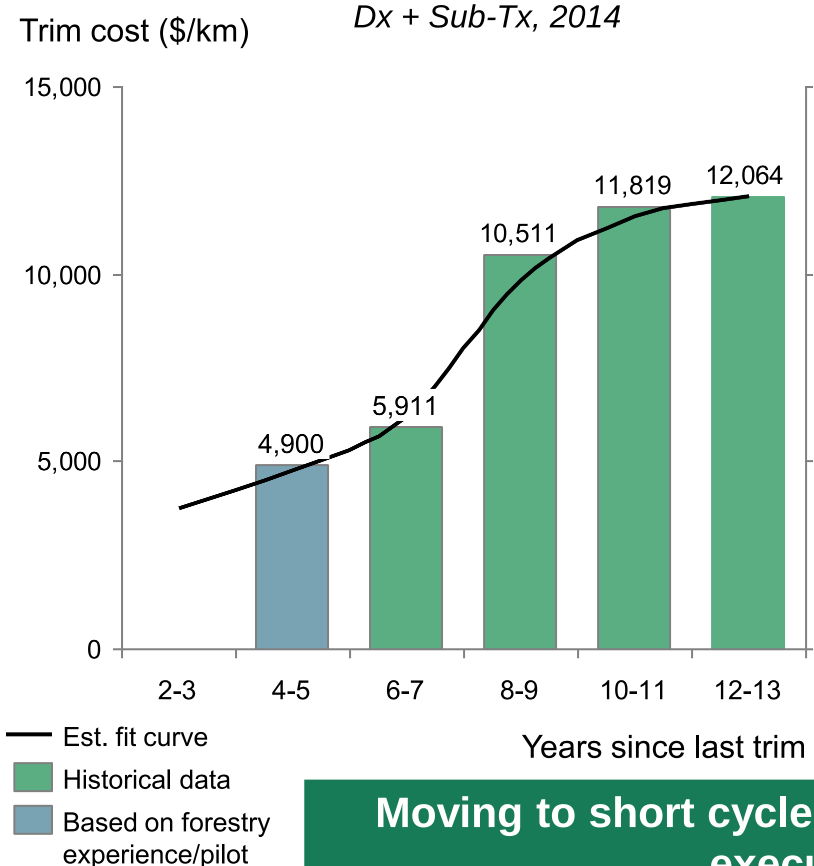
Future

	High potential reliability levers	$/ACI + ease of implementation
OM&A	4 Clear current backlog	Dx: $589 Sub-Tx: $405
OM&A	5 Adjust trim cycle	Dx: **($549)** Sub-Tx: **($589)**
OM&A	6 Increase strategic trim	Dx: $170 Sub-Tx: $96
OM&A	7 Enhance trim standards	• Trim standards in line with others; opportunity to address hazard trees?
OM&A	8 Tech-enabled risk-based trim	Dx: $310-$646 Sub-Tx: $245-$493
CapEx	9 Spacer cables	Dx: $26-$525[1] Sub-Tx: $22-$499[1]
CapEx	10 Aerial bundled cables	Dx: $2,250-2,960 Sub-Tx: $1,850-2,430

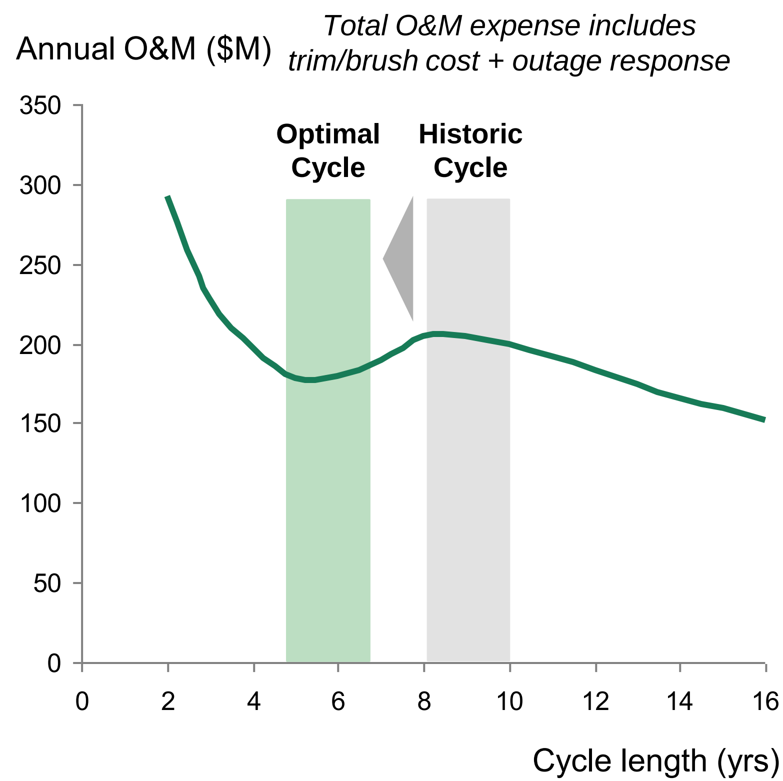
Source: BCG Analysis, H1 OMS Data, 1. Lower limit of cost range reflects $/ACI for first 100km of addressible line.

Increased trim costs with age lead to lower overall VM costs with shorter cycles

Trim cost rises with age since last trim



Opportunity to reduce total O&M expense through shift to shorter cycle

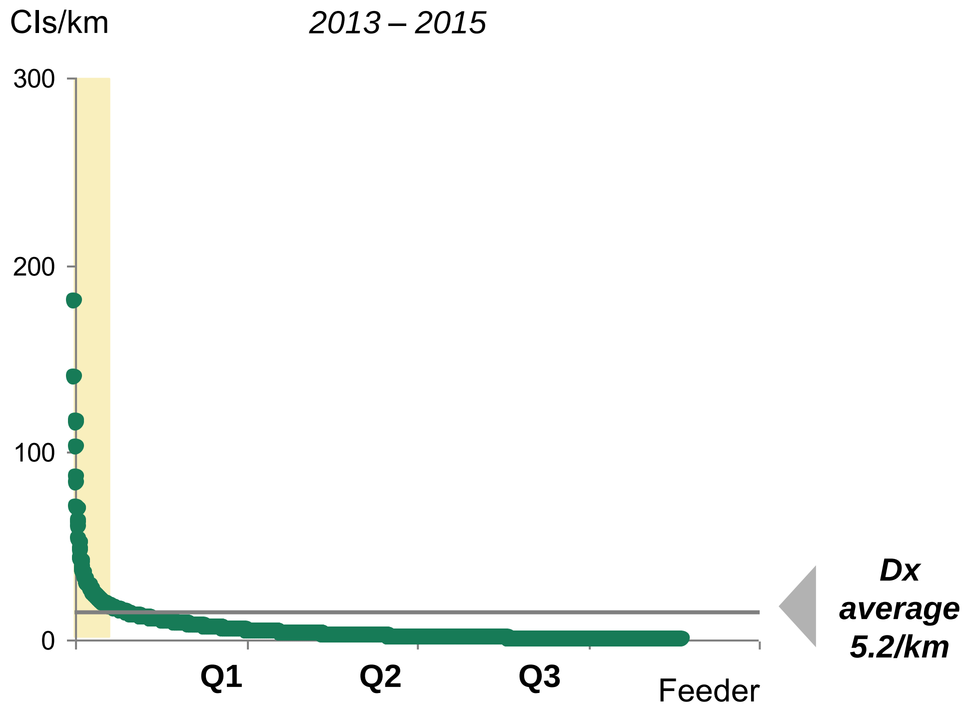


Moving to short cycle on all feeders not optimal due to execution constraints

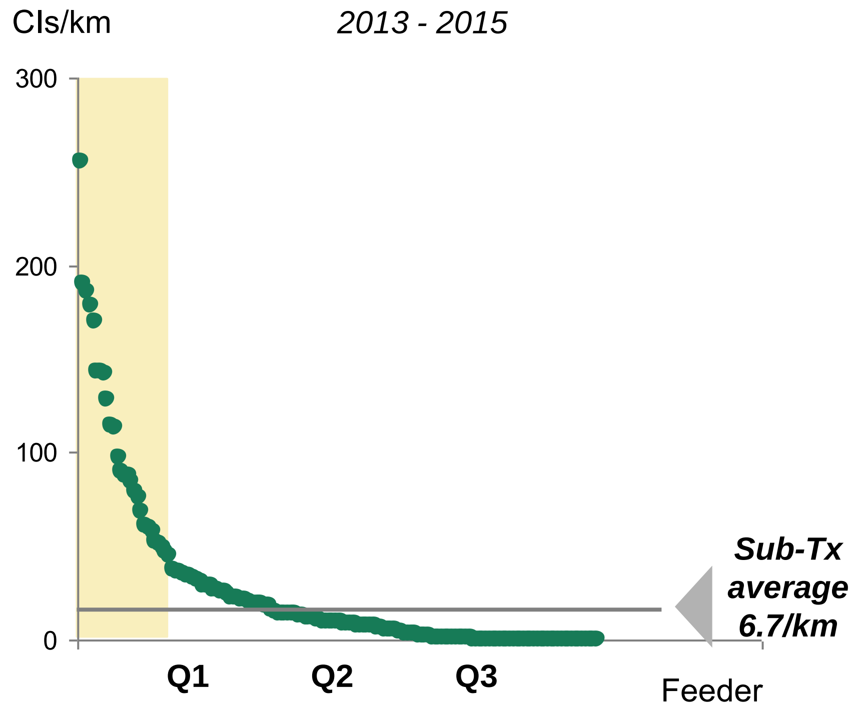
Source: H1 forestry data, H1 OMS data, H1 short cycle study

Small number of feeders have significantly more tree-related outages than system average

Tree-related customer interruptions for Dx feeders



Tree-related customer interruptions for Sub-Tx feeders



= opportunity for strategic trim

Note: Data includes LOS and excludes FM; data follows the Hydro One standard defining a sustained outage as greater than 1 minute; FM events calculated using 10% methodology
Source: H1 OMS Data, BCG Analysis

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Adjusting strategic trim prioritization mechanism yields significant cost benefits

H1's current strategic trim prioritization emphasizes overall SAIDI/SAIFI

H1's current prioritization criteria
- Feeder-level reliability data (SAIDI / SAIFI for last 3 years) - **(70%)**
- Years since last trim - **(20%)**
- Condition data from SAP on per-pole defects - **(10%)**

Age and defect count do not enhance prediction of future reliability

More cost efficient to prioritize based on potential $/ACI

Focus on CI/km rather than absolute number of interruptions
- Customer interruptions (non-FM) per km is more relevant reliability metric than total CI

Factor in variation in trimming costs
- Longer feeders are more expensive to trim
- Trimming costs vary significantly by region

Projected SAIFI impact of highest priority Dx feeder trim

	H1 2016 Scheduled[1]	H1 2016 Prioritized[2]	New Priority[3]
Cost ($M)	25.5	25.7	7.3
SAIFI Improve.	0.013	0.013	0.013
$/ACI	302	303	88

1. Highest priority feeders using H1 methodology scheduled for work in 2016. 2. Highest priority feeders using H1 methodology. 3. Highest priority feeders using new $/ACI methodology.
Source: H1 OMS Data, BCG Analysis

Spacer cables provide opportunity to reduce outages from tree fall-ins, but are not suitable everywhere

Spacer cables offer potential to reduce tree-caused outage baseline

Network reliability benefits
- Reduction in tree-caused outages of 70-90%[1] relative to bare wires

Reduced tree trimming costs
- Compact design and shielded wires allow vegetation to grow closer to lines

Assumptions

Reduction in VM spend of 30%[3,4] and tree-related outages by 70%[1]

Incremental spacer cable cost is 15% above bare line cost[3,4]

Spacer cables have low $/ACI on select feeders

	Dx	Sub-Tx
Spacer Cables	$26-$525[2]	$22-$499[2]

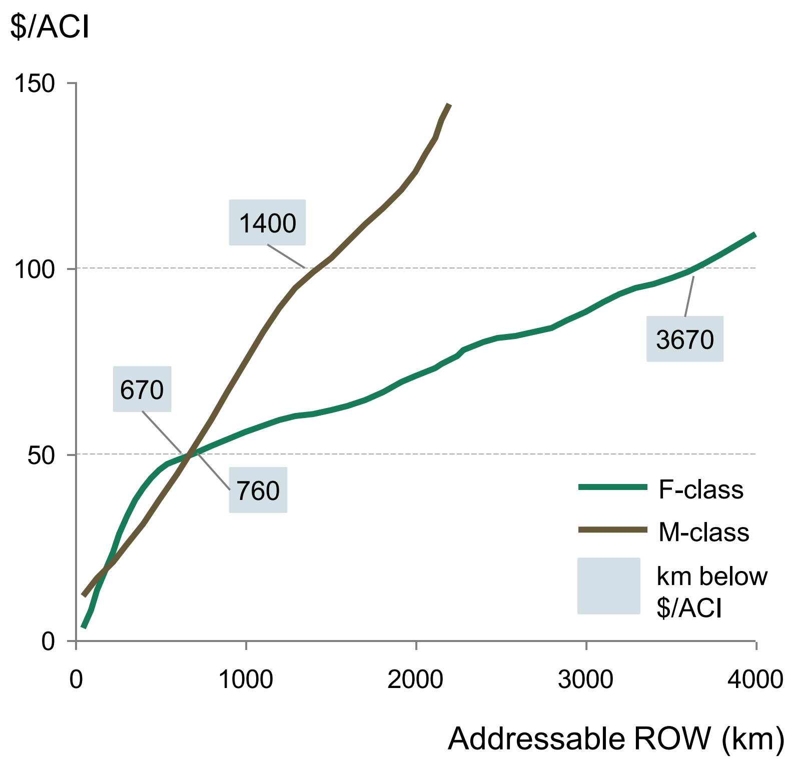
Initial Observations

1. Low $/ACI for both Dx and Sub-Tx on high-impact feeders
2. Cost effectiveness of spacer cables highly dependent on reduction in customer interruptions
3. Spacer cables likely not suitable for widespread deployment, but appear cost effective for some feeders

Outages measured under all conditions
Source: H1 OMS Data, 1. Electric Power Distribution Handbook, T&D World. 2. Lower limit of cost range reflects $/ACI for first 100km of addressible line. 3. CEMIG (Brazil) case study 4. Hendrix Wire and Cable, BCG Analysis

Spacer cables cost effective on significant portion of ROW

ROW addressable by spacer cables



Replacement program targets highest impact feeders at end of line life

Spacer cables only suitable when line is at end of life or for new build

- Not cost effective to replace conductors which are in good condition

Feeders with highest CI/km are most attractive target for replacement

- Areas with either high outages/km (densely forested) or high CI/outage (densely populated) are good candidates

Trimming standards can be adjusted on replaced feeders

- Compact design and covered conductors permit smaller clearances

Deployment will require implementation of new design standards as lines reach end of life

Source: H1 OMS data, H1 forestry data

Summary of proposed vegetation management program

1. **Strict maintenance of shorter cycle on high-priority feeders**
   - Maintain M-class, LDA-serving, and 3-phase F-class feeders on strict cycle corresponding to lowest total VM costs
2. **Increased use of targeted strategic trim on lower-priority feeders**
   - Adjust prioritization methodology to maximize avoided customer interruptions per dollar
   - Continue to evaluate tech-based monitoring to better assess vegetation risk
3. **Deployment of spacer cables in high-impact areas as lines reach end of life**
4. **Management of existing backlog to maintain system integrity**
   - Will need to establish maximum age since last trim
   - Likely to be driven by regulatory pressures

Appendix

Shortening trim cycle results in lower costs and higher reliability

Methodology

Calculated total veg mgmt cost for various trim cycle lengths
- used historical $/km trim cost data

Determined historical outages/km for all Dx feeders based on time since last trim

Estimated impact of scenarios on tree-related SAIFI
- reduction in tree-related outages used to calculate O&M savings from storm/trouble calls

Assumptions

Sub-Tx feeders display same rate of reliability benefit degradation from veg mgmt as Dx feeders

Shorter trim cycle would yield lower overall costs and better reliability

Cycle Length	Total cost *(trim + brush + trouble calls)*	Tree-related SAIFI
1	485	0.420
2	292	0.433
3	229	0.446
4	197	0.460
5	178	0.473
6	179	0.486
7	190	0.500
8	207	0.513

Initial Observations

- System will be further segmented to determine optimal cycle length for feeder subsets

Note: Data includes LOS and excludes FM; data follows the Hydro One standard defining a sustained outage as greater than 1 minute; FM events calculated using 10% methodology
Source: H1 OMS Data, BCG Analysis

Targeted strategic trim is more cost effective than cyclic trim

Methodology

Estimated $/ACI for each feeder
- Outages/km assumed to reach system average after targeted trim
- Trim cost estimated from historical data

Rank ordered feeders from worst to best based on $/ACI

Determined total cost and reliability impact for all feeders with $/ACI below $300

Assumptions

Assumed feeder outages/km reaches system average after strategic trim

Linear decline in VM benefit over 5 year period

Projected impact from first year targets

	Dx	Sub-Tx
Total ACI (5-yr)	220,000	209,000
Trim Cost	$37 M	$20 M
SAIFI Improvement	0.034	0.032
$/ACI	**170**	**96**

H1 has strategic trim program

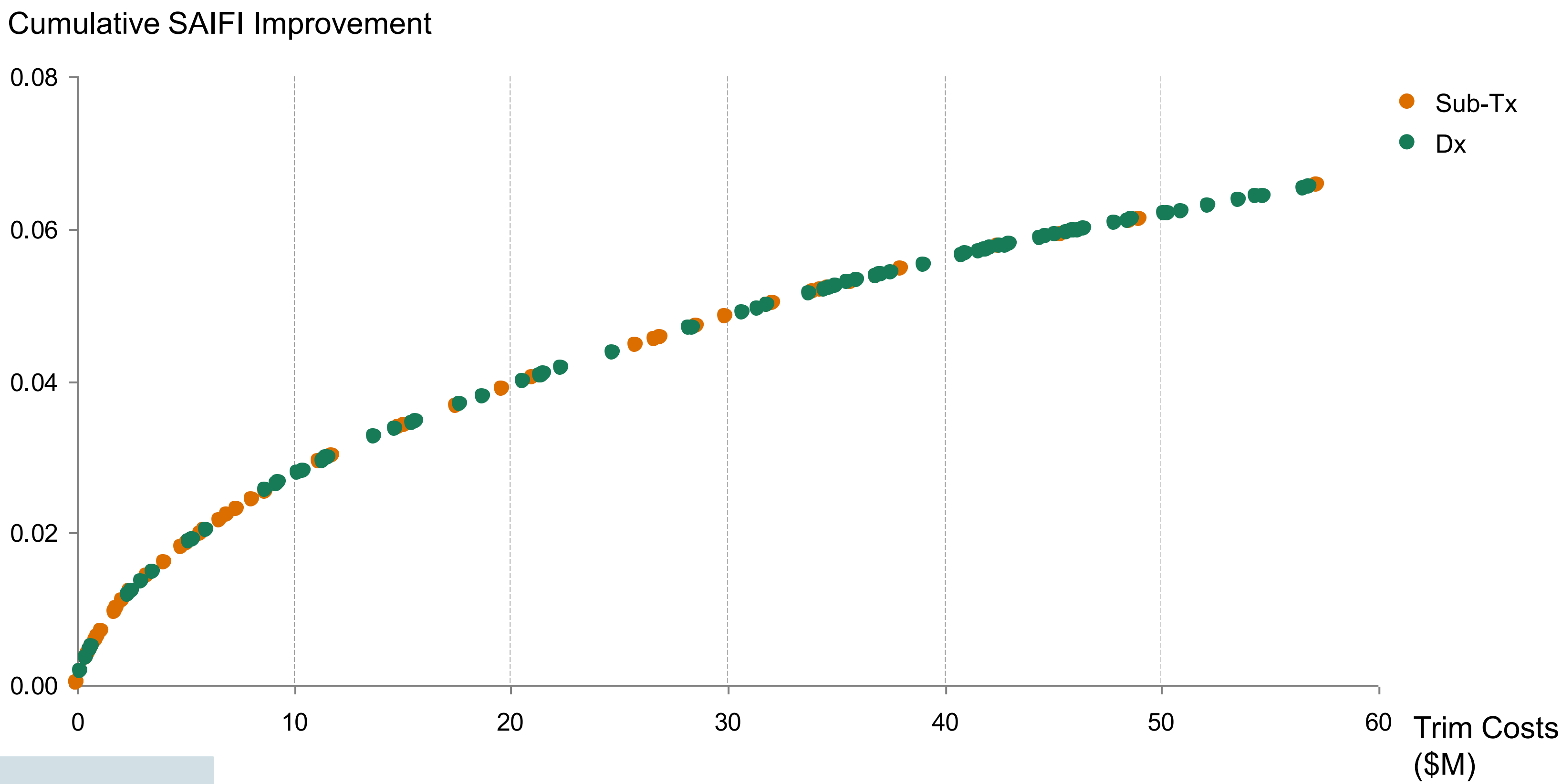
Initial Observations

1. High-outage feeders represent large SAIFI improvement opportunity
2. Hydro One initiated strategic trim program on F-class feeders in 2016

Source: H1 OMS Data, BCG Analysis

Well-targeted strategic trim has large SAIFI impact

SAIFI Improvement for various levels of strategic trim spend



SAIFI Imprvt.	**0.028**	**0.040**	**0.048**	**0.056**	**0.062**
$/ACI	**$56**	**$79**	**$95**	**$111**	**$124**

Source: H1 OMS Data, BCG Analysis

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Recent reliability is best predictor of future SAIFI

Years since last trim and defects/km do not reliably predict SAIFI for individual feeders

Factors used in current strategic trim prioritization

1. Feeder-level reliability data (SAIDI / SAIFI for last 3 years) - (70%)
2. Years since last trim - (20%)
3. Condition data from SAP on per-pole defects - (10%)

Recent CI/km is only significant predictor of 2015 CI/km[1]

	Coeff.	Std. Error	p-value
2012-2014 CI/km	0.66	0.06	2×10^{-25}
Age (yrs)	-0.21	0.16	0.21
Defects/km	0.14	0.31	0.66

Suggested new prioritization criteria

1. Length-normalized feeder-level reliability data (CI/km for last 3 years)

\+

2. Trimming cost/km

= **Projected $/ACI for each feeder**

1. Multiple regression analysis performed on feeders trimmed prior to 2014. Coefficient indicates rise in 2015 CI/km for one unit rise in independent variable listed. P-value is likelihood relationship between variables was obtained by chance.

Jurisdictions with mandated vegetation management have similar clearance standards to Hydro One but shorter cycles

State/province (standard)	Horizontal Clearance (m)	Vertical Clearance (m)	Trim Cycle (yrs)	Motivation
Hydro One	3.0 (at trim)	3.0 (at trim)	8	• Provide cost effective service that mitigates tree related risk
Maryland	3.0 (at trim)	3.0 (at trim)	4 (urban) 6 (rural)	• Response to PEPCO's status as one of the most unreliable utilities
Alberta	1.0	2.0	n/a	• Desire to create 'best in class' utilities which comprehensively address risk of tree contact
Oregon	1.5	1.5	n/a	• Attempt to mitigate accidents and electrocutions from climbing tree near power lines
California	1.2	1.2	n/a	• Primarily adopted to reduce high risk of fire
Missouri	n/a	n/a	6(r) 4 (u)	• Improve utility reliability
Oklahoma	n/a	n/a	4	• Improve utility reliability
Florida	n/a	n/a	3	• Reduce hurricane related damage

Source: 1. CNUC 2010 Regulatory Requirements Report 2. Oregon Public Utilities Commission Division 24 Safety Standards. 3. Electrical Protection Act Alberta Electrical & Communication Utility Code Section 3.1.7 4. MD PSC RM 43 Vegetation Management 5. California Public Resource Code 4293, General Order 95 Rule 35

Backlog has now grown to nearly 30% of entire right-of-way, increasing strain on vegetation management

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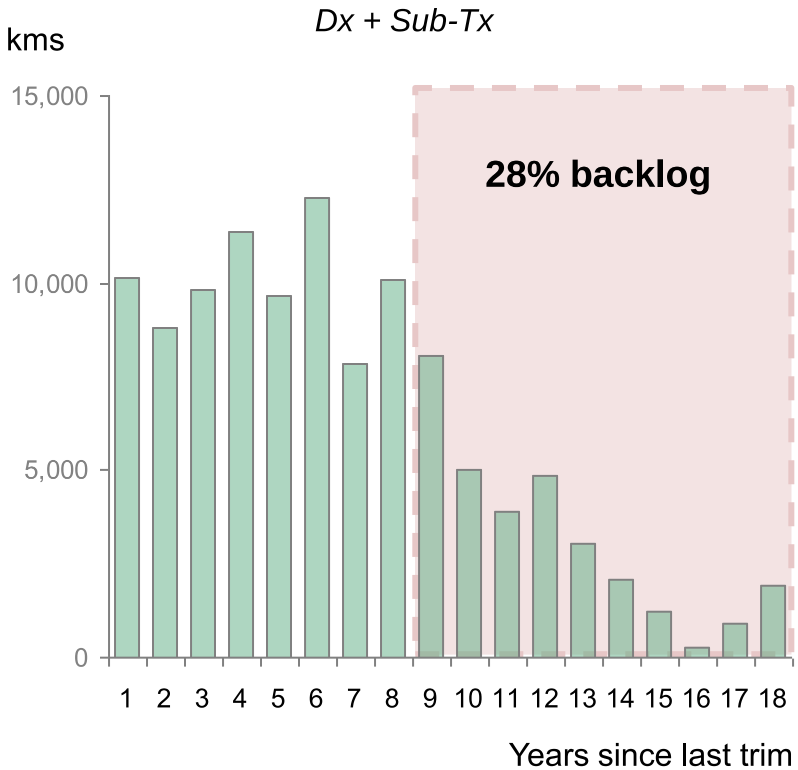
28% of right-of-way is greater than 8 years since last clearing



Backlog imposes growing burdens on vegetation management

Trimming costs increase with years since last trim
- More trees must be addressed in cyclic trim
- Higher-cost labor must be employed for brush management when brush nears lines (>6 years)

Safety concerns rise for trimming and outage response
- Overgrown feeders present greater challenges for forestry and repair crews working in vicinity of lines

Tree-related outages increase with years since last trim
- Outage rate rises linearly with trim age causing deterioration in system SAIFI

Source: Hydro One Asset Portfolio Document: Right-of-Way Management

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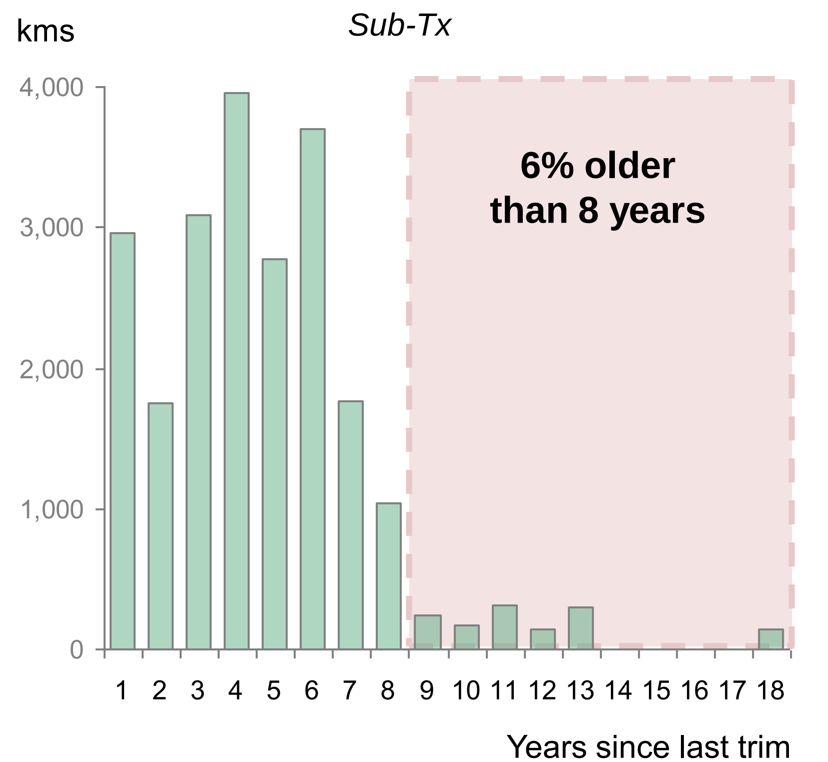
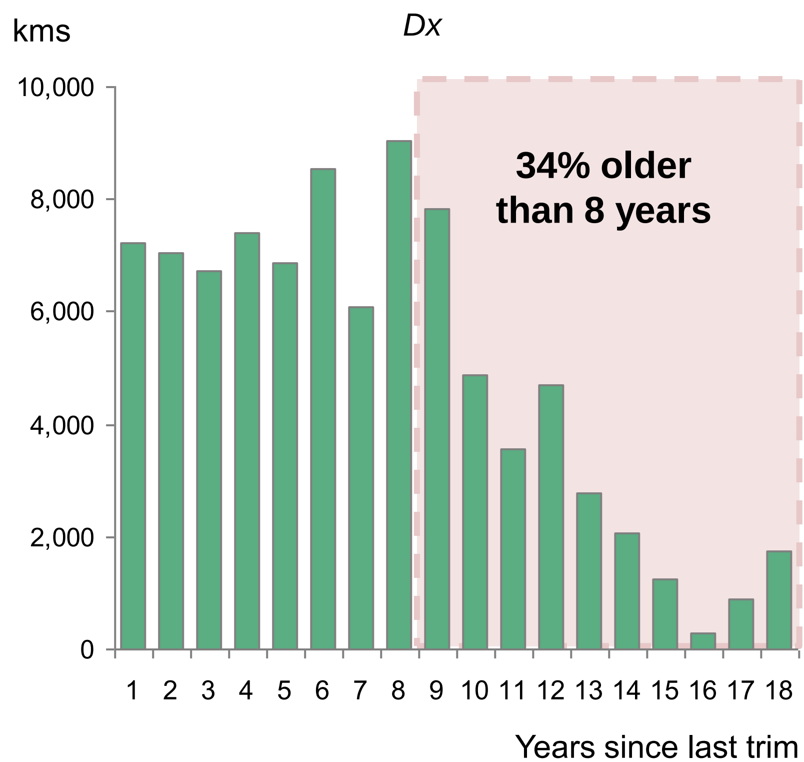
Sub-Tx lines have been maintained on a 6-8 year cycle at the expense of Dx lines

Nearly all Sub-Tx lines have been maintained on 6-8 year cycle



Over one third of Dx feeders older than 8 years old



Current vegetation management spending insufficient to maintain all ROW on <8 year cycle

Source: Hydro One Asset Portfolio Document: Right-of-Way Management