ONTARIO ENERGY BOARD

IN THE MATTER OF the *Ontario Energy Board Act, 1998*, S.O. 1998, c. 15, Sched. B, as amended;

AND IN THE MATTER OF an application by Alectra Utilities Corporation for an order or orders approving or fixing just and reasonable rates and other services charges for the distribution of electricity as of January 1, 2020.

EB-2019-0018

CROSS-EXAMINATION COMPENDIUM

DISTRIBUTED RESOURCE COALITION

October 16, 2019

EB-2019-0018

CROSS-EXAMINATION COMPENDIUM

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JT2.2 Q1 Attachment - Proposed M-Factor Funded Capital Investments by Rate Zone

	($MM)
Brampton	**26.0**
Goreway TS Expansion (CCRA) - 10 Yr True-Up Payment	5.6
MS-12 Hansen Rd 4.16kV Voltage Conversion	5.5
MS-2 Church St 4.16kV Voltage Conversion	4.4
42M69 Feeder Extension Williams Pkwy - Main St to Kennedy Rd	1.1
Cable Injection Project - (F4-G4) - Main - Steeles - Chinguacousy - Queen, Brampton	1.1
Cable Replacement Project - (F4-G4) - Main - Steeles - Chinguacousy - Queen, Brampton	1.0
136M6 Goreway TS Extensions	1.0
Cable Injection Project - (F3-G3-H3) - Phase 2, Brampton	0.8
Fleet_2024_ Central North Vehicle Replacement_Reel Carriers	0.7
Facilities_2022_Reno_Sandalwood - CDM Relocation from Jane	0.6
Cable Injection Project - (G1) - Hwy 410 - Kennedy - Wanless - Main, Brampton	0.6
Fleet_2024_ Central North Vehicle Replacement_S/Bucket	0.5
Fleet_2023_ Central North Vehicle Replacement S/Bucket 8910	0.5
Fleet_2020_ Central North Vehicle Replacement-180 Loader	0.3
Fleet_2023_ Central North Vehicle Replacement_Stake Trucks	0.3
New WiMAX Communications System - Central North	0.3
Fleet_2021_ Central North Vehicle Replacement_ Step Vans 6310	0.3
Fleet_2020_ Central North Vehicle Replacement-Step Van 8108	0.2
SS-2019-Station LED Lighting Upgrades -EAST	0.1
136M9 Feeder Extension Castlemore Rd, Goreway Dr to McVean Dr	0.1
42M66 OH Feeder Egress Mississauga Rd, Bovaird to CNR	0.1
SS-2019-Upgrade to Station Facilities (Building / Civil work) MultiYear-EAST	0.1
Fleet_2023_ Central North Vehicle Replacement_Trailer	0.1
42M64 Feeder Extension Mississauga Rd, Williams Pkwy to Queen / Embleton	0.1
JY TS1 Bus & Main Breaker Protections Replacement	0.1
Fleet_2021_ Central North Vehicle Replacement_Vans	0.1
SS-2019-Driveway Paving- Various Stations-Intitiative-EAST	0.1
Fleet_2022_ Central North Vehicle Replacement pick ups	0.1
Fleet_2023_ Central North Vehicle Replacement pick ups	0.1
Fleet_2021_ Central North Vehicle Replacement Pick up 9514	0.1
Fleet_2020_ Central North Vehicle Replacement-Van 5910	0.1
Fleet_2024_ Central North Vehicle Replacement_Trailer 11510	0.0
Fleet_2022_ Central North Vehicle Replacement SUVs	0.0
Fleet_2022_ Central North Vehicle Replacement Car	0.0
42M66/25M7 New Ducts Main St & Queen St	0.0
Enersource	**51.8**
44kV New Feeder Extension Centre View Dr	6.5
Duke MS New 20 MVA Substation	6.2
27.6kV Feeder Extension Traders	5.5
Port Credit Village East New Feeders (Marina)	4.4
Left behind - ERZ	2.7
Clarkson Voltage Conversion 4.16-27.6kV (4 Sections)	2.7
Windjammer	2.7
Mini-Orlando MS 27.6kV Land Purchase	2.2
27.6kV New Feeders Lakeview Development	1.9
44kV Feeder Extension York/Meadowpine	1.8
13.8kV Feeder Extension 9th Line, Derry to Argentia	1.2
Shelter Bay Rd.	1.1
QEW Expansion Dixie West OH Betterment	1.1
Truscott Plaza Voltage Conversion 4.16 - 27.6kV (3 Sections)	1.0
MS Transformer & HV Switchgear Replacement (ACA)Munden MS35 T1 & HV1	0.9
MS Transformer & HV Switchgear Replacement (ACA) Western MS36 T1 & HV1	0.8
Fleet_2024_Central South Vehicle Replacement-Step Vans	0.7
Mason Heights	0.7
Bough Beeches Blvd.	0.7
Station Switchgear Replacement (ACA) Bloor MS38 LV1	0.7
Fleet_2024_Central South Vehicle Replacement- Material Handler	0.6
Airport 88M5 & 88M7 HONI Purchase	0.5
Distribution Cable Replacement - Area of Erin Mills pkway. and South Millway	0.5
Fleet_2024_Central South Vehicle Replacement-209-09 S/bucket	0.5

Fleet_2023_Central South Vehicle Replacement-236-10 S/bucket	0.5
Fleet_2021_Central South Vehicle Replacement-210-09 S/bucket	0.5
New WiMAX Communication Network - Central South	0.4
Fleet_2024_Central South Vehicle Replacement-Vans	0.3
King St. Voltage Conversion & Loop (LRT Betterment)	0.3
Fleet_2022_Central South Vehicle Replacement-Step Vans	0.2
Fleet_2020_Central South Vehicle Replacement-Step Van	0.2
Fleet_2022_Central South Vehicle Replacement- Vans	0.2
Fleet_2024_Central South Vehicle Replacement-Trailers	0.2
SS-2019-Installation of SWI Video security system Intiative at 4 MS stations per year - -CENTRAL	0.2
Fleet_2024_Central South Vehicle Replacement-Pick ups	0.2
Fleet_2022_Central South Vehicle Replacement-Pick ups	0.2
SS-2019-Station LED Lighting Upgrades -CENTRAL	0.1
SS-2019-Driveway Paving- Various Stations-Intiative-CENTRAL	0.1
Fleet_2024_Central South Vehicle Replacement-SUV	0.1
Fleet_2022_Central South Vehicle Replacement- SUV	0.1
Fleet_2020_Central South_Vehicle Replacement -Vans	0.1
Fleet_2020_Central South Vehicle Replacement-Pick ups	0.1
Fleet_2024_Central South Vehicle Replacement-Van	0.1
Fleet_2021_Central South Vehicle Replacement- Van	0.1
Fleet_2021_Central South Vehicle Replacement- trailer	0.0
Fleet_2020_Central South Vehicle Replacement-SUV	0.0
Fleet_2023_Central South Vehicle Replacement-Bocat	0.0
Fleet_2023_Central South Vehicle Replacement- Arrowboard	0.0
Guelph	**4.1**
GUELPH - Campbell TS 36M63 Feeder PHASE 2	1.2
GUELPH - Campbell TS 36M63 Feeder PHASE 1	1.2
GUELPH - Rear Lot Conversions	0.6
GUELPH - Southgate Dr to Maltby Rd O/H Extension	0.6
GUELPH - Arlen MTS - New Feeder	0.5
GUELPH - Capacitor Bank Installations	0.1
GUELPH - SS - Driveway Paving Intiaitive	0.0
GUELPH - SS - Station LED Lighting Upgrades	0.0
Horizon	**47.4**
Deerhurst MS Voltage Conversion	7.8
HaLRT_New Stirton Feeder for TPSS#4 and 8852X load shedding	4.8
Dewitt MS Voltage Conversion	4.1
Eastmount MS Voltage Conversion	3.8
Aberdeen MS Voltage Conversion_2020 to 2022	3.3
Galbraith MS Voltage Conversion	3.3
Rear Lot Conversion - Marsdale	3.1
Elmwood MS Voltage Conversion	2.8
Rear Lot Conversion - Richlieu Dr and Trelawne Dr	2.4
North Central feeders capacity (Carlton TS to Lakeshore/Lake) relief	2.0
Montgomery Dr Voltage Conversion and Rear Lot Relocate_ANC	1.8
Waterdown 3rd Feeder	1.7
Vansickle TS True-up Payment	1.6
Rear Lot Conversion - Strathcona Dr	0.9
2D7X Pimlico Dr - Voltage Conversion and Rear Lot	0.6
Nebo TS 27.6kV True-up Payment	0.5
New WiMAX Communications System - West	0.5
Facilities_2019_Reno_John St Roof Deck – Employee Breakout Area Rooftop Green Space	0.4
Fleet_2023_West_Vehicle_Replacement_Bucket Truck_1-354	0.4
Fleet_2020_West_Vehicle Replacement_Step Vans	0.4
Fleet_2024_West_Vehicle_Replacement_Pickups	0.2
SS-2019-Installation of SWI Video security system Intiative- 4 MS stations per year - WEST	0.2
Fleet_2020_West_Vehicle Replacement_SUVs_1-268,1-226,1-227	0.1
Fleet_2023_West_Vehicle_Replacement_Pickups	0.1
Fleet_2023_West_Vehicle_Replacement_Trailer	0.1
SS-2019-Driveway Paving- Various Stations-Intiative-WEST	0.1
Fleet_2024_West_Vehicle Replacement_Forklift	0.1
Fleet_2023_West_Vehicle Replacement_ Pole Trailer_1-405	0.1
Fleet_2022_West_Vehicle_Replacement_Trailers	0.1
SS-2019-Station LED Lighting Upgrades -WEST	0.1

Multiple	25.0
CC&B upgrade 2021 - 2022	13.3
Alectra Workforce Management Software	4.7
Alectra Drive at Home	2.7
Blockchain	2.4
Alectra Drive for the Workplace	0.8
Alectra Single Platform Website ongoing	0.3
Fieldworker Upgrade 2020	0.3
Back-end Automation (Orchestration Tool\Setup)	0.2
IT Innovation (ITx, 2024)	0.2
Powerstream	**110.6**
Vaughan TS#4 Feeder Integration - Part 3	8.8
Residential Meter "ICON F" Meter Replacement Initiative- East	7.3
Install Two 27.6kV Ccts on 16th Ave from Hwy 404 to Woodbine Ave	5.5
Markham TS #4 Feeder Egress Part 3	4.9
Residential solar-storage	4.0
Rear Lot Supply Remediation - Royal Orchard - North	4.0
Install Double Cct Pole Line on Major Mackenzie - Hwy 27 to Huntington Rd	3.7
Bathurst Street Widening	3.4
Connection Cost Recovery Agreement (CCRA) – Midhurst TS – 15th Anniversary True-up	3.2
Cable Replacement - (V15) - Jardin Dr	2.9
Cable Replacement - (A02) - Steeplechase Ave	2.9
Cable Injection Project - (V17) - Langstaff - Keele - Rutherford - Dufferin, Vaughan	2.8
Install two additional 27.6 kV ccts on Hwy 7 from Jane St to Weston Rd	2.6
Rear Lot Supply Remediation - East of Queen St. to Eastern Ave./North of Greenway St.	2.6
Rear Lot Supply Remediation - Main Street / Unionville / Carlton	2.5
Cable Replacement Project - (V17) - Langstaff - Keele - Rutherford - Dufferin, Vaughan	2.4
New Barrie 20MVA Substation - Harvie	2.2
Rebuild 27.6 kV pole line for 4 Ccts on Warden Ave from Major Mack to Elgin Mills	2.2
Cable Replacement - (M33) - 16th Avenue and Village Parkway	2.1
27.6 kV Pole Line on 14th Ave from Hwy 48 to 9th Line	2.0
Aurora MS6 Expansion - (Year 1 of 2) - Design & Order Equipment	2.0
New Alliston 10MVA Substation - Industrial Parkway	1.9
Rear Lot - Gunn/Oakley Park/St.Vincent	1.8
Rear Lot - East of Queen Street/North of Mill Street	1.8
Cable Replacement – (Barrie) - Cook St and Steel St	1.7
Net Zero Energy Emissions	1.6
Two Ccts on Birchmount Rd from ROW to 14th Ave	1.6
Radial Supply Remediation/Conversion - 13.8 kV to 27.6 kV on Miller Ave	1.5
Cable Injection Project - (V50) - Hwy 7 - Kipling - Steeles - Hwy 27, Vaughan	1.5
Pole Line Installation Double Cct on Major Mack - Huntington Rd to Hwy 50	1.4
Install a new 4 ccts CNR yard overhead crossing on the south side of Hwy 7	1.4
Add one Additional 27.6 kV Cct on Major Mack Dr and 9th Line	1.3
Build double ccts 27.6kV pole line on 19th Ave between Leslie St and Bayview Ave	1.3
Cable Injection Project - (V25) - Major Mackenzie - Keele - Rutherford - Jane, Vaughan	1.3
Cable Injection Project - (V24) - Langstaff - Jane - Rutherford - Keele, Vaughan	1.3
Install 44kV & 13.8kV Bryne Drive	1.1
Cable Replacement - (Barrie) - Cundles Rd and Janine St	1.1
Cable Replacement Project - (V51) - Langstaff - Kipling - Hwy 7 - Hwy 27, Vaughan	1.0
Cable Replacement Project - (V24) - Langstaff - Jane - Rutherford - Keele, Vaughan	1.0
Fleet East 2024 Vehicle replacement - Cube Vans	0.7
Fleet East Unit # 75 83' Double Bucket	0.7
Cable Injection Project - (V51) - Langstaff - Kipling - Hwy 7 - Hwy 27, Vaughan	0.7
Fleet East Unit # 125, 83' Double Bucket	0.7
Install 2nd 27.6 kV Cct on Woodbine Ave from Elgin Mills Rd to 19th Ave	0.6
Cable Injection Project - (V31) - Langstaff - Weston - Rutherford - Jane, Vaughan	0.6
Hydro One Asset Purchase - Alliston	0.5
Redundant Fibre Path to Aurora MS#4 Sub-Station	0.5
Markham TS#2 Line Protections and HMI Upgrade - KDU-10 Replacement	0.5
Split the 1/0 loop on Cityview Blvd into two loops	0.5
Fleet East Unit # 61 Digger truck replacement	0.4
Vaughan TS#1 Bus Differential & Overcurrent Protections Upgrades	0.4
Dufferin St S, between MS431 and Albert St S, Alliston	0.4
Markham TS#1 Bus Differential & Overcurrent Protections Upgrades	0.4

Markham TS#3 Bus Differential & Overcurrent Protections Upgrades	0.3
Markham TS#2 Bus Differential & Overcurrent Protections Upgrades	0.3
Markham TS#1 T1/T2 "B" Overcurrent Protections and HMI Upgrade	0.3
Vaughan TS#2 Bus Differential and Overcurrent Protections Upgrade	0.3
Rear Lot Supply Remediation - Blake/Kempenfelt	0.3
Fleet East 2024 Vehicle replacement - Extened Vans	0.2
Markham TS#2 T1/T2 "B" Differential Protections Upgrade	0.2
Vaughan TS#1 T1/T2 "B" Differential Protections Upgrade	0.2
Markham TS#3 T1/T2 "B" Differential Protections Upgrade	0.2
Richmond Hill TS#2 Upgrade Bus, Line & Transformer Protections	0.1
Aurora MS6 (AMS6) Transformer and Bus Protection Upgrade	0.1
New Three Sector WiMAX Node - MS305	0.1
Vaughan TS3 - Station Service Transfer Upgrade	0.1
Cityview microgrid enhancements	0.1
Vaughan TS#2 T1/T2 "B" Differential Protections Upgrade	0.1
Fleet East 2024 Vehicle replacement - Work Van	0.1
Fleet East 2024 Vehicle replacement Pickup truck 2500	0.1
Greenwood Expansion Station Service Supply Backup	0.0
Fleet East 2021 Vehicle addition - Van pool van	0.0
Fleet East 2020 Vehicle addition - Van pool van	0.0
Fleet East 2024 Vehicle replacement - SUV	0.0
Grand Total	**265.0**
Fleet_SUM	**12.7**
Fleet_SUM out of Grand Total (%)	4.81%

Electric Vehicles & Charging Stations

INNOVATION » Electric Vehicles & Charging Stations

Electric Vehicle Charging Stations

Alectra Utilities (formerly PowerStream) identified Electric Vehicles (EV) as a major opportunity for sustainable mobility in late 2010. In the years following, we have led the charge for better and wider access to EV charging infrastructure. Alectra Utilities is committed to providing safe, reliable and accessible charging facilities to the growing number of customers who use EVs. In pursuit of that goal, we installed one of the first DC fast chargers in Ontario at our head office in Vaughan in late 2014. The success of this program has reinforced our belief that EVs are truly the way of the future.

EV Charging Station Locations:

Alectra Utilities Vaughan Office (161 Cityview Blvd, Vaughan, ON)

In November 2014, Alectra Utilities unveiled a level 3 charger unit at its office in Vaughan, which is free to the public to use. Power is supplied by Alectra Utilities and paid for by Survalent Technology and G&W Canada. The unit, which charges 10 times faster than the more common-place level 2 chargers, is equipped to handle both CHAdeMO and Society of Automotive Engineers (SAE) compatible electric vehicles.

Markham Civic Centre (101 Town Centre Blvd, Markham, ON)

Alectra Utilities is glad to announce that we have installed a new DC fast charger, compatible with CHAdeMO and SAE vehicles, located at the Markham Civic Centre, in partnership with The City of Markham and Nissan Canada. Courtesy of Nissan Canada, the charger will be free to the public until early September 2015 (to coincide with the PanAm games) and will then revert to a paid service. In order to use the charger, EV drivers will need to sign up to the VERnetwork, one of the largest charging networks in Canada. Users can sign up to receive an idVER™ card (which has an associated cost), or download the free mobile phone app that allows users to enable chargers remotely. Visit VERnetwork to find out more about how you can sign up and the associated rates for charging.

For more information about the Alectra Utilities EV program, email us at SmartCharging@PowerStream.ca.

In July 2011, Alectra Utilities took ownership of the first two Nissan LEAF™ 100% electric, zero gas, zero tailpipe emission vehicles (EVs) ever delivered in Canada.

At the time of the delivery, the Nissan LEAF was the world's first zero emission, all-electric car made for the real world driving needs of consumers. With no tailpipe and no CO2 emissions, the vehicles each have a range of 160 kilometres (LA4 test cycle) on one full charge.

The two Nissan LEAF vehicles have been added to the company's fleet and are now used in conjunction with the Alectra Utilities electric vehicle smart charging station pilot program. By using the Nissan LEAF with smart charging technology, Alectra Utilities is identifying the most cost effective means to control the electrical loading of its distribution system assets resulting from the advent of electric vehicle technology.

2011 Nissan LEAF EV Fast Facts

Vehicle range on full charge	160 kms
Top speed	150 kph
Cost	$35,000 (before $8,500 government rebate)
Cost to fully charge battery	$2.88 (at $0.12/kWh)
Battery capacity	25 - 30 kWh
Battery life	8 years or 160,000 kms
Emissions	ZERO!

Have more questions about the Nissan LEAF electric vehicle?
Read our FAQs About Nissan LEAF Vehicles

5.3.4.5 GRID MODERNIZATION APPROACH

Alectra Utilities' distribution system needs to evolve so that it is prepared for a future for which it was not initially designed. The traditional distribution system design is based on large generating stations which are located away from the power consumption areas, one way flows of electricity and information, and which offer limited choices to customers in the way electricity is produced, distributed and transacted. The following are the drivers which require the electrical grid to evolve.

- Changing Electricity Supply Mix (e.g. penetration of DERs)
- Advancement in Information and Control Technologies
- Electrification of Transportation Infrastructure
- Providing New Market Opportunities for Customers
- Threats to Resilience and Reliability

Alectra Utilities' approach to grid modernization considers the above-noted drivers and attempts to solve the challenges of integrating conventional and renewable sources with energy storage, integrating electric vehicles and smart buildings, deploying condition monitoring and using real time telemetry data to gain operational efficiencies while ensuring that the grid is resilient and secure to withstand growing cybersecurity and aging challenges.

Alectra Utilities' grid modernization plans take into account the extent of grid modernization efforts made by each of its predecessor utilities and the paths they were on. The company has also sought to leverage the best practices of the predecessor utilities in developing its singular approach to grid modernization for the utility as a whole, and for managing the system to meet customer expectations for service, quality, choice, and affordability.

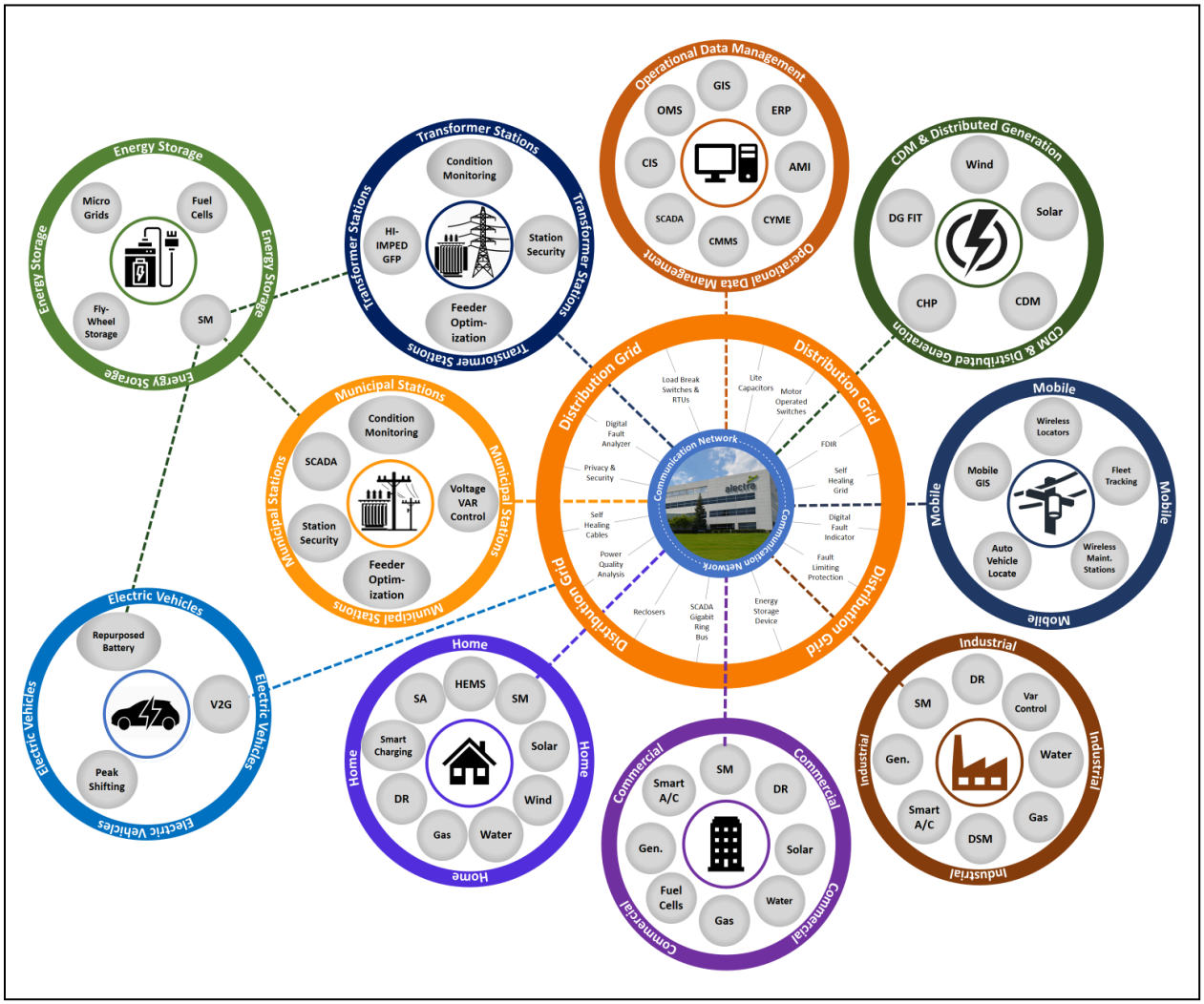
In some cases, this requires adopting one of the predecessor utility's technology, systems, or processes to build upon. In other cases, it requires a move to something entirely new. The company's decision framework involves considerations about pacing and sustainability of change management, maturity and inertia of existing processes and technology, best practice evolution, expected outcomes, and cost.

Grid modernization is not an end state; rather it is a process that has been occurring since the first grid was built. Every year, improvements bring more value to the grid for its customers through the introduction of new technologies, systems, and processes. Alectra Utilities operates a grid

today that is highly developed with layers of information technology and operational technologies ("IT/OT"), many of which have not been traditionally considered part of the "smart grid" but which, in Alectra Utilities' view, are all part of grid modernization. Customer support systems like web portals, CIS, business decision-support systems like ERP, mobile production support systems like Automatic Vehicle Location ("AVL"), mobile GIS, Field Worker, station security systems, feeder optimization software, and others are all considered investments in grid modernization. The integration of all these advancements in IT/OT with the "foundational technologies" more traditionally considered part of todays "smart grid" like SCADA, Automated Distribution Management Systems ("ADMS"), Outage Management System ("OMS"), and smart meters, continues within Alectra Utilities with ongoing refresh.

These foundational technologies and systems are leveraged incrementally in a way that takes advantage of emerging opportunities to harness the value of DERs, energy storage, electric vehicles ("EV"s), enhanced Advanced Metering Infrastructure ("AMI"), Home Energy System ("HEMS"), condition monitoring, intelligent devices and Artificial Intelligence ("AI"). Alectra Utilities' representation of the modern grid is presented in Figure 5.3.4 - 1 below. This representation is useful to illustrate the connectedness and integration of grid components with communications and information systems, and interface boundaries with entities outside the organization.

Figure 5.3.4 - 1: Alectra Utilities' Representation of Modern Grid



Alectra Utilities' grid modernization efforts are focused on the following areas:

A. Deployment and integration of DERs.
B. Deployment of smart technologies for grid operation and status (SCADA, ADMS), metering and distribution automation to improve reliability, security and efficiency of the grid.
C. Increased use of digital information and condition monitoring to improve reliability and maximize asset life.
D. Preparing the grid for the electrification of transportation infrastructure.

E. Development and incorporation of demand response, demand-side resources, and energy-efficiency resources and measures to ensure timely information to customers and open new market opportunities for customers.
F. Ensuring that the deployed resources and grid operations are fully secure against cyber threats.

Alectra Utilities has presented investments for the next 5 years as part of this DSP so as to balance near-term system needs with its longer-term plans for grid modernization. Investments are largely in foundational systems to meet the challenges posed by the drivers, such as to advance capacity for bi-directional energy management, automated restoration, improved communication, condition monitoring, system hardware and software upgrades, and cyber security. Over these five years, as more information and results from pilots become available, Alectra Utilities will further calibrate the pace and direction of its grid modernization needs. Alectra Utilities will also use the planning period to continue to engage with stakeholders to ensure investments remain appropriate and that the grid is being modernized in keeping with system needs, policy, customer expectations, technology, and affordability.

A Deployment and Integration of DERs

DERs are technologies which include rooftop solar, energy storage, microgrids, load control, energy efficiency, and communication and control technologies — that produce, store, manage, and reduce the use of energy. They are small enough to be “distributed” all around the grid, close to customers and can make a meaningful impact in meeting load requirements in certain cases. The use of DERs has been growing and Alectra Utilities believes that resources can help make the grid more reliable, resilient, and equitable. DERs represent a shift from the traditional model of centralized energy resource control and ownership. In the new paradigm of state, community and consumer-driven investment in renewables, utility planning efforts must be revised to ensure the evolution towards a future grid that is notably different from the grid of the past. In order to avoid overbuilding the system and having assets stranded, Alectra Utilities believes that utility planning should proactively take into account current DER growth trends. On this basis, Alectra Utilities proposes to invest in developing capacity in DERs with the objective of being able to deploy such assets at scale to defer investments such as TS and MS upgrades as well as other distribution infrastructure, which would otherwise be planned to take place in the period after

2020-2024 Further information on this investment is provided in Appendix A13 - Stations Capacity.

DER Integration investments are required to implement pilot projects, which will enable Alectra Utilities' to develop its capability to monitor, control and optimize the integration of DERs onto its distribution system. It will enable Alectra Utilities to build capabilities that could predict the grid operational impacts of DERs, help mitigate power quality issues associated with DERs and reduce peak demand. These capabilities will be built as part of the overall DER Control Platform, also known as Distributed Energy Resource Management System ("DERMS"), further enabling a Virtual Power Plant ("VPP") with integrated controls and real time signals in order to operationalize DERs as an aggregated source of capacity and storage.

For further information please refer to Appendix A16 - Distributed Energy Resources (DER) Integration.

B Deployment of Smart Grid Technologies for Grid Operations, Metering and Reliability

B.1 Grid Operational Technologies

Continuity of service including restoration will be supported through intelligent sensors, systems, data management and automated switches for sectionalizing and self-healing in Fault Detection, Isolation and Recovery ("FDIR"), and Automatic Feeder Restoration ("AFR") schemes, Advanced Metering Infrastructure ("AMI"), automated voltage control, dynamic volt/var compensation, and dispatchable storage to support power quality.

As the central hub of real-time control and telemetry, Alectra Utilities' control room represents the critical nerve center for the entire utility. During fault events, power system controllers will utilize systems such as the ADMS to perform switching, isolation and restoration activities, and the OMS to record operational and reliability data associated with the event. Further, SCADA systems are used to facilitate the real-time communications of telemetry data, such as asset status (e.g. open or closed switch), loading, current and voltage levels, as well as real-time operational control of SCADA-enabled assets, such as stations circuit breakers and distribution gang-operated load-break switches. Further details on these investments are provided in Appendix A11 - SCADA and Automation.

B.2 Distribution Automation

Alectra Utilities is planning several investments that are designed to add fault indication, distribution automation, and upgrade the associated communication infrastructure. These include:

- Distribution Automation
- Fault Indication
- Communication Infrastructure

These three investments are interrelated because communication infrastructure is required to leverage feeder automation and fault indication. They also provide better customer service due to quicker fault finding.

Distribution Automation ("DA") introduces a number of critical advantages across the system, including the ability to perform all sectionalizing, isolation and restoration activities automatically and typically under one minute. DA also provides the ability to reduce outages to momentary interruptions for customers serviced by the segments of the feeder energized after isolating the faulted segment section of the feeder.

Based on voltage level, average feeder loading and restoration times and customer outage cost, Alectra Utilities has calculated the quantity of automated devices (overhead and underground) that can be installed on each feeder. Alectra Utilities has determined that it can support the investment of 7 devices per feeder on the 27.6/44kV system, and 4 devices per feeder on the 13.8kV system. While these values can be supported, they are based on averages. From the initial customer survey, Alectra Utilities determined that its customers prefer that the company install automated devices during renewal activities. Therefore, considering that one of the automated devices will be a tie switch, the company is targeting 3.5 devices per feeder on its 27.6/44kV system and 2.5 devices per feeder on its 13.8kV system. Similar analysis was completed for other voltage levels to determine the appropriate number of devices to target.

Table 5.3.4 - 5: Automated Devices Summary

Voltage Level	No of Feeders	SCADA Enabled Devices	Devices per Feeder	% Progress
44 kV	99	138	3.5	40%
27.6 kV	290	659	3.5	65%
13.8 kV	701	239	2.5	14%
8.32 kV	16	7	2.5	18%
4.16 kV	300	28	2	5%
Total	1,406	1,071		29%

Table 5.3.4 - 5 provides an overview of the penetration of DA devices at Alectra Utilities as of December 2018. The highest level of automation is on the 27.6kV system, which also services the largest portion of customers per feeder. Fault Indication investments are also included and appropriate as they allow for quicker fault finding and, by consequence, restoration from failures. Lastly, communication as between the multitude of devices, be it automated switches or fault indicators, requires a communications backbone. Alectra Utilities has proposed several investments necessary to leverage automation and self-healing initiatives. Further details on these investments are provided in Appendix A11- SCADA and Automation.

C Increased use of digital information and condition monitoring to improve reliability and maximize asset life

Alectra Utilities plans to leverage the results of real time telemetry data and install condition monitoring equipment primarily on stations assets with the expectation that this enhanced visibility on the condition of these assets will help to maximize their asset life.

C.1 Installation of Condition Monitoring

Alectra Utilities plans to deploy assets and technologies to obtain real-time telemetry data from both distribution and substation equipment. Real-time telemetry, such as online DGA monitoring, oil levels and temperature, allow the utility to proactively manage the performance of these substation assets through maintenance activities, and can ultimately be used to indicate when

rebuilds or full replacements must be performed. By deploying condition monitoring equipment and increasing the availability of more extensive, real-time data, Alectra Utilities will be further able to maximize asset life and reduce system renewal expense. Further details on these investments are found in Appendix A14 - System Control, Communications and Performance.

C.2 Real Time Telemetry Data and Communication

During the DSP period, Alectra Utilities plans to invest in communications equipment that connects the utility's substations and distribution system equipment. This equipment allows the company to control distribution equipment that is connected by the SCADA system.

Alectra Utilities plans to invest primarily in two communications systems, as follows:

- WiMAX Infrastructure**:** Alectra Utilities will install WiMAX communication hubs in order to enable high-speed broadband communications support for overhead reclosers, SCADA-enabled padmounted switches, FIT monitoring data concentrators and ethernet-enabled revenue meters. It also plans to update existing communications systems at municipal substations to the WiMAX standard, thus providing improved communication support for substation equipment.
- Fibre Optic Infrastructure**:** Alectra Utilities plans to invest in two forms of fiber optic communications systems: (i) backup fibre optic lines to provide redundancy should one communications path fail, and (ii) replacement of obsolete and deteriorated connection points in the fibre optic network (called "SONET nodes") with modern-standard nodes.

Further details on these investments are provided in Appendix A14 - System Control Communication and Performance.

D Electrification of Transportation Infrastructure

In the long term, it is reasonable to expect that transportation will shift from its dependency on the internal combustion engine to electric power. However, the pace of this shift will be dictated by many factors such as pricing, range and incentives. Public transportation is expected to start this shift soon, but will take time to mature as fleet assets are replaced over time.

Alectra Utilities' "Drive – Workplace" initiative is driven by the following factors:

- Exponential growth in electric vehicle (EV) adoption combined with increasing quantity and value of electric vehicles from global automakers.
- Workplaces being challenged (e.g. building code efficiency requirements, visiting customers and employees seeking charging stations) to serve this new and unfamiliar market with limited understanding of the technology.
- Facilities large enough to host this type of EV charging service and responsible for electricity demand charges also being large enough to have other load demands (e.g. Heating, Ventilation and Air Conditioning equipment) which can be temporarily reduced to balance between EV and building loads.

According to the IESO's 2016 Ontario Planning Outlook[62], while EVs are expected to have only a modest impact on the quantity of electricity consumed in Ontario (i.e. 1-5% increase by 2035), their impact on peak demand is more impactful at the distribution level due to their ability to consume relatively large amounts of power for a short period of time while they are charging. The draw from EVs can be either a negative or a positive impact on the electricity grid, depending on how their consumption is matched to the availability of capacity, and how it can be increased or decreased as capacity availability changes. This workplace EV charging project seeks to pilot technologies and business models that will allow Alectra Utilities to coordinate DER uptake and operation and avoid these impacts – without requiring expensive enhancements to the distribution network. Details on the investment are further provided in Appendix A12 – Lines Capacity.

E New Market Opportunities for Customers

Supply and demand management will involve customers using the grid in ways that facilitate the efficient matching of supply and demand, taking account of available generation, storage, pricing signals, rate options, incentives and available technologies, including microgrids, HEMS, and grid/customer interface controllers. Mechanisms for coordinating with the IESO at terminal stations and providing visibility and dispatch capabilities across station assets will likely be part of this future view. The following are the projects that Alectra Utilities plans to implement to further this initiative. These projects are pilots that will provide results which the company intends to leverage for deployment on a larger scale.

[62] http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Ontario-Planning-Outlook

This project will involve the development of a software platform to provide real-time transparency, tracking, and management of Distributed Energy Resources (DERs) providing energy services to the distribution grid. Alectra Utilities will gather real-world data on this new distribution system model by evolving the existing Power.House initiative.

Through the platform, Alectra Utilities will issue requests for the Power.House customer systems to provide distribution market services where each aspect of market participation will be transacted through and recorded transparently in real-time by the platform. These transactions will provide end-to-end visibility on customer usage and DER participation patterns. By analyzing these patterns, Alectra Utilities can prove to be a highly effective broker between understanding customer usage and changing customer behavior, consequently providing tangible incentivized benefits.

Therefore, the pilot project is a pre-requisite for the widespread adoption and utilization of DERs, and includes the following benefits:

- Developing efficient procurement processes around customers and utilities
- Enabling real-time smart contracting capabilities binding the provider and the customer through contractual obligations
- Providing real-time and efficient financial settlement processes to improve customer trust and engagement leading to higher customer value
- Securing compliance obligations through a set of highly measurable and transparent verification processes around energy transactions/incentivization between customers and utilities
- Enabling Alectra Utilities to defer or avoid investment in distribution infrastructure by leveraging the value of widespread adoption of DERs
- Minimizing the negative impact of DERs on the operation of the distribution grid

Further details on this investment are provided in Appendix A16 – Distributed Energy Resources (DER) Integration.

E.1 Data Analytics

The goal of this project is to identify which facilities/customers should be targeted for deployment of DERs, such as solar and storage assets, smart thermostats, connected home equipment and

EVs. Alectra Utilities proposes to provide data from its existing data sources, along with data from its data platform provider and 3rd parties, which will then be assessed, integrated and analyzed to identify:

- Which areas (feeders, transformers) would benefit the most from the deployment of DERs through the deferral of system upgrades or repairs
- Model the impacts of customer uptake of DERs on grid operations against a variety of different scenarios to inform utility planning and customer engagement strategies
- Identify which customers are the most likely to be able to support the deployment of DERs from a technical (roof size, orientation) perspective
- Perform research to understand the customer barriers (administrative processes) and characteristics (demographic, economic)

In a sense, this project will provide an achievable potential study for DERs, along with recommendations for how to obtain these resources. This will allow these resources to be more fully integrated into utility planning processes and provide an actionable plan for how to pursue the acquisition of these resources to defer traditional wires infrastructure. The details of this investment are provided in Appendix A18 – Information Technology Systems.

E.2 Customer Engagement and Access

In addition to traditional face-to-face, phone, survey, web portals and basic mobile apps, customers will be able to make choices about their energy mix, energy use, generation, storage and use preferences based on their needs and preferences through home interface controllers at the component level. Alectra Utilities has proposed investments in aligning websites and the creation of a Customer Self Service Portal. This provides customers the ability to access information and further supports alignment of the LDC with the objective of being an ally for customers who also seek to modernize their preferences.

F Ensure that the deployed resources and grid operations are fully secure against cyber threats

On March 15, 2018, the OEB issued a directive requiring licensed electricity transmitters and distributors in Ontario to use an industry-developed Ontario Cyber Security Framework to report on their cybersecurity and privacy readiness and maturity. Alectra Utilities' program is designed

to enhance the hardware and software infrastructure within the company in order to meet the requirements of the Ontario Cyber Security Framework. The investment includes the replacement of and upgrades to Alectra Utilities' telecommunications and control technologies that are essential to system control and operations, as well as the implementation of cyber-security frameworks and solutions across the organization to provide enhanced protections and risk mitigation against cyber-security threats (including cyber terrorism). The details of this investment are provided in Appendix A18 – Information Technology Systems.

placed feeder ties to facilitate the expeditious transfer of affected customers in the event of station failure or loss of supply. For the 2015-2019 period, Alectra Utilities (including its predecessors) spent approximately $44.7MM on projects related to renewing station assets. For the 2020-2024 period, Alectra Utilities plans to invest approximately $28.7MM on investments associated with station renewal. The reduced level of capital investment on station renewal over the 2020-2024 period is a result of the company's investment strategy, described above, of enhancing station asset monitoring, spill containment and implementing feeder ties, supported by its ability to leverage its consolidated inventory of station spares. With the implementation of these practices, Alectra Utilities is able to focus its resources on the higher priority need for investment in its underground systems to address the increasing frequency of cable failures. Alectra Utilities believes that the planned level of and approach to station renewal investments appropriately balances risk, reliability and customer preferences to mitigate cost increases. Details related to substation renewal investment needs, planned projects to address these needs and expected outcomes are provided in the Station Renewal investment summary in Appendix A08 - Substation Renewal.

C.2.5 Establish linkages between legacy systems and examine emerging technologies so as to mitigate the need for system expansions

Alectra Utilities plans to make targeted investments in establishing additional connections between adjacent legacy systems to assist it in balancing loads more effectively, thereby enabling it to defer the need for costly system expansions. Alectra Utilities has identified specific capital investments in areas where capacity constraints or back-up capability is required, which would have historically been addressed by predecessor utilities through the construction of additional stations or feeders. Instead, these are now being addressed by Alectra Utilities through the utilization of existing assets with minimal investment for feeder extension and ties. An example is the planned extension of 27.6kV Feeder 25M9 from Jim Yarrow TS into Mississauga along Derry Road at an investment of $2.1MM (please see project 150357 in Appendix B - Material Investment Business Cases), which eliminates the need for Alectra Utilities to build a new municipal station in northern Mississauga, the cost of which was estimated at $7.5MM.

In addition to establishing linkages between predecessor utility systems, Alectra Utilities plans to develop its capability to monitor, control and optimize the integration of Distributed Energy

Resources (DERs) into the distribution system through three related pilot projects. Through these pilot projects, Alectra Utilities intends to develop the capability to optimize the operation of DERs so as to prevent power quality issues and reduce peak demand. The projects will provide valuable data, which will help improve system planning practices. Ultimately, the ability to draw upon this data and experience will enable the company to reduce peak demand, which in turn will enable it to defer more traditional and costly distribution system investment needs. The pilot projects will also advance Alectra Utilities' ability to control and monitor DERs connected to its distribution network – ensuring they are isolated from the grid to protect employees working on the network during outages – on a pilot scale before implementing such resources more broadly in the future.

The DER integration pilot projects are driven by two investment needs. First, Alectra Utilities needs to evaluate DERs as system planning alternatives. Understanding DER capabilities will enable Alectra Utilities to utilize DER deployment as a feasible non-wires solution to defer distribution and transmission infrastructure expansion. Second, as a prudent distributor Alectra Utilities is obligated to prepare its distribution system to accept and support new technologies, including the integration of electric vehicles and charging infrastructure, solar photovoltaic generators, battery storage and home automation. By undertaking these pilot projects in the near term, Alectra Utilities is preparing its distribution system to safely and reliably respond to the expected uptake of DERs and other emerging technologies in the longer term with a coordinated architecture that balances the benefits of these resources to their owners, with the costs they potentially pose on all of the company's customer-base. Without this preparation, Alectra Utilities risks supressing customer choice due to distribution system constraints, as well as experiencing reliability of supply issues as a result of intermittent, uncontrolled supply from DERs. Over the 2020 to 2024 planning period, Alectra Utilities plans to invest $4.1MM in DER integration. Please refer to Appendix A16 - Distributed Energy Resources (DER) Integration for further details about the DER.

D Forecast Impact of Investments on O&M Costs

Alectra Utilities recognizes the importance and impact of prudent asset management and capital expenditure planning in relation to the company's long term ability to contain O&M cost. The timely renewal of assets reaching end of useful life or posing significant risks to the company (e.g.

G.3.6 DER Integration

Overview	The Distributed Energy Resource ("DER") Integration investments will build Alectra Utilities' capability to monitor; control; and optimize the integration of DERs (e.g., solar generation, battery storage, smart thermostats, electric vehicles ("EVs")) into the distribution system, and to provide real-time transparent, tracking and management of DER participation in energy services. The investments that are planned for the 2020-2024 period will enable Alectra Utilities to effectively serve the increasing amount of customers that already are and will continue to adopt DERs in its service area. Ontario already has at least 4,100 MW of DERs that have been contracted or installed in the last 10 years[1]. This DER capacity growth closely rivals the 5,600 MW net growth in transmission-connected generation added during that same time period.
Investment Drivers and Need	Primary Driver: Capacity Constraints Secondary Drivers: Customer Access and Choice
Investment Description	The DER Integration investment is required to implement two related projects to develop Alectra Utilities' capability to monitor, control and optimize the integration of DERs onto the distribution system. The DER Integration investments consist of two projects: (1) DER Control Platform: This project will integrate DERs with Alectra Utilities' traditional distribution

[1] IESO. (2018). 2018 Electricity Data. Retrieved from http://www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data.

	operation systems and enable the utility to optimize the operation of DERs. (2) Smart DER Platform: This project will involve the development of a platform that utilizes blockchain technology to enable real-time processes for procurement, smart contracting, automated verification and settlement for customers participating in grid services with their DERs.
Outcomes and Benefits	Customer Access and Choice, Infrastructure Expansion Deferral
Investment Timing and Pacing	These pilot projects must be implemented now to enable Alectra Utilities to prepare its distribution system to safely and reliably respond to the expected uptake of DERs with a coordinated architecture that balances the benefits of DERs to their owners, with the costs they potentially pose on all of Alectra Utilities' customer-base and maximize the benefit of DERs for all customers connected to the distribution system. Please refer to Appendix A16 for more information.
Options Analysis	Alectra Utilities considered several options including status quo (i.e. do nothing), reactively responding to DER uptake or evaluating DER integration.

1

Appendix A02 - Customer Connections

I Overview

Investments in the Customer Connections category are connections, modifications or realignments to the distribution system that provide Alectra Utilities' customers with access to electricity. All of the work in the Customer Connections portfolio is mandatory, as it is required to satisfy the conditions of Alectra Utilities' license and the Distribution System Code (DSC).There are five types of investments in this category, each of which is summarized below:

- Layouts;
- New Services;
- New Subdivisions;
- Renewable Generation; and
- Customer Initiated Distribution System Projects.

Layouts

Layouts consist of work to make the system ready for new residential infill services, and upgrading residential services and small commercial services. A layout is typically is comprised of a single page drawing with sufficient detail to provide crews or contractors the information to construct the service. It also includes a cost estimate that is provided to the customer for design, materials and construction of the service. A layout is provided to each customer at a given location. The customer's service could be underground or overhead and is the connection from the main plant on the boulevard to the building. Costs are shared between the customer and Alectra Utilities in accordance with the DSC and Alectra Utilities' Conditions of Service. This includes the provision of a basic connection allowance for each residential service. This basic connection credit equates to 30m of an overhead service and 10m of an underground service.

New Services

New Services consists of new and/or upgraded primary services to industrial, commercial and institutional customers (such as medical buildings, small plazas or factories). A New Service typically consists of a Work Order being issued with complete drawings and work instructions

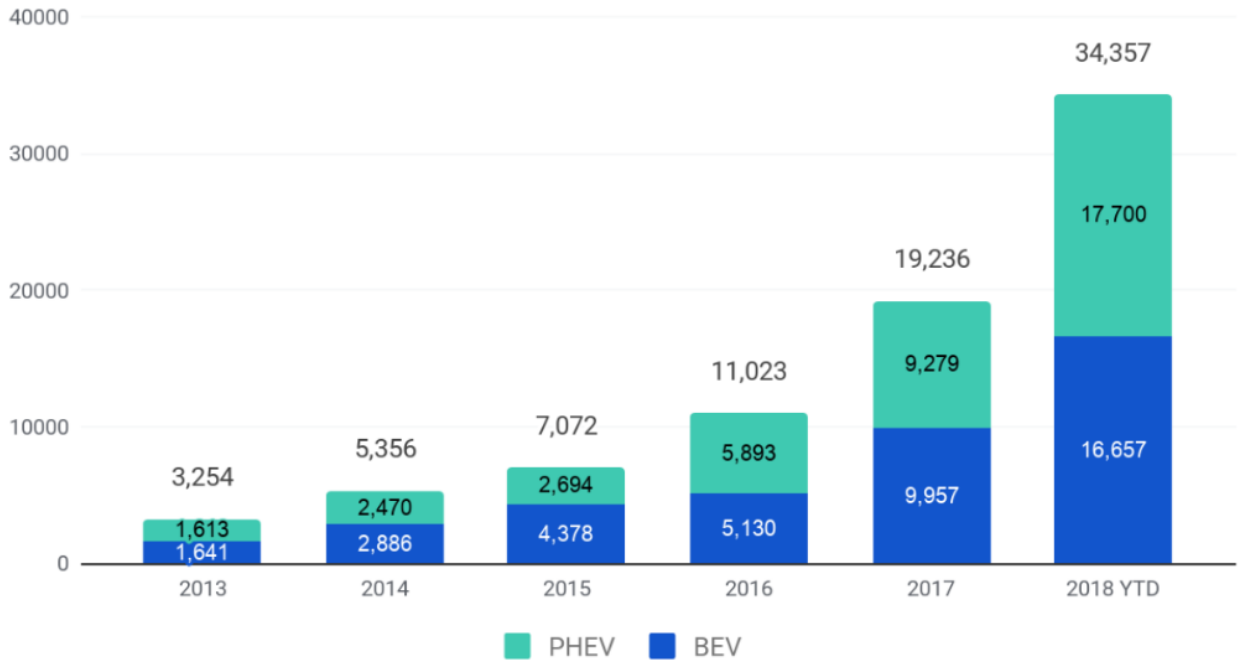
Figure A02 - 9: VivaNext

Predicted uptake for development along the corridors of the Metrolinx projects is approximately 25 institutional projects for the first three years of the reporting period and then tapers off in the latter three years in terms of rate of increase in projects.

2.6 Electric Vehicle ("EV") Charger Upgrades

This investment will include upgrades to account for electric vehicle chargers across Alectra Utilities' service territory. Electric vehicles will continue to become a vehicle of choice as technology and affordability increase. Refer to Figure A02 - 10 for recent sales data.

Figure A02 - 10: Annual Canadian EV Sales[70]



Year	2013	2014	2015	2016	2017	2018 YTD
BEV	1,641	2,886	4,378	5,130	9,957	16,657
PHEV	1,613	2,470	2,694	5,893	9,279	17,700
TOTAL	3,254	5,356	7,072	11,023	19,236	34,357

Single residential units that install EV chargers will do so through the layout process. Upgrades to commercial facilities or condos, where there are 3 phase transformers, will have requests through the ICI process, as these involve metering upgrades and possibly transformer replacements, as was the case in 2018.

[70] "Electric Vehicles Sales Update Q3 2018, Canada" fleetcarma, Nov 6, 2018. URL: https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/

Appendix A13 – Stations Capacity

I Overview

Alectra Utilities' Stations Capacity investments consist of construction of new or capacity upgrades at existing substations within Alectra Utilities' service territory over the 2020-2024 period. These investments are necessary to ensure that Alectra Utilities has sufficient capacity for existing and new customers while maintaining system reliability. It also includes forward-looking development work to better utilize Non-Wires Alternatives ("NWA") for future distribution system capacity needs.

Increasing population, employment and densities within Alectra Utilities' service area are increasing the demand on the utility's municipal stations (also called substations or "MS"). Alectra Utilities' commercial, industrial, institutional and residential customer connections are increasing.[115] In areas where this customer growth is occurring, many of Alectra Utilities' substations are approaching capacity limits. Without the planned investments, Alectra Utilities may not be able to connect new customers to the distribution system, and its quality of service to current connections may deteriorate.

As discussed in Section III – Investment Drivers and Need below, Alectra Utilities plans its investments with the goal of ensuring that the distribution system has the capacity to accommodate load transfers when an element of the grid fails (referred to in electrical planning as a "contingency") and maintain supply to customers.

- The planned Stations Capacity investments focus on the Eastern and Central operational areas of Alectra Utilities' service territory: The Eastern station projects address station capacity needs in Markham, Alliston, Barrie and Bradford. The Markham station investment included in this investment relates to the cost of conducting a Class Environmental Assessment (EA) for a new Transformer Station (TS) which is required to be in service by 2027. The Stations Capacity investments in Alliston, Barrie and Bradford include the costs of land purchase, transformer upgrade or construction of new MS. These projects are discussed in Section 3.2 below.

[115] These trends are discussed in section 3.1 below.

projected load growth through capacity upgrades at the existing stations as well as new stations builds at new growth locations.

Addressing capacity constraints in key growth areas is crucial as stations approach capacity limits. If not dealt with proactively, these growth trends will impact Alectra Utilities' ability to connect customers to the distribution system. Without the planned investments to address these trends, Alectra Utilities may not be able to connect customers in some areas.

3.1.2 Reliability

The secondary driver of these investments is reliability. Consistent with utility best practices across Canada, Alectra Utilities plans its distribution system such that the system can continue to operate within normal limits when one element of the grid fails. This is called "N-1 contingent", since the system is operating with one element less than it normally does. In the context of substation planning, this means that Alectra Utilities must be able to transfer the loads associated with any given transformer in the substation network to adjacent substations, while remaining within the substation transformers' contingency ratings.[119] In a network comprised of three or more substations, the N-1 contingency standard is satisfied even if substation transformers in the network are loaded beyond 50% of the contingency rating.[120] The planned investments are necessary for Alectra Utilities to provide customers with a level of reliability consistent with the N-1 contingent standard.

3.1.3 Preparing for a Distributed Energy Connections

The ability to integrate new technologies which can provide customers with more choice, improve reliability or reduce the impact on the environment was identified by Alectra Utilities' customers

[119] The contingency rating is determined by the cooling capabilities of the transformer and is equivalent to the highest cooling rating; i.e., Oil Natural Air Natural (ONAN) (100% of nameplate rating) for self-cooled transformer units, Oil Natural Air Forced ("ONAF") (133% nameplate rating) or ONAF/ONAF (166% of nameplate rating) for transformer units with single and dual stage fans. The ONAN rating is the normal rating of the transformer without additional cooling, while the ONAF rating is the maximum permissible loading on the transformer before exceeding the permissible loading of the transformer.

[120] A minimum of three substations is required to fully satisfy the N-1 contingency criterion when loading exceeds 50% of the transformer contingency rating. Due to the minimum of three substation requirement to satisfy the contingency criterion, Alectra applies the triad criterion, which ensures that upon loss of a single substation transformer, the two remaining transformers can accommodate the transferred load in addition to their native load, thereby mitigating any potential load shedding or stranded customers as a result of the outage.

as one of the top three priorities during the customer engagment. As customer preferences with respect to energy evolve in favour of more choice and greater control and customization, as evidenced by customers' growing levels of adoption of distributed generation and smart thermostats, traditional distribution system planning and operation needs to change as well. While rapid technological innovation is driving down the costs of energy technologies, an increasing level of DER penetration will change how the traditional distribution system is operated. These changes must be understood, and reflected in the planning and operation of the grid through higher visibility of DERs, effective communication between the utility and DERs owners, and coordinated operations.

The NWA project is driven by the following needs to:

- Evaluate non-wires solutions as system planning alternatives to be used to manage local peak demand; increase reliability and efficiency; and to defer or avoid capital and operating costs associated with distribution infrastructure;.
- Test the integration and customer adoption of new technologies which can provide customers with more choice, improve reliability and/or reduce the impact on the environment; and
- Increase the readiness of Alectra Utilities' distribution system to facilitate and support the integration of new energy technologies, including: electric vehicles; electricity generation technologies; battery storage; and home automation.

Understanding effective use cases for non-wires alternatives will enable Alectra Utilities to deploy them where they are feasible solutions, in order to defer or avoid more costly transmission and distribution infrastructure. The York region, specifically Vaughan, has been identified as an area of emerging load growth and thereby an optimal area where non-wire alternatives may provide system benefits and value.

By undertaking this investment now, Alectra Utilities is preparing the distribution system to efficiently, safely and reliably respond to the expected uptake of DERs and balance the benefits of DERs to customers while cost-effectively modernizing the distribution system. Without this preparation, Alectra Utilities introduces the risk of:

Appendix A16 - Distributed Energy Resources ("DER") Integration

Overview

The Distributed Energy Resource ("DER") Integration investments will build Alectra Utilities' capability to monitor; control; and optimize the integration of DERs (e.g., solar generation, battery storage, smart thermostats, electric vehicles ("EVs")) into the distribution system, and to provide real-time transparent, tracking and management of DER participation in energy services. The investments that are planned for the 2020-2024 period will enable Alectra Utilities to effectively serve the increasing amount of customers that already are and will continue to adopt DERs in its service area. Ontario already has at least 4,100 MW of DERs that have been contracted or installed in the last 10 years[141]. This DER capacity growth closely rivals the 5,600 MW net growth in transmission-connected generation added during that same time period.

The DER Integration investments consist of two projects:

(1) DER Control Platform: This project will integrate DERs with Alectra Utilities' traditional distribution operation systems and enable the utility to optimize the operation of DERs.

(2) Smart DER Platform: This project will involve the development of a platform that utilizes blockchain technology to enable real-time processes for procurement, smart contracting, automated verification and settlement for customers participating in grid services with their DERs.

The DER Control Platform project provides an integration backbone for DERs, including hardware and software services, to be controlled and managed through Alectra Utilities' core operational and control platforms. The Smart DER Platform project enhances the value of DER integration by providing customers with more choice over their energy and costs, thereby providing the utility with an effective means of identifying the introduction of DERs into the distribution system which is a pivotal utility problem associated with the proliferation of DERs.

While the initial load to be controlled will be modest – approximately 100 kW – the DER Control Platform project will enable Alectra Utilities to assess the integration and operation of the platform

[141] IESO. (2018). 2018 Electricity Data. Retrieved from http://www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data.

before it is used at a larger scale to provide benefits to the distribution system as a whole. As more DERs are connected to Alectra Utilities' system, the DER Control Platform will enable Alectra Utilities to optimize DER operations to prevent power quality issues and reduce peak demand in real time. It will also provide valuable data for improving Alectra Utilities' forecast of DERs uptake and operation based on customer adoption that can be used for utility planning purposes.

The Smart DER platform will enable customers and the utility to transparently record the flow of electricity to and from DERs, enabling the efficient procurement of energy services, such as demand response, solar generation and frequency regulation. The Smart DER Platform will provide a robust settlement mechanism backed by timely and efficient financial transactions to enable overall trust and customer value delivery, leading to increased customer satisfaction.

The planned projects will create multiple benefits for Alectra Utilities' distribution system and its customers, including:

1. Improved distribution system planning to enable system right-sizing and optimal expansion;
2. Improved safety and system performance through effective control and monitoring of DERs; and
3. Enhanced understanding of customer needs and behaviour.

Improved Distribution System Planning: Alectra Utilities expects that these projects will provide valuable data to improve system planning practices. The planned projects will help the utility incorporate the benefits of DERs for the benefit of all customers by reducing peak demand, and deferring or avoiding the need for traditional distribution investment. Alectra Utilities may be able to lower the energy costs for the entire customer base by proactively managing DER in such a way that incremental infrastructure cost upgrades to safeguard the grid from DER adoption or power quality issues are mitigated. This will include any upgrades, maintenance or reactive outage related costs incurred due to overloading of the distribution network. The planned projects will also enable Alectra Utilities to encourage adoption in areas where the value of managing DERs is highest, for example where feeder capacity is limited or where transformers are overloaded.

Improved Safety and System Performance: The projects planned for the DSP period will advance Alectra Utilities' ability to control and monitor DERs connected to the distribution network, ensuring DERs are isolated from the grid to protect the employees working on the network during outages. The planned projects will provide valuable learnings on how to mitigate the future risks introduced by high penetration of DERs in a typical distribution network, including power quality issues, safety concerns and adverse impacts of intermittent and uncontrolled DERs. In the absence of these learnings, Alectra Utilities will be faced with reactionary infrastructure upgrades required to safe guard power quality and reliability standards, since it will not have the ability to perform real-time management of DERs to balance the system or provide peak shaving opportunities.

Enhanced Understanding of Customer Needs and Behaviour: The projects will provide Alectra Utilities' further understanding of customer needs and behaviour associated with DERs. Understanding customer DER needs and behaviours is important because it is ultimately the customers that will adopt these DER technologies. Alectra Utilities needs to integrate, optimize, control and manage DERs in ways that maximize the benefits of DERs for the grid as well as for the customers. For example, the DER Control and Smart DER platforms will provide enhanced information and analytics on, but is not limited to, customers' preferred DER ownership structures and control features, and DER incentive structures that promote the effective use of DERs on the distribution system. Without this information obtained from the two platform investments, Alectra Utilities would be limited with establishing the right balance of ownership and control customers want over DERs, which impacts Alectra Utilities' ability to monitor, optimize and control DERs for the benefit of the grid. In addition, Alectra Utilities would be limited in understanding how to incentivize DER uptake and participation in DER management programs in areas where capacity constraints or issues in power quality or reliability may exist. As a result, customers may not be inclined to allow Alectra Utilities to control the operation of their DERs or customers may not want to participate in DER management programs if the incentives to participate in such programs aren't adequate.

Table A16 - 1: Investment Subgroup Summary ($MM), Drivers and Outcome Summary

	Historical Spending				Bridge	Forecast Spending				
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
CAPEX ($MM)	$0.0	$0.0	$0.0	$0.0	$0.90	$0.66	$0.67	$0.90	$0.91	$0.92
Primary Investment Driver:	Capacity Constraints									
Secondary Driver:	Customer Access and Choice									
Investment Outcomes:	Efficiency, Coordination/Interoperability									

Investment Description

The DER Integration investments planned over the 2020-2024 DSP period are driven by expected increasing adoption of DER in Alectra Utilities' service territory and the significant challenges and opportunities that such a trend presents for the utility's distribution system and for its customers. At least 4,100 MW of DERs have already been contracted or installed in Ontario in the last 10 years[142]. This does not include an unrecorded amount of load control, behind-the-meter energy storage and demand response capacity that can also be regarded as DERs. This DER capacity growth closely rivals the 5,600 MW net growth in transmission-connected generation added during that same time period. Some estimates indicate that the most of the newly installed generation (transmission and distribution connected generation) could be on the distribution side as soon as 2023 in certain parts of the world, such as the U.S.[143] For example, in the United States, the most recent edition of the U.S. Energy Information Administration's (EIA) Long-Term Energy Outlook projects DERs to be the fastest growing segment of America's electricity industry generating capacity for the next 30 years[144].

In its own service territory, Alectra Utilities has connected over 5,409 renewable projects including FIT, microFIT, and commercial and residential net metering installations comprising over 147.9 MW of potential generation: 564 FIT contracts with 108.4 MW of installed capacity and 4,845 microFit contracts with 39.5 MW of installed capacity. Forecasts of these DER technologies indicate that North America is expected to install 260.1 GW of solar photovoltaic (PV) between 2018 and 2027 at a compound annual growth rate (CAGR) of 14.0%[145] . In terms of EVs, there were 83,000 EVs on the road in Canada as of Q3 2018[146] and one third of Ontario EVs,

[142] IESO. (2018). 2018 Electricity Data. Retrieved from http://www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data.
[143] John, J. (2018). Distributed Energy Poised for 'Explosive Growth' on the US Grid. *Green Tech Media*. Retrieved from https://www.greentechmedia.com/articles/read/distributed-energy-poised-for-explosive-growth-on-the-us-grid#gs.kd4L=NM
[144] United States Energy Information Administration, "Annual Energy Outlook 2019", January 24, 2019 Table: Electricity Generating Capacity, Case: Reference case
[145] Navigant. 2018. Market Data: Solar PV Global Forecasts. Retrieved from https://www.navigantresearch.com/reports/market-data-solar-pv-global-forecasts
[146] Fleet Karma. (2018). Electric Vehicle Sales Update Q3 2018, Canada. Retrieved from https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/

approximately 10,000 vehicles, are in Alectra's service territory[147]. With Ontario EV sales increasing 60% year-over-year for the past five years[148], Alectra could expect a higher adoption of EVs in its service territory in the next few years. These increasing trends across many DER technology sectors further demonstrate the need for Alectra Utilities to adopt platforms that will enable DERs to contribute to grid services and energy markets and provide value to customers.

The increasing adoption rates of DERs are driven by the following global mega trends:

1. Rapid technological innovation driving down the costs of various energy technologies
2. Changing customer preferences - desiring more energy options, control, engagement and customization
3. Increasing threats of climate change pushing the de-carbonization of energy systems
4. Intensifying urbanization

Energy Technology Cost Curves

In 1970, the average cost of solar PV was $100/Watt (W) and every year since the cost of solar has reduced by 11.5%[149]. Now in certain parts of the world, solar cost is $0.30/W[150]. In Ontario, the cost of solar is $3.07/Watt as of 2019[151] and is expected to continue to follow the declining cost curve experienced in other markets. Similarly, lithium ion battery costs have reduced by 20% per year between 2010-2016[152]. Electric vehicles ("EVs") have been and will continue to benefit from declining lithium ion battery costs as Bloomberg New Energy Finance predicts that EVs will become cost competitive against comparable combustion engines as early as 2024[153]. Finally, Ernst and Young estimates that the north eastern regions of North America are 13 years away

[147] Ontario Ministry of Transportation
[148] Fleet Karma. (2018). Electric Vehicle Sales Update Q3 2018, Canada. Retrieved from https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/
[149] Seba, T. (2017) Clean Disruption of Energy and Transportation, Clean Energy Action Conference, June 8 2017
[150] Seba, T. (2017) Clean Disruption of Energy and Transportation, Clean Energy Action Conference, June 8 2017
[151] Energy Hub. (2019). Cost of Solar Power in Canada 2019. Retrieved from https://energyhub.org/cost-solar-power-canada/
[152] Seba, T. (2017) Clean Disruption of Energy and Transportation, Clean Energy Action Conference, June 8 2017
[153] Bloomberg New Energy Finance. (2018). Electric Vehicle Outlook 2018. Retrieved from https://bnef.turtl.co/story/evo2018?teaser=true.

from reaching cost parity between off-grid customer solar-storage and customers staying on the grid and paying their utility's electricity bills[154]. Within another 8 years it is estimated that the north eastern region of North America will have a completely decentralized electricity system as the cost of transporting electricity will exceed the cost of generating and storing it locally[155] .

Intensifying Urbanization

The United Nations estimates that 70% of the world population will live in urban areas by 2050[156]. Canada already surpasses this threshold as 81% of the population lives in urban areas[157]. Alectra Utilities serves some of the fastest growing neighbourhoods in Canada: Markham's population is expected to increase by 52% by 2041, Brampton's by 50% and Guelph's by 45%[158]. Given this rapid intensification and urbanization in Alectra Utilities' service territory, Alectra Utilities can expect to experience high levels of load growth in these areas. DERs can provide an alternative to infrastructure investments or help increase power quality as the populations in the communities it serves increase.

The need to proactively manage DERs within Alectra Utilities' distribution system

As customer preferences with respect to energy evolve in favour of more choice and greater control and customization, traditional distribution system planning and operation needs to change as well. While rapid technological innovation is driving down the costs of energy technologies, an increasing level of DER penetration will impact how the traditional distribution system will be operated. These changes must be understood and represented in the planning and operation of the distribution system through higher visibility of assets, effective communication, and coordinated activities. DERs pose potential challenges in terms of: increased intermittent generation; unexpected fluctuations in supply and demand; and the potential for stranded assets. The following is an overview of the key areas of focus to understand the nature of DERs and their impact on the distribution system:

[154] EY. Alectra September 2018. Presentation.
[155] EY. Alectra September 2018. Presentation.
[156] United Nations. (2018). 68% of the world population projected to live in urban areas by 2050, says UN. Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.
[157] Statistics Canada. (2018). Canada goes urban. Retrieved from https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015004-eng.htm.
[158] Appendix A13 - Stations Capacity, Table 3

Ramping and Variability: Certain types of DERs create significant changes in power requirements, such as morning and evening solar ramp ups/down that are different than those historically experienced by the distribution system. Readiness of the distribution system for planning, installation, and operation of DER resources is an ongoing need as the generation resource mix evolves on both transmission and distribution systems.

Reactive Power: Modern technologies, including inverters for new rooftop solar PV installations, have the capability to support voltage and ride-through voltage excursions. Use of these capabilities will be increasingly important to support the reliability of both the transmission and distribution systems.

Frequency Ride-Through: As DERs are added to the system, frequency and voltage ride-through capabilities become more important and must be considered both locally and for bulk electric system to improve the reliability.

System Protection: High levels of DER with inverters can also result in a reduction of short circuit current, which can make it more difficult for protection devices to detect and clear system faults. Hence, the implications of DERs as part of system protection must be taken into consideration while planning the distribution systems.

Visibility and Control: Many DERs are generally not visible to the utility. The lack of visibility and control is not only a challenge for operations, but must also be accounted for in the planning of the distribution system. At higher penetration levels, the need for DER visibility and control becomes increasingly critical.

Interconnection Requirements: Interconnection requirements are evolving with increasing DER penetration. Consequently, a number of DER classes with very different dynamic behaviours will emerge in the distribution system. It will be important to understand this information, at least in aggregate, so that the dynamic characteristics can be modeled correctly for system planning.

Potential Risks to Reliability: With increased DER adoption, the effect of these resources presents certain reliability challenges that require careful understanding and measured actions. This leads to a need for further study to better understand the impacts, and how those effects can be included in planning and operation of the distribution system.

Data on installed and projected DER units is needed for reliability modeling purposes. Important data for modeling includes information on the location, type, size, configuration, interconnection characteristics, disturbance response characteristics, and schedule of operation of the equipment. DER generation profiles would also improve the accuracy of modeling results rather than forcing models to assume worst-case scenarios.

Utilities require sufficient levels of reliability measures, from on-line resources, for reliable operation of the distribution system. It is not necessary that all resources provide services at all times, but if conventional resources are off-line or replaced by DERs, it may be increasingly important to use DERs for active power control and essential reliability services.

Voltage Fluctuation: Frequent power variations due to intermittent and un-controllable nature of certain DERs cause voltage fluctuations that were not anticipated in the original design of feeders, especially radial distribution feeders. These fluctuations will have an impact on the frequency of operation of feeder voltage-regulating equipment. It is important to assess, monitor and manage the impact of varying DER output on distribution system operation performance.

The many unexplored features of DERs, such as but not limited to integration challenges, power quality issues, and safety considerations, require further investigation to minimize the risk and optimize the value to the distribution system.

As DER adoption continues to rise, Alectra Utilities expects that distributors will need to revise its approach to distribution system planning to maximize the benefits of DERs to the system, while maintaining reliability and reasonable costs for customers. The planned DER Integration investments are required for Alectra Utilities' to build capabilities and learnings to be prepared to plan and build a system that can safely integrate and optimize value from DERs.

Alectra Utilities will consider not only how DERs can be more fully integrated into the system to take advantage of DER benefits, but also how traditional distribution system planning and investment can account for DERs. Alectra Utilities will identify and communicate the hosting capacity considerations, utility needs and constraints to allow the adoption of DERs, and will increase access to certain types of system information to enable customers and DERs providers to help meet the grid needs. Alectra Utilities will have projections of DERs penetration in various parts of the system to ensure a thorough understanding of risks and opportunities, and will standardize interconnection requirements to maintain and enhance the reliability and flexibility of

the grid with increased DER integration. Alectra Utilities needs to learn how to plan for, monitor, control and optimize the safe and reliable integration of DERs onto such a distribution system, as well as develop business processes on how to provide real-time transparency, tracking and management of DER participation in energy services. These are the drivers and objectives of the two DER Integration projects planned for the 2020-2024 period, as described in the following sections.

Project 1: DER Control Platform

The objective of the DER Control Platform project is to integrate DERs with Alectra Utilities' traditional distribution operation technology systems. It will enable Alectra Utilities to: build capabilities that could predict the grid operational impacts of DERs; help mitigate power quality issues associated with DERs; and reduce peak demand. These capabilities will be built as part of the overall DER Control Platform, also known as Distributed Energy Resource Management System ("DERMS"), further enabling a Virtual Power Plant ("VPP"), with integrated controls and real time signals in order to operationalize DERs as an aggregated source of capacity and storage.

The focus of Alectra Utilities' DER Control Platform project is to aggregate, integrate, control and optimize concentrated and dispersed DER, as a source of virtually aggregated deployment, in order to reduce system capacity demand necessary for system optimization and load balancing.

The expected benefits of the DER Control Platform project include:

- Enabling integration of DERMS with Alectra Utilities system control and operational systems, including Supervisory Control And Data Acquisition ("SCADA"), Geographical Information System ("GIS"), Outage Management System (OMS) and Network Simulation Software.
- Enabling system planning and business process development within Alectra Utilities to utilize DER deployment as a feasible non-wires solution to defer distribution and transmission infrastructure expansion;
- Establishing public and employee safety practices, protection settings and standards to facilitate safe and reliable operations of distribution system with high DER penetration;
- Understanding customers' preferred DER ownership structures and control features so that Alectra Utilities can determine the right balance of ownership and control that

customers want over DERs, which ultimately informs how Alectra monitors, optimizes and controls the DERs for the benefit of the grid and customers;

- Implementing a secured infrastructure through necessary cyber security standards to facilitate a secure and reliable real-time communications necessary for monitoring and controlling DERs; and
- Monitoring, controlling, coordination, and management of DERs connected to the utility using a real-time communication infrastructure.

Through Alectra Utilities' DER Control Platform, the utility aims to provide a flexible and scalable solution to effectively engage with its customers with DERs, support optimization of their DER utilization and provide automated business processes around DER management. The platform will be designed to address challenges in utility planning, communications and operational processes for Alectra Utilities to ensure successful integration of DERs. For instance, by utilizing field data from GIS, SCADA and DERs, the platform will be able to support the development of efficient models to address the challenges in utility network planning, as well as ancillary decision-making at operational and planning levels. The DER Control Platform will help Alectra Utilities to ensure that growing DER challenges are met through supporting efficient network planning and impact analysis and provide visibility of the entire network state in real-time. It will provide the ability to define, aggregate, forecast, settle and control DER within Alectra Utilities' service territory. For instance, using DER generation forecast analysis and DER optimization techniques, Alectra Utilities will be able to manage grid resources more effectively.

By undertaking this project now, Alectra Utilities is preparing the distribution system to efficiently, safely and reliably respond to the expected uptake of DERs and optimize the benefits of DERs to customers and the grid. Without Alectra Utilities' Control Platform, Alectra Utilities will not be able to realize the full potential benefit of DER integration.

Project 2: Smart DER Platform

The objective of the Smart DER Platform is to develop the real-time administration platform and processes needed to manage: solar PV; battery storage; EVs; and other DERs to both reduce their adverse impact on the grid, and provide capacity and power quality services. The platform

will also help Alectra Utilities to strengthen control and visibility over DER owners and provide benefits to the entire customer base over the long-term

Power.House was Canada's first virtual power plant that uses an aggregate fleet of 20 residential solar PV and battery storage units at customer homes that can be autonomously controlled, aggregated and monitored through software to simulate a single, large and sustainable power generating facility. Participating customers benefit from cost savings and outage protection, while Alectra Utilities can use these resources to provide benefits to the grid, such as demand response, operating reserve, and regulation service The Power.House pilot project allowed Alectra Utilities to test the ability of DER to safely and reliably provide the above-mentioned grid services in various scenarios.

Alectra Utilities preformed a follow-up study to determine a technical and economically feasibility uptake of 30,000 Power.House units in the York region, by 2031, including a 2 year deferral of distribution infrastructure[159]. Further to the Power.House feasibility study, Alectra Utilities conducted a separate investigation to evaluate the use of DER to defer capital investment for distribution reinforcement in Markham-Richmond Hill area. The study determined that in order to defer capital investment for a 2-year period under existing levels of distribution system efficiency (0.9 power factor measured at the substation), a fleet of 21,711 residential storage devices providing active power to the grid were required. By using smart inverters to regulate the reactive power and improve the power factor from 0.9 to 0.95, we can achieve the same deferral benefit by just using 2,647 residential storage devices. The study confirmed that DER solutions in the distribution system are a feasible solution to be piloted as an alternative to the traditional wires expansion typically considered to meet growth and expansion needs.

Alectra Utilities aims to leverage these existing Power.House customers to participate in an energy marketplace powered by a blockchain-based software platform. Blockchain technology essentially provides a distributed ledger that can record transactions between two parties efficiently, and in a verifiable, permanent and secure way. Through the Smart DER Platform, Alectra Utilities will issue requests for the Power.House customer systems to provide distribution energy services where each aspect of customer participation will be transacted through and recorded transparently in real-time by the platform. The Smart DER Platform will provide end-to-end visibility on customer usage and DER participation patterns, and such information can only

[159] Alectra. Power.House Feasibility Study.

be accessed by parties who have been granted permission through the platform. By analyzing these patterns, Alectra Utilities can prove to be a highly effective intermediary between understanding customer usage and changing customer behavior, consequently providing tangible incentives that promote the beneficial use of DERs to customers and the distribution grid.

Therefore, the project is a pre-requisite for the widespread adoption and utilization of DERs, and includes the following benefits:

- Developing efficient procurement processes around customers and local distribution companies;
- Enabling real-time smart contracting capabilities binding the provider and the customer through contractual obligations;
- Providing real-time and efficient financial settlement processes to improve customer trust and engagement leading to higher customer value;
- Securing compliance obligations through a set of highly measurable and transparent verification processes around energy transactions/incentivization between customers and utilities;
- Emerging sector interest in developing regional or distribution-level markets to enable DERs to provide local system needs;
- Understanding the incentive structures that effectively promote customers to uptake DERs and participate in DER management programs in ways that benefit both the grid and customers;
- Enabling Alectra Utilities to defer or avoid investment in distribution infrastructure by leveraging the value of widespread adoption of DERs; and
- Minimizing the negative impact of DERs on the operation of the distribution grid

2.1 Summary of Investment Outcomes and Benefits

Table A16 - 2: Investment Outcomes and Benefits

Outcome	Investment Benefits and Objectives
Efficiency	The integration of DERs with Alectra Utilities' traditional distribution operation technology systems will enable Alectra Utilities to optimize the operation of DERs to prevent power quality issues and reduce peak demand. In addition, these projects will provide valuable data to improve Alectra Utilities' system planning practices by incorporating the benefits of DER uptake and operation to reduce peak demand and defer traditional distribution investment. Currently, these values are not incorporated in Alectra Utilities' system planning practices. As DER penetration increases, ignoring these resources will lead to economic inefficiencies, as Alectra Utilities would require investment for additional infrastructure to manage the impact of the DERs on the distribution system. The projects remove key barriers to the utilization of DERs and will promote participation in distribution and wholesale electricity energy services. They will enable and enhance the utility's opportunity to ensure better visibility of the location, size and application of the integrated DERs that are being introduced in Alectra Utilities' system, while providing customers with tangible benefits from integration. By bringing the procurement, contracting, settlement, and verification functions required to administer a market into a Smart DER Platform, we expect significant process and cost efficiencies from removing integration or coordination of separate platforms. It will also facilitate broader adoption of DERs by customers by providing an accessible way for them to participate and obtain value.
Customer Value	By optimizing DER operations, Alectra Utilities can maximize the benefit of DER connected to the network to mitigate power quality and capacity limitations constraints. Therefore, the planned investments enable greater energy choices for Alectra Utilities customers who wish to consume and generate their own electricity while remaining connected to the network. The projects will also allow customers with DERs to better utilize their DER capability while also providing a benefit to the grid. In return, these customers

Outcome	Investment Benefits and Objectives
	will receive payment for the services they provide – generating value for these customers. Customers benefit by saving money on their electricity bill and making money through selling self-generated electricity back to the grid. In terms of customers without DERs, Alectra Utilities may be able to lower the energy costs for the entire customer base by proactively managing DERs in a way that incremental infrastructure cost upgrades to safeguard the grid from DER adoption or power quality issues are mitigated. This will include any upgrades, maintenance or reactive outage related costs incurred due to overloading of the distribution network.
Reliability	By developing the contracting, verification, and settlement infrastructure that allow the coordination of DERs, Alectra Utilities can utilize these DERs to prevent distribution assets from being over loaded. They can be a cost-efficient alternative to traditional grid infrastructure investments and be used so that Alectra Utilities can maintain a reliable electricity supply for all customers.
Safety	The projects will advance Alectra Utilities' ability to control and monitor DERs connected to the distribution network – ensuring DERs are able to be isolated from the grid in order to protect the employees working on the network during outages.
Cyber-security and Privacy	Cyber security and data privacy are key considerations for the projects, given the integration of assets located in customer's homes with Alectra Utilities' system control and operational systems, such as, but is not limited to, SCADA, GIS and OMS. Through these projects, Alectra Utilities' aims to participate in the development of industry leading practices adopting cyber-security technologies, architecture and standards for a distributed electricity network. The projects will be backed by a robust blockchain infrastructure with cyber-security and data privacy at its core. Blockchain technology essentially provides a distributed ledger that can record transactions between two parties efficiently, and in a verifiable, permanent and secure way. Through the Smart DER Platform, Alectra Utilities will issue requests for the Power.House customer systems to provide distribution energy services where each aspect

Outcome	Investment Benefits and Objectives
	of customer participation will be transacted and recorded transparently in real-time by the platform. The Smart DER Platform will provide end-to-end visibility on customer usage and DER participation patterns, and such information can only be accessed by parties who have been granted permission through the platform.
Coordination / interoperability	The projects will provide the procurement, contracting, verification, settlement, control and monitoring processes required for coordination and interoperability of DERs with the existing electricity distribution network. Without this coordination of DERs, Alectra Utilities will be unable to cost-effectively procure, coordinate and optimize the application of DERs and will either have to enhance its network with traditional infrastructure and/or limit connections of DERs to the network. Meanwhile, if the DERs are managed as an aggregated fleet, local benefits such as reduced transformer or feeder loading could be achieved by scheduling for DERs to shave load or self-generate during peak periods.
Environment	One of the use-cases demonstrated by the Smart DER Platform is a greenhouse gas ("GHG") avoidance market. The platform will receive near-real time data on the GHG intensity of the grid from the IESO, triggering a response from participants to reduce their electricity consumption or discharge their battery above a pre-set GHG threshold. This will demonstrate the ability for the platform and participants to achieve targeted, verifiable reductions in GHGs. Furthermore, DERs tend to be zero-emissions technologies, therefore, increasing the penetration of these technologies reduces output from GHG emitting centralized electricity generators.
Other Benefits	Evaluate DERs as system planning alternatives. Understanding of DER capabilities will enable Alectra Utilities to utilize DER deployment as feasible non-wires solution to defer distribution and transmission infrastructure expansion.

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III Investment Drivers and Need

The DER Integration projects are driven by the following investment needs:

- Understand, mitigate and reduce the risks DERs pose regarding capacity constraints, power quality, and reliability on the distribution grid and ready Alectra Utilities' distribution system to accept and support DERs, including electric vehicles, solar PV systems, and battery storage
- Improve efficiencies around integrating, controlling, optimizing, tracking, and settling transactions with DERs on Alectra's distribution grid
- Provide customers with the alternative choices to the traditional electricity supply model, including the DER technologies and ownership structure, and participation in grid benefiting services
- Reduce energy affordability issues that arise when DERs are unmanaged

By undertaking these projects now, Alectra Utilities is preparing the distribution system to safely and reliably respond to the expected uptake of DERs with a coordinated architecture that balances the benefits of DERs to their owners, with the costs they potentially pose on all of Alectra Utilities' customer-base.

Without this preparation, Alectra Utilities introduces the risk of:

- supressing customer choice in the short term due to constraints in the distribution system to support DERs;
- creating power quality and reliability of supply issues as a result of intermittent, uncontrolled generation from DERs, and the increasing frequency and duration of interruptions to grid supply from adverse weather conditions; and
- reactionary and expensive upgrades to distribution infrastructure in response to these risks.

3.1 Purpose

Table A16 - 3: Investment Drivers

Investment Driver	Reasoning and Investment Benefits
Capacity constraints, power quality, and reliability	Implementation of the projects provide Alectra Utilities a prudent and paced manner to evaluate and understand all implementation and operational issues as well as benefits of DERs. The uptake of DERs in Alectra Utilities' service areas pose both a risk and an opportunity for the distribution system: • DERs which include solar PV panel and EVs have the potential to impact peak demand and create power quality issues in the network – if operating in an uncoordinated manner without visibility by the Alectra Utilities. • DERs such as battery storage units or smart inverters can help to provide back-up supply during grid outages, reduce peak demand, and alleviate power quality problems The DER Integration projects seek to coordinate and incentivize DER uptake and operation, and avoid these negative impacts. Finally, the projects will implement the operational monitoring and control technologies required for real-time control over DERs in order for Alectra Utilities to maintain supply capacity within existing infrastructure, and maintain voltages within standard requirements.
Efficiency	For Alectra Utilities to manage DER integration, it needs to undertake the following functions: - Procurement: transparency between customers and the utility to ensure efficient procurement of services. • Contracting: ability to secure services with performance requirements and penalties bound by contractual obligations. • Compliance: measurement and verification of participant performance to ensure they meet contractual obligations.

Investment Driver	Reasoning and Investment Benefits
	• Settlement: timely and efficient financial settlement according to terms agreed upon through contracting. Using blockchain technology, the transaction management aspect becomes much more simplified, transparent and trustworthy with respect to a traditional legacy implementation, such as a centralized database [160]. Alectra Utilities expects reduced management and auditing overhead from each of these processes due to the inherently secure architecture of a blockchain based platform. For example, the ability to code digital contract terms and verify and settle transactions instantaneously will reduce the overhead associated with contract management.
Customer access and choice	Customers increasingly expect Alectra Utilities to provide choice in how electricity is consumed and produced. DERs have the potential to be an economic and environmentally friendly alternative to the traditional wires solution for our customers. Alectra Utilities endeavors to develop cost-effective access to the distribution system without adversely impacting the safe and reliable operation of the system. The DER Integration projects will develop the operational systems and business processes to maximize the safe, reliable, and fair connection of DERs with Alectra Utilities' network. The project will also enable a commercial framework that allows DER owners to allow their assets to contribute to grid management, and help optimize DER operations to allow for greater uptake within the traditional distribution system.

[160] IBM, https://www.ibm.com/blogs/blockchain/2019/01/whats-the-difference-between-a-blockchain-and-a-database/

Investment Driver	Reasoning and Investment Benefits
Customer affordability	Affordability of electricity is a priority for Alectra Utilities' customers. As the price of DERs has fallen, they have the potential to deliver significant electricity bill savings to customers. However, if not managed appropriately, there is a risk of increasing electricity costs for other customers. For example, unmanaged solar PV generation will require new network infrastructure to manage power quality (e.g. over-voltage) and reverse power flow – paid for in-part by non-PV owners. Alectra Utilities' DERMS and Smart DER Platforms will help proactively mitigate those risks and maintain customer affordability.

IV Investment Timing and Pacing

4.1 Summary of Expenditures

Table A16 - 4: Historical and Proposed Investment Spending

	Historical Spending				Bridge	Forecast Spending				
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
CAPEX ($MM)	$0.0	$0.0	$0.0	$0.0	$0.90	$0.66	$0.67	$0.90	$0.91	$0.92

4.2 Historical Expenditures (2014-2019)

Alectra Utilities has successfully completed pilots of emerging technologies and shared learning with other distributors as well as industry stakeholders to facilitate the development and solutions for customers interested in alternative electrical supply choices. It is important to note the scope and scale of historical projects differs from the proposed DER Integration projects, hence historical expenditures for such projects are not included in Table A16 - 4 above. Examples of successful projects completed by Alectra Utilities or legacy utilities that formed Alectra Utilities include:

- Power.House Pilot Project (as described in Section 2 above)
- Alectra Utilities' Cityview Microgrid is designed to seamlessly connect or disconnect from the distribution system. Alectra Utilities implemented its Microgrid demonstration project

in two phases. In phase one, Alectra Utilities generated electricity from a solar array, a wind turbine, and a battery storage system in order to provide electricity to building loads such as lighting, air conditioning and refrigeration. Electricity generated from this combination of clean and renewable sources was used to power an electric vehicle charging stations and to maintain a steady charge in the Microgrid's storage batteries. In the second phase of the pilot, Alectra Utilities developed an integrated solution to control and optimize the connected assets, including the electric vehicle charging station, vehicle-to-grid charging station, the solar battery storage system and load bank to introduce peak demand management, and to participate in simulated demand response events.

4.3 Future Expenditures (2020-2024)

Future expenditures from 2020 to 2024 for the two DER Integration projects will total $4MM. The proposed projects are a limited step toward evaluating how different platforms, such as the DER Control Platform and the Smart DER Platform, can prepare Alectra Utilities to reduce the previously mentioned risks and maximize the benefits of DERs integrated with Alectra Utilities Distribution system. Such integration projects will provide Alectra Utilities with a direct real-time communication link with the status and condition of DERs on the distribution network, and the means to optimize and coordinate DER outputs for the benefit of the distribution system and customers connected to it.

4.4 Investment Pacing and Prioritization

These two DER Integration projects will be conducted simultaneously because the projects address two very different and specific needs:

1. DER Control Platform: this project will integrate DERs with Alectra Utilities' traditional distribution operation systems and enable the utility to optimize the operation of DERs to benefit both the grid and customers.
2. Smart DER Platform: This project will develop a platform that uses blockchain technology to enable real-time processes around procurement, smart contracting, automated verification and settlement for customers participating in grid services with their DERs.

As the learnings from these projects are equally important for Alectra Utilities to prepare the distribution system to safely and reliably respond to the expected uptake of DERs, Alectra Utilities will pursue these projects simultaneously during the 2020-2024 period.

Between the two projects, the different activities will be prioritized based on their interdependencies. For example, the procurement process within the Smart DER Platform will have a direct dependency on DER Integration as part of the DER Control Platform, and will be prioritized accordingly.

These projects will be prioritized in areas within Alectra's service territory where the adoption and the management and control of DERs with DER Integration Platforms, such as the DER Control Platform and Smart DER Platform, can offset or reduce grid issues. Areas typically categorized with high growth, low reliability or capacity will be targeted as beneficial sites for DER adoption and subsequent testing of the DER Integration Platforms that mitigate the risks and maximize the benefits of DERs.

4.5 Execution Approach

Alectra Utilities will utilize internal staff and external vendors to complete the design and execution of the two projects. Specifically, the execution phase will follow Alectra Utilities' project management practices, which provides guidelines, procedures, work instructions, and industry best practices that allow the project work to be performed in an economically efficient, cost-effective, and safe manner.

Constraints

Due to the emerging nature of certain of the technologies tested at Alectra Utilities, the timing of projects can be constrained by the development efforts and capability of technology vendors. Alectra Utilities mitigates this risk by undertaking thorough and on-going evaluation of potential vendors, and gaining experience with vendors in smaller-scale projects.

V Options Analysis

Alectra Utilities considered several alternatives in developing DER Integration projects:

- Option 1 Be Reactive with Traditional Distribution Infrastructure Investments: Reactively respond to DER uptake and organic load growth by investing in traditional 'poles and wires' infrastructure as capacity, power quality, and reliability issues become apparent. Additionally, Alectra Utilities won't have the capability to monitor and control DERs without a DER Management and Control platform. Option 2 – Being Proactive with DER Integration Projects: Integrate DERs located throughout the network into Alectra Utilities' Advanced Distribution Management System (ADMS), allowing these resources to be controlled, monitored, and optimized by Alectra Utilities and, where applicable, providing the capability to defer or avoid traditional distribution infrastructure upgrades.

Efficiency: Option 1 (Traditional Distribution Infrastructure) requires major replacement/enhancements reactively to the network and is therefore an inefficient option in response to the grid benefits posed by DERs. Option 2 (DER Integration Projects) will provide Alectra Utilities the ability to optimize the operation of DERs to prevent power quality issues, reduce peak demand, and defer/avoid traditional distribution enhancements as DER adoption becomes widespread throughout the network.

Customer value: Option 1 represents the *status quo* for customer value. Option 2 maximizes the number of DERs connected to the network before power quality and capacity limitations constrain the connection of new DERs - provides greater energy choices for our customers who wish to consume and generate their own electricity while remaining connected to the network.

Reliability: Option 1 provides poor reliability in the long term, due to a reactive response to peak demand and power quality issues from DER growth. Option 2 will allow Alectra Utilities to proactively address peak demand growth and power quality issues; thus, ensuring the reliable operation of the network.

Safety: Option 1 - Alectra Utilities' assets will not be at long-term risk of being loaded above operating limits, although the option will not provide Alectra Utilities the monitoring or control capability required for safe operation during outages. Option 2 is the safer option, as it allows

Alectra Utilities to coordinate DER operation during outages, and maintain loading on distribution assets within operating limits in the short and long term.

Cyber-security/Privacy: Although Options 1 provides a greater level of cyber security, it refrains from providing any benefits associated with DER adoption. While there are some new risks associated with Option 2 due to the nascent distributed network being developed, it will be a key requirement of the project to develop best-practice security standards and processes to mitigate any risks.

Coordination / Interoperability: Option 1 minimizes the need for DER coordination and interoperability by instead solving any possible capacity, reliability, or power quality problems with additional distribution infrastructure. Accordingly, this option has limited coordination/interoperability outcomes. Option 2 provides the necessary control and monitoring platform for the physical coordination and interoperability of DERs with the existing electricity network.

Environment: Options 1 represents the status quo for environmental outcomes – centralized electricity generation and distribution. Option 2 allows for increased DER uptake, and therefore offsets GHG emissions from centralized generation, and defers/avoids the need for new infrastructure development in the community.

As a result of considering the criterial of efficiency, safety, reliability, cyber security, interoperability and the environment, Option 2 was selected as the basis for the planned investments in the 2020-2024 period.

VI Investment Projects

The investments from 2020 to 2024 that form the DER Integration investments are included in Table A16 - 5.

Table A16 - 5: Material Projects and Initiatives

Project Code	Project Name	CAPEX ($MM)
150747	DER Control Platform	1.6
150693	Smart DER Platform	2.4

Appendix A19 - Fleet Renewal

I Overview

Alectra Utilities requires trucks, vehicles and equipment to perform work, and to transport materials as well as employees to and from job sites. The Fleet Renewal investments maintain the vehicles, trailers, and other equipment necessary to support system capital and maintenance work across Alectra Utilities' distribution system.

Although Alectra Utilities does not plan to increase the size of its fleet during the DSP period, it must replace a significant population of vehicles that have surpassed their typical useful life. As of 2018, over 64 percent of vehicles in the utility's fleet had surpassed their useful lives. As such, significant capital investments will be required in future years to bring the vehicle fleet to normal operating conditions to ensure vehicle availability to support operations, reduce potential safety risks to employees and public.

As discussed in Section 2 below, Alectra Utilities annually assesses its fleet based on a defined set of criteria designed to ensure that the cost to operate and maintain each vehicle is less than a captial and operating costs of a replacement vehicle, and that Alectra Utilties complies with all statutory regulations. Alectra Utilities also considers emissions and fuel consumption of the new vehicles compared to the ones being replaced. The planned Fleet Renewal investments will ensure that Alectra Utilities can respond to customer needs promptly, manage system reliability, and mitigate safety and environmental risks.

Table A19 - 1: Fleet Renewal Investment Expenditures, Drivers and Outcomes

	Historical Spending				Bridge		Forecast Spending			
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
CAPEX ($MM)	$7.5	$4.3	$3.2	$6.7	$8.5	$8.9	$9.5	$9.9	$10.3	$10.2
Primary Driver:	System capital and maintenance work support									
Secondary Driver:	Business operational efficiency									
Investment Outcomes:	Customer Value, Safety, Reliability, Environment and Efficiency									

II Investment Description

During the DSP period, Alectra Utilities' planned fleet investments are focused on renewing vehicles that are either in poor condition, have high mileage/engine usage or have surpassed their typical useful life. Alectra Utilities does not propose to increase the size of the utility's fleet in this period.

Alectra maintains a fleet of 560 vehicles, 156 trailers, and other miscellaneous equipment to ensure safe and reliable vehicles for employees to perform their daily activities. Alectra Utilities' has garages in Markham, Mississauga, Brampton, St. Catharines, Guelph and Hamilton. The garages in Hamilton and Mississauga operate with extended hours of operation to provide Alectra Utilities with more flexibility in managing its fleet inventory, maintenance and repairs.

Alectra Utilities' fleet consists of:

- Heavy-duty vehicles;
- Medium-duty vehicles;
- Light-duty vehicles;
- Trailers; and
- Fleet equipment (e.g., forklifts, generators, and compressors).

Heavy-duty and medium-duty vehicles are the primary means of transporting equipment and materials to and from job sites. Light duty vehicles facilitate the engineering, management and planning functions of the utility. Trailers mainly provide storage for equipment at work sites. Fleet equipment is used to perform lifting, towing and are used mainly by operations and stores departments at Alectra Utilities.

As discussed in Section 3 below, a significant number of vehicles in Alectra Utilities' fleet have deteriorated to unacceptable levels. These vehicles pose safety risks for employees and the general public and must be replaced. To the extent that they are unable to fulfil their operational functions, either partially or entirely, these deteriorated vehicles negatively impact Alectra Utilities' ability to serve its customers. Replacing these vehicles is the focus of Alectra Utilities' fleet investments during the 2020-2024 DSP period.

Table A19 - 2 identifies the quantity and the types of vehicles and other assets that Alectra Utilities plans to replace through Fleet Renewal investments during the DSP period.

Table A19 - 2: Planned Fleet Renewal Investment by Vehicle Type

Vehicle Type	2020		2021		2022		2023		2024		2019-2024 Total	
	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)
Heavy Duty Vehicles	8	3.5	15	6.8	14	5.7	12	6.3	10	5.3	**59**	**27.6**
Medium Duty Vehicles	12	1.6	11	1.2	9	1.6	6	1.0	7	2.0	**45**	**7.4**
Light Duty Vehicles	61	2.7	16	0.8	41	1.9	38	1.7	33	1.6	**189**	**8.7**
Equipment	6	0.9	3	0.5	3	0.6	9	0.8	9	0.9	**30**	**3.7**
Trailers	0	0.0	1	0.1	0	0.0	8	0.4	8	0.3	**17**	**0.8**
Shop Equipment and Tools	5	0.2	3	0.1	3	0.1	2	0.1	5	0.1	**18**	**0.6**
Total	**92**	**8.9**	**49**	**9.5**	**70**	**9.9**	**75**	**10.3**	**72**	**10.2**	**358**	**48.8**

The planned investments reflect a set of objectives and drivers, ranging from the condition of existing vehicles to external regulatory and safety requirements. Table A19 - 3 outlines the objectives and drivers of the utility's planned fleet investments.

Table A19 - 3: Fleet Renewal and Sustainment Objectives and Drivers

Objectives	Drivers of Replacement Investments
Alectra Utilities' fleet replacement and sustainment objectives are to: • Identify vehicle replacements required to ensure adequate support for capital work, maintenance and corporate travel requirements on an annual basis • Ensure that Alectra Utilities' vehicle replacement criteria are aligned with utility best practices, vehicle manufacturer requirements and applicable industry standards • Ensure vehicle specification standards appropriate for each vehicle class are established to reduce inventory requirements, streamline vehicle maintenance and expedite delivery timelines • Ensure that Alectra Utilities' fleet operates in compliance with all appropriate federal, provincial, and municipal legislations, and specific licences • Establish and maintain a fleet that can meet existing and future geographic challenges and operating environments • Continue to assess, investigate and evaluate efficiencies and benefits of fleet inventory with vehicles powered by alternative sources of energy • Ensure alignment to support Alectra Utilities' Environmental and Sustainability Development initiatives	Alectra Utilities identifies specific investments based on the following factors, as applicable to the different classes of vehicles, trailers, and other equipment that are the subject of the plan: • Manufacturing Standards • Industry Standards • Construction and Operating Standards • Vehicle Operational Conditions • Vehicle Age • Vehicle Total Mileage • Highway Traffic Act • Canadian Motor Vehicle Safety Standards • All related Canadian Safety Association standards, specifically those that relate to aerial devices and hydraulic equipment • Motor Vehicle Inspection Station requirements • Infrastructure Health and Safety Association of Ontario, where applicable • Corporate Health and Safety and Environmental Policies

Alectra Utilities annually assesses its trucks and vehicles based on the replacement assessment criteria that focus on vehicle condition, age, mileage, engine hours and operational requirements as defined within Table A19 - 4 below.

Table A19 - 4: Vehicle Renewal Assessment Criteria

Fleet Class	Renewal Assessment Criteria
Light Duty Vehicles:	• Assessed at 7 years and every year after, and/or high mileage (excess of 250,000 km) • Replacement schedule: at 7 years, (250,000 km).
Medium Duty Vehicles	• Assessed at 10 years and every year after, and/or high mileage (excess of 250,000 km) • Replacement schedule: at 10 years, (250,000 km).
Heavy Duty Vehicles:	• Assessed at 12 years' service, and every year after, and/or high mileage (excess of 500,000 km) • High engine hours (excess of 12,000 engine hours) • Replacement schedule: at 15 years, (500,000 km or 12,000 hrs.)
Trailers:	• Trailer replacement will follow the same core principles as the vehicle replacement criteria with the following differences: • Assessed at 15 years' service • When assessing trailer conditions, trailers will be refurbished rather than replaced. • Where trailers cannot be refurbished due to application change or condition, trailers will be flagged for replacement. • Replacement/Refurbishment: 15 years.

2.1 Assessing Opportunities to Reduce Fleet Size

As discussed further in Section 4.4, Alectra Utilities also conducts additional screening to ensure the vehicle being replace is still required or if a different type a vehicle is required in the event operational requirements may have changed. This screening occurs annually and prior to ordering new vehicles. When a vehicle is assessed, Alectra considers whether the actual vehicle can be disposed of rather than replaced, based on usage or operational effectiveness.

Alectra Utilities does not believe that it can prudently reduce the size of the utility's total fleet. Alectra Utilities has engaged Mercury Associates and a vehicle utilization study is currently underway. Alectra Utilities plans to continue assessing opportunities to minimize the costs of its fleet while maintaining the level of service and safety that the utility and customers require.

2.2 Garage Management System

During the DSP period, Alectra Utilities plans to implement a Garage Management System (GMS) which will allow the utility to manage its fleet information more efficiently and effectively. The system will allow Alectra Utilities to manage its resources, inventory levels and vehicle preventive maintenance schedules more efficiently. The GMS system will create detailed usage reports on parts, labour and inventory, as well as track and consolidate all costs from Alectra Utilities' ERP system. Costs tracked will include those incurred from a third-party maintenance providers and/or internal fleet operational centres at the individual vehicle and equipment level. The capital expenditure associated with this GMS software is included in Appendix A18 – Information Technology Systems.

2.3 Summary of Investment Outcomes and Benefits

Table A19 - 5 summarizes the outcomes and benefits associated with the Fleet Renewal investment.

Table A19 - 5: Investment Outcomes and Benefits

Investment Benefits	Reasoning and Investment Benefits
Customer Value	Working and operational vehicles ensure that Alectra Utilities can manage its commitment to customers by getting to work locations on-time and effectively address issues on-site.
Reliability	Contributes to Alectra Utilities' system reliability by ensuring work crews have the necessary vehicles and equipment to perform distribution work when required on a 24/7 basis.
Safety	Contributes to the safety of Alectra Utilities' operations by minimizing safety risks to crews and to the public.
Environment	Contributes to Alectra Utilities' environmental performance by reducing GHG emissions associated with fleet fuel consumption by: • Utilizing hybrid and electric vehicles where possible; and • Implementation of anti-idling technology and GPS reporting.
Efficiency	Through the replacement of fleet assets, Alectra Utilities can realize efficiency savings in several ways: • Via reduction in total life-cycle costs, including a reduction in maintenance costs, associated with new vehicles • Via reduction in fuel costs, due to the improved fuel economy of new vehicles, along with the utilization of hybrid and electric vehicles and idle-reduction technologies New Alectra Utilities vehicles will align with the utility's current-state processes and practices, and new vehicle specifications allowing the utility to avoid the cost associated with maintaining vehicles with different capabilities and maintenance requirements.

III Investment Drivers and Need

3.1 Purpose

The planned Fleet Renewal investments are driven by the condition of the utility's existing fleet, and by the operational needs of the distribution system. Both drivers are discussed in the following subsections.

3.1.1 Condition of Existing Fleet

Alectra Utilities' fleet consists of different types of trucks and vehicles that are each designed for specific work purposes. At the job site, truck and vehicle uses include:

- Lifting and positioning material;
- Storing material;
- Preparing material for installation; and
- Planning and coordinating work.

Fleet vehicles must be available to support these functions in a safe, reliable, and operationally efficient manner.

As shown in Table A19 - 6, a significant portion of Alectra Utilities' fleet is due for replacement. This figure shows the proportion of Alectra Utilities vehicles that are still in service but are either due for replacement (labelled "Current") or past-due ("Overdue"), by the utility's fleet renewal assessment criteria. Table A19 - 6 provides the percentage of vehicles purchased between 1999 and 2016 replacement status. In effect, this table shows that:

- Over 51% of vehicles purchased between 1999 and 2016 are overdue for replacement.
- Over 28% of vehicles purchased between 1999 and 2016 are currently do for replacement.

Table A19 - 6: Alectra Utilities Fleet Replacement Status Table

Model Year	Current Replacement Need	Overdue Replacement Year
1990	0.00%	0.13%
1999	0.00%	0.40%
2000	0.00%	0.93%
2001	0.00%	1.06%
2002	0.00%	1.19%
2003	0.00%	0.93%
2004	0.00%	3.17%
2005	0.00%	1.06%
2006	0.00%	6.22%
2007	0.00%	3.57%
2008	0.00%	12.96%
2009	0.00%	6.75%
2010	0.00%	13.62%
2011	4.10%	0.00%
2012	6.08%	0.00%
2013	3.84%	0.00%
2014	4.76%	0.00%
2015	5.42%	0.00%
2016	4.10%	0.00%
All Vehicles	**28.30%**	**51.99%**

Table A19 - 7: Alectra Utilities Vehicles 2020 – 2024 Replacement Age

Fleet Types (2020-2024)	Replacement Criteria (Years)	Average Age at Replacement Period (Years)
Trailers Replacement	15	19.5
Fleet Equipment Replacement	15	21.8
Light Duty Vehicles Replacement	10	10.6
Medium Duty Vehicles Replacement	12	12.3
Heavy Duty Vehicle Replacement	15	17

Alectra Utilities fleet capital expenditures between 2020 and 2024 will focus on vehicles that have reached or surpassed their end of life. Alectra Utilities medium duty vehicles replacement criteria is 10 years and heavy-duty vehicles is 15 years. Vehicles being replaced between 2020 and 2024 were manufactured in 2010 or earlier. Table A19 - 7 sets out the number of vehicles that Alectra

Utilities forecasts will be at or beyond their end of life in each year of the DSP period. As shown in Table A19 - 2 above, Alectra Utilities does not propose to replace all of the vehicles identified in Table A19 - 8 below, to help mitigate rate increases.

Table A19 - 8: Summary of Alectra Utilities Vehicles at or Beyond End of Life

Alectra Utilities Vehicle Replacement Overdue by Type			
Years	**Light Duty**	**Medium Duty**	**Heavy Duty**
2020	114	31	13
2021	77	22	18
2022	83	18	14
2023	53	12	11
2024	33	7	4
Total	**360**	**90**	**60**

As vehicles deteriorate with use, age and exposure to weather conditions, Alectra Utilities has experienced an increased risk of potential safety issues as a result of structural failures, component failure as well as vehicle electrical faults. Vehicle failures and faults are typically triggered by a number of factors, including corrosion. Alectra Utilities' fleet vehicles are continuously used throughout the year and continuously exposed to environmental conditions including severe weather and rugged working site elements.

Figure A19 - 1 illustrates some examples of fleet vehicle degradation modes, including corrosion/rusting, leaking and exterior damage.

Figure A19 - 1: Examples of Alectra Utilities' Fleet Vehicle Degradation

Vehicle age, use, salt on city streets are the main reasons for increasing corrosion conditions as corrosion damages and weakens the frame of the truck or vehicle over time. The frame is the main structure of a vehicle to which all running gears are secured, and supports the entire weight of the vehicle and is fastened to the wheels, suspension, and steering components. Severe rust to the frame can lead to breaks while under load (for example, during a lift operation, pulling cable, or material loading). Frame weakness can also decrease the ability of the vehicle to withstand crashes, thus jeopardizing the safety of the operators and the general public.

Corrosion may also occur on components that are critical to the operation of the vehicle, such as transmission and brake lines, that are often not observable without substantial teardown. Rust on these components results in weak spots that have the potential to rupture and leak, and cause failures while in use. For example, a transmission line rupture could result in a seized transmission. Transmission failure of heavy-duty trucks and vehicles introduces significant risk to

the operators' safety and the safety of the general public. Similarly, brake line failures introduce safety risks due to loss of control and ability of the operator to appropriately stop the truck or vehicle.

Regular use of the fleet assets over time can lead to the failure of critical components that are not readily serviceable or observable by maintenance staff. Components such as the hydraulic hoses running through an aerial bucket truck, for instance, cannot be directly inspected at service intervals. As these hoses age, they become less flexible and more brittle. Hose failure results in hydraulic fluid leaking into the environment and could potentially result in stranding an employee operating a bucket at significant heights. Rescuing an employee from an aerial bucket truck presents a potential risk to the employee in the bucket as well as other field employees and the general public in the vicinity.

As vehicles deteriorate, components designed to protect the vehicles' electrical circuitry can become compromised as the vehicle ages and deteriorates with regular use, leading to potential electrical failures. The risk of vehicle electrical circuitry failure increases with the use and age of the truck or vehicle. Vehicle electrical failures introduce the risk of failing auxiliary safety lighting systems and onboard equipment which are mandatory to protect the public and also permit staff to perform the work safely.

Timely vehicle replacement is necessary to avoid undue vehicle downtime and associated negative impacts on customer response time and employee productivity. Trucks and vehicles are "the workplace" for over 60% of Alectra Utilities' workforce. Providing and maintaining a safe and reliable fleet is key to building a better workplace for Alectra Utilities' employees and providing them with the tools required to provide service to Alectra Utilities' customers.

As shown in Table A19 - 4, Alectra Utilities uses the age of a vehicle to trigger more detailed assessment of the vehicle's condition. Age is a good preliminary measure of condition since utility vehicles are subject to consistent wear and deterioration which negatively impacts their safety, reliability and operational efficiency. Alectra Utilities has determined that once the age profile of a truck or vehicles surpasses the ages identified in Table A19 - 4, their reliability is typically compromised, and may pose risks to the employees and public safety and reliability of distribution work. Furthermore, once the average age of the fleet exceeds the age within the specified replacement schedule, Alectra Utilities has experienced increased costs for the vehicle-related

parts and services and vehicle down time at the shop. The utility's average annual operating budget of $3.2MM has proven insufficient to maintain and repair 560 vehicles, 156 trailers, and other miscellaneous equipment. As shown in Table A19 - 9, the actual cost of the utility Vehicle Maintenance and Repairs budget has increased by $0.9MM annually on average, due in part to material and labour to keep end of life vehicles in operations due to the lack of required capital expenditures in previous years. Alectra Utilities expects that the vehicle-related operating costs and down-time will continue to escalate as the average age of the fleet increases and end of life vehicles are not replaced. Investment in fleet sustainment and renewal is required to optimize the total cost of ownership while supporting Alectra Utilities' work and travel requirements.

Table A19 - 9: Vehicle Maintenance and Repairs (Actual vs. Budget) for 2017 and 2018 ($MM)

2017			2018		
Actual	Budget	Variance	Actual	Budget	Variance
$4.1	$3.3	$(0.9)	$4.2	$3.2	$(1.0)

3.1.2 Operational Needs

As operational needs and work requirements evolve with standards and technologies, specific vehicle and equipment configurations are required to be updated such as higher and heavier hydro poles requiring bigger trucks with longer and higher capacity booms. Alectra Utilities is also installing underground infrastructure within its service territory which requires differently designed vehicles to handle longer and heavier underground cabling. Larger capacity transformers also require vehicles with higher lifting capacity and finally, smaller vehicles that can accommodate work within higher population density areas are required. As part of the planned vehicle replacements, Alectra Utilities will work closely with Operations and Manufactures to procure vehicles that are better position to support operational needs and work requirements in the years to come.

The primary driver of the fleet renewal investment is to provide trucks and vehicles necessary to support Alectra Utilities' capital and maintenance work and 24/7 trouble response. The secondary driver of the investments is business operations efficiency, as the renewal investment will ensure that Alectra Utilities' continues to deliver reliable and timely services to customers in an efficient manner.

Table A19 - 10 provides further details of the primary and secondary drivers of the fleet renewal investment.

Table A19 - 10: Fleet Renewal Investment Drivers

Investment Driver	Reasoning and Investment Benefits
System Capital and Maintenance Work Support	This investment is designed to support Alectra Utilities personnel to access and work on the distribution system, and provide the ability to respond to urgent daily operational work in a timely manner.
Business Operations Efficiency	This investment is designed to introduce business efficiencies in respect to getting crews to sites in a more cost efficient manner, due to savings in fuel and maintenance costs enabled by updated fleet assets.

IV Investment Timing and Pacing

4.1 Summary of Expenditures

Table A19 - 11 provides the year-over-year breakdown of overhead asset renewal investments, including the historical period from 2015-2018, the bridge year in 2019, and the forecast period from 2020-2024.

Table A19 - 11: Historical and Proposed Fleet Renewal Investment 2015-2024

	Historical Spending				Bridge	Forecast Spending				
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
CAPEX ($MM)	$7.5	$4.3	$3.2	$6.7	$8.5	$8.9	$9.5	$9.9	$10.3	$10.2

4.2 Historical Expenditures (2014-2019)

Historical fleet expenditures between 2015 and 2019 total $30.2MM. During the historical period, fleet investments varied due to two factors: (i) differences between the fleet management practices and policies of the four predecessor utilities, and (ii) deferred expenditures to accommodate high-priority, non-discretionary capital investments and to ensure effective integration of the five predecessor utilities' fleets.

The predecessor utilities each employed their own fleet management approaches. Alectra Utilities developed a consolidated vehicle replacement process following the merger. Expenditures in 2018 were the first to be based on the utility's consolidated approach. Most of the predecessor utilities vehicle replacement criteria resulted in vehicles staying in operations based on manufactures replacement guidance, poor vehicle conditions, other utilities replacement criteria, and recommended industry best practices. Alectra Utilities vehicle replacement criteria is more in line with manufactures replacement guidelines, other utilities replacement criteria, and recommended industry best practices. Table A19 - 12 captures the vehicles replacement criteria of the initial four predecessor utilities and Alectra Utilities.

Table A19 - 12: Alectra Legacy Utilities Vehicle Replacement Criteria's Summary:

Vehicle Class	HOBNI	PowerStream	Horizon Utilities	Enersource	Alectra Utilities
Cars	10 yrs/ 200,000 km	200,000 km	6-8 yrs/ 150,000 km	5 yrs	7 yrs/ 175,000 km
Hybrid Vehicles	8 yrs/ 200,000 km	200,000 km	6-8 yrs/ 150,000 km	5 yrs	7 yrs/ 175,000 km
Pickups	10 yrs/ 200,000 km	275000 km	6-8 yrs/ 150,000 km	5 yrs	7 yrs/ 200,000 km
Pickups RGVW 4500KG.		250,000 km	6-8 yrs/ 150,000 km	8 yrs	7 yrs/ 200,000 km
Passenger Vans	10 yrs/ 200,000	200,000 km	6-8 yrs/ 150,000 km	5 yrs	7 yrs/ 200,000 km
S.U.V.	10 yrs/ 200,000	200,000 km	6-8 yrs/ 150,000 km	5 yrs	7 yrs/ 200,000 km
Work Vans	10 yrs/ 200,000	250,000 km	10 yrs/ refurbish	8 yrs	10 yrs/ 200,000 km
Tractor	15 yrs/ 10,000 hrs/ 400,000 km	250,000 km/ 12,000 hrs	16-19 yrs/ 15,000 hrs/ 200,000 km	12 yrs	15 yrs/ 12,000 hrs/ 250,000 km
Digger Derrick	10 yrs/ 10,000 hrs/ 200,000 km	250,000 km/ 12,000 hrs	16-19 yrs/ 15,000 hrs/ 200,000 km	12 yrs	10 yrs/ 12,000 hrs/ 200,000 km
Hiab (Crane Truck)	20 yrs/ 10,000 hrs/ 200,000 km	250,000 km/ 12,000 hrs	16-19 yrs/ 15,000 hrs/ 200,000 km	8 yrs	15 yrs/ 12,000 hrs/ 200,000 km
Trailers	15 yrs	15 yrs	10 yr assessment/ replace or refurbish	15 yrs	15 Years
Tension Machine	12 yrs/ 10,000 engine hrs	15 yrs	10 yrs assessment/ replace or refurbish	15 yrs	10 yrs/ 10,000 hrs
Lift Trucks	15 yrs/ 10,000 hrs	15 yrs	15 yrs	15 yrs	15 yrs
Pole Trailer/ Flatbed	15 yrs/ 400,000 km	20 yrs	10 yr assessment/ replace or refurbish	15 yrs	10 yr replace or refurbish/ 15 yr replace
Enclosed Trailer	15 yrs	15 yrs	10 yr assessment/ replace or refurbish	15 yrs	15 yrs
Single Bucket	10 yrs/ 10,000 hrs/ 250,000 km	250,000 km/ 12,000 hrs	16-19 yrs/ 15,000hrs/ 200,000 km	8 yrs	15 yrs/ 12,000 hrs/ 225,000 km
Double Bucket	10 yrs/ 10,000 hrs/ 250,000 km	250,000 km/ 12,000 hrs	16-19 yrs/ 15,000hrs/ 200,000 km	12 yrs	15 yrs/ 12,000 hrs/ 225,000 km
Dumps		250,000 km/ 12,000 hrs.	16-19 yrs/ 15,000hrs/ 200,000 km	8 yrs	10 yrs/ 15,000 hrs/ 200,000 km

In the historical period, and particularly in 2016 and 2017, Alectra Utilities and its predecessor utilities deferred some fleet expenditures that would otherwise have been required to maintain the utilities' respective fleets. In this period, Alectra Utilities deferred all but the most critical fleet investments, in order to ensure and confirm that the replacements would not exceed the needs of the consolidated entity. It would likely have been imprudent for Alectra Utilities or its predecessors to invest in new vehicles if one of the other legacy utilities owned the vehicles necessary to meet the newly-formed utility's needs. Following the merger, some practices were harmonized, reducing the need to replace planned vehicles by legacy utilities during 2017 and 2018 as per Table A19 - 13 below.

Table A19 - 13: Vehicle Reductions Between 2017 and 2018 Summary ($MM)

Vehicle Reductions	Legacy Utility	2017	2018
Dump Truck Not Replaced	Central - South	$0.1	$0.0
Dump Truck Not Replaced	Central - South	$0.1	$0.0
Dump Truck Not Replaced	Central - South	$0.1	$0.0
Pickup Truck Not Replaced	Central - South	$0.1	$0.0
Three Engineering Vehicles Not Replaced	West	$0.1	$0.0
Vacuum Truck Not Replaced	Central - North	$0.5	$0.6
Total		**$1.0**	**$0.6**

4.3 Future Expenditures (2020-2024)

Forecast expenditures between 2020 and 2024 totals $48.8MM. This expenditure is needed to bring the utility's vehicle fleet to ensure vehicles are available and in condition necessary to support operations, reduce potential safety risks to employees and public, and to operate efficiently.

Table A19 - 14 provides the year-over-year breakdown in terms of units replaced and expenditures across the fleet vehicle categories. (This table is identical to Table A19 – 2 above).

Table A19 - 14: Planned Fleet Renewal Investment by Vehicle Type

Vehicle Type	2020		2021		2022		2023		2024		2019-2024 Total	
	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)	No.	CAPEX ($MM)
Heavy Duty Vehicles	8	3.5	15	6.8	14	5.7	12	6.3	10	5.3	59	27.6
Medium Duty Vehicles	12	1.6	11	1.2	9	1.6	6	1.0	7	2.0	45	7.4
Light Duty Vehicles	61	2.7	16	0.8	41	1.9	38	1.7	33	1.6	189	8.7
Equipment	6	0.9	3	0.5	3	0.6	9	0.8	9	0.9	30	3.7
Trailers	0	0.0	1	0.1	0	0.0	8	0.4	8	0.3	17	0.8
Shop Equipment and Tools	5	0.2	3	0.1	3	0.1	2	0.1	5	0.1	18	0.6
Total	**92**	**8.9**	**49**	**9.5**	**70**	**9.9**	**75**	**10.3**	**72**	**10.2**	**358**	**48.8**

Relative to the utility's needs, the planned fleet investments are conservative. To minimize the impact on ratepayers, Alectra Utilities has decided to spend less on Fleet Renewal during the DSP period than prescribed by its vehicle replacement criteria. As shown in Table A19 - 15, if Alectra Utilities were to strictly follow its vehicle replacement criteria, the current condition its fleet would result in expenditures of approximately $12.5MM per year throughout the DSP period.

Table A19 - 15: Vehicle Replacement Criteria vs. Proposed DSP Expenditures

Alectra Utilities Fleet Capital Expenditure ($MM)	2020	2021	2022	2023	2024	Total
Needs Determined Through Condition and Replacement Criteria	$12.8	$12.4	$12.8	$11.9	$13.2	$63.1
Proposed	$8.9	$9.5	$9.9	$10.3	$10.2	$48.8
Difference Between Needs and Proposed	**$3.9**	**$2.9**	**$2.9**	**$1.6**	**$3.0**	**$14.3**

4.4 Investment Pacing and Prioritization

When planning and executing Fleet Renewal investments, Alectra Utilities considers several factors as part of an ongoing screening process for fleet assets. To execute and sufficiently pace and prioritize the Fleet Renewal investment, Alectra Utilities implemented a first pass screening process which includes an assessment of the vehicle type, usage and age. At this time, the vehicles' mileage, engine hours, utilization, and Power Take Off ("PTO") hours are documented. This assessment provides Alectra Utilities a baseline to initiate the capital replacement assessment process. During this time, the vehicle utilization is also examined and internal discussions take place with various business units on the vehicle requirement. Alectra Utilities examines the possibility to re-allocate vehicles to maximize utilization as well as considers replacement options (e.g., like-for-like vehicle replacement or revision of vehicle to match evolved business requirements).[166]

Vehicle refurbishment is also considered, particularly for large and higher investment vehicles such as bucket, digger, and derrick trucks.

[166] Trucks and vehicles may be renewed by different models or types depending on updated operation processes, corporate initiatives and customer requirements.

4.5 Execution Approach

Once the vehicle replacements have been confirmed and approved, vehicles are sourced and purchased based on Alectra Utilities Procurement Policy and Processes. Alectra Utilities previously issued annually a Request for Proposal ("RFP"). The utility then would award purchases based on the RFP scope and selection criteria. Instead of annual procurements, Alectra Utilities will be issuing an RFP for its 2020 to 2024 vehicle replacements, working directly with vehicle manufactures to maximize its purchasing volume and obtain more favorable pricing and terms.

V Options Analysis

Alectra Utilities has considered the following intervention options concerning Fleet Renewal investments:

5.1 Status Quo / Run to Failure
5.2 Replacing Portions of Heavy-Duty Vehicles instead of full replacement
5.3 Replacing Medium- and Heavy-Duty Vehicles with Demonstration Vehicles Instead of New
5.4 Replacing Fleet Vehicles Based on Alectra Utilities Renewal Criteria

5.1 Status Quo / Run to Failure

Under the status quo option, Alectra Utilities would continue to utilize existing and deteriorating fleet vehicles, which will continue to expose Alectra Utilities employees as well as the general public to potential safety hazards should these vehicles fail and vehicle availability to support daily operations. Furthermore, system reliability will be impacted as Alectra Utilities crews risk prolonged transport to outage sites should trucks and vehicles fail to function.

As described in Section 4.5, Alectra Utilities uses an annual procurement process that maximizes economies of scale from planned procurement of fleet vehicles. Alectra Utilities planned approached to replacing its fleet, ensures vehicle specifications standardization, better pricing and plan for long delivery lead times on mid and heavy duty vehicles that could take up to 18 months to manufacture. In addition to the very serious safety risks associated with a run to failure approach, Alectra Utilities (and ratepayers) would lose some of the cost-efficiency that results from planned procurement.

5.2 Replacing Portions of Heavy-Duty Vehicles Instead of Full Replacement

Replacing portions of a heavy-duty vehicle is a viable option and one that predecessor and Alectra Utilities have exercised in the past with some success, and Alectra Utilities will continue to consider this as an option. The challenge with this option is the overall vehicle condition that may not make financial or operating sense, access and availability of material replacements and long waiting periods to get the vehicles back in service. Vehicle replacements need to be planned due to manufacturing scheduling, long delivery timeframes and obtain better pricing.

5.3 Replacing Medium- and Heavy-Duty Vehicles with Demonstration Vehicles Instead of New

Replacing medium- and heavy-duty vehicles with demonstration models instead of new vehicles would theoretically help mitigate the cost of needed Fleet Renewal investments. However, it is difficult to locate demonstration vehicles that meet the operational criteria.

Alectra Utilities cannot rely on this approach, since the availability and quality of demonstration vehicles cannot be planned or depended upon. Further, in the event that Alectra Utilities can locate a satisfactory demonstration vehicle that is available for purchase, the utility does not believe that a sufficient volume will be available to address its needs. Alectra Utilities rejected this approach because it would be imprudent and unrealistic to rely on the availability of demonstration vehicles.

5.4 Replacing Fleet Vehicles Based on Alectra Utilities Renewal Criteria

Alectra Utilities' planned investments are based on the level prescribed by the criteria described in Section 2 above. As described in Section 4.3, Alectra Utilities has proposed to spend less on Fleet Renewal during the DSP period than prescribed by its vehicle replacement criteria.

Alectra Utilities believes that the level of Fleet Renewal investment in the DSP is the minimum needed to mitigate the risks posed by the current condition of the utility's fleet.

Table A19 - 16 outlines the risk levels concerning probability and impact, based upon the current condition and performance of the fleet population, as well as the necessary actions needed to mitigate these risks. Based on this analysis, it is necessary for Alectra Utilities to execute the investment as proposed over the DSP period.

Table A19 - 16: Risks for Not Replacing Vehicles Based on the Replacement Criteria

Risk	Probability (High/Med/ Low)	Impact (High/Med/ Low)	Expected Outcomes
Vehicle availability and reliability	High	High	Deteriorated vehicles cannot perform well, required more frequent repair and maintenance spend more time in the shop or down for long period of time, reducing the number of vehicles availability and reliability to support customers.
Employee and public safety	High	Med	Vehicles in poor condition create potential safety risks for employees and the public. Additional resources and operating expenditures are required to keep such vehicles operational.
Increasing systems outages response timelines to support customers	High	High	Vehicle down time due to required repairs and increased maintenance may limit Alectra Utilities' ability support customers and could increase the duration of system outrages.

VI Investment Projects

There are no material projects and initiatives for Fleet Renewal from 2020 to 2024.