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DURHAM REGION

The Regional Municipality of Durham Report

To: Committee of the Whole
From: Chief Administrative Officer
Report: #2023-COW-14
Date: April 12, 2023

Subject:

2023 Annual Corporate Climate Action Plan Update Report & Light Duty Fleet Electrification Plan

Recommendation:

That the Committee of the Whole recommends to Regional Council:

A) That Council receive the 2021 corporate greenhouse gas footprint update and forecast showing a projected eight per cent reduction by 2025 and a 17 per cent reduction by 2030 (as compared to a 20 and 40 per cent reduction target over 2019 levels, respectively) for information;

B) That the Durham Region Light Duty Fleet Electrification Plan, as presented in this report, and included as Attachment #1, be endorsed in principle including the following preliminary target years for 100 per cent light duty vehicle electrification by fleet group:
   i) Public Works – 2032
   ii) Paramedics Services – 2030
   iii) Police Services – 2042
   iv) Transit - 2032

C) That the Council-endorsed light duty fleet electrification road maps for each fleet group be referred to Departments for consideration, including further assessment of technical and financial feasibility of options as part of the 2024 and future business planning and budget cycles; and

D) That Regional staff be directed to report annually on progress made in the implementation of the proposed light duty fleet electrification roadmaps through the Corporate Climate Action Plan Update Report.

Report:

1. Purpose

1.1 This report provides an update on the implementation of the Durham Region Corporate Climate Action Plan (CCAP). Specifically, this report will provide:

a. an overview of the corporate climate governance and management framework;

b. a corporate greenhouse gas (GHG) inventory update and forecast to 2025 and 2030 relative to Council approved interim targets;

c. a summary of 2022 accomplishments by operating area and priority initiatives planned for implementation between now and 2030; and

d. next steps to scale-up corporate climate action and close the gap between forecasted emissions and approved targets.

1.2 In relation to Section 1.1d, this report also details a Light Duty Fleet Electrification Plan for the existing fleet stock that is designed to help further close the gap between forecast corporate GHG emissions and Council-endorsed targets. The objectives of this Plan are to:

a. provide a recommended light duty vehicle (LDV) fleet electrification roadmap for each of the Region's four fleet groups' existing fleet to make a meaningful contribution to achieving overall corporate GHG targets in a cost-effective manner;

b. ensure that LDV electric vehicle (EV) options considered for each fleet group can meet existing operational requirements; and

c. identify the required EV charging infrastructure required to support LDV Fleet electrification needs to ensure availability and reliability of the fleet.

1.3 Given the proposed Plan considers levels of service, lifecycle management of vehicles and proposed mitigation approaches to climate change, including GHG emission reduction goals and targets, as a high-level asset management planning road map, the Plan assists with aligning with municipal asset management planning legislation and the Region's Corporate Strategic Asset Management Policy.

2. Background, Previous Reports, and Decisions

2.1 In early 2020, Regional Council declared a climate emergency, joining local area municipal councils in Pickering, Ajax, Whitby, Oshawa, Clarington, and Brock ("local Councils") and more than 600 other Canadian municipalities. Through these declarations Regional and local councils have accepted that urgent action is required to transition Durham Region towards a low carbon and climate resilient future, and that municipalities have a key leadership role to play. The Region and most local area municipalities have established corporate (i.e., covering municipal and agency operations) and community-level GHG reduction targets that range from 80 per cent to 100 per cent (i.e., net zero) by 2050.

2.2 In February 2020, through Notice of Motion 9.1, Council directed staff to develop a Low Carbon Fleet Strategy to guide fleet conversion and implementation of related facility and infrastructure upgrades.

2.3 Regional Council subsequently endorsed a Corporate Climate Action Plan (CCAP) in March 2021, through Report #2021-A-3 which:

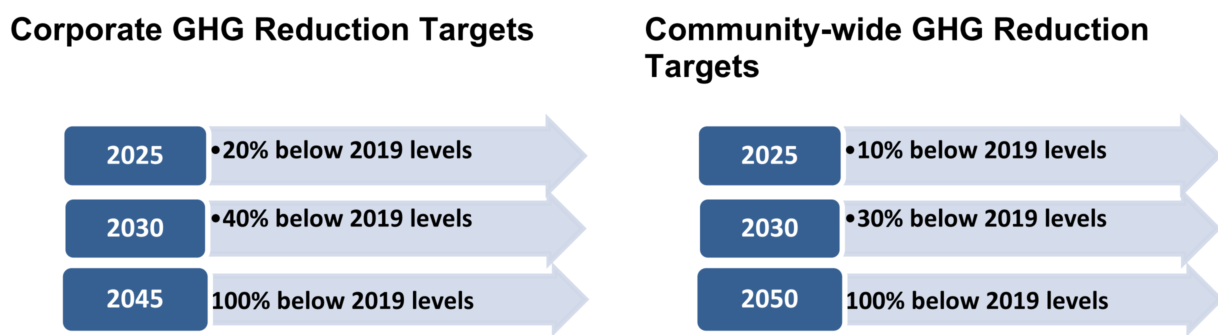
a. established corporate and community-wide GHG targets, as shown in Figure 1, below;

b. developed a carbon budget management framework to embed consideration of climate change within the business planning and budget processes;

c. created an annual monitoring and reporting process for corporate climate action, of which this report is an integral part; and

d. included direction to prioritize low carbon solutions for the Region's fleets and established a goal of moving towards 75 per cent of annual average unmodified LDV purchases being zero carbon or hybrid between 2022-2025, and 100 per cent between 2026-2030.

Figure 1: Corporate and Community-wide GHG Targets



2.4 In February 2022, Regional Staff provided Council with the first annual update on implementation of the CCAP (Report #2022-COW-3). This report identified accelerated zero-carbon fleet transitions as a key opportunity to close the gap between forecasted corporate GHG emissions, and Council-endorsed GHG reduction targets.

2.5 In June 2022 Council adopted Report #2022-F-16 – E-Mission Zero – DRT Fleet Electrification Plan which referred the plan to Transit's long-term Strategy. The Plan outlines how DRT will transition its bus fleet to zero-emission technologies by 2037. The Region's ten-year servicing and financing strategy incorporates a multi-year phase in for zero emission bus fleet. In February 2023, Regional Council approved Report #2023-F-5 Transit Service and Financing Strategy (2023 – 2032) which incorporates the next ten-years of DRT's transition towards a zero-emission bus fleet.

3. Corporate Climate Governance and Management Framework

3.1 Staff have identified four key long-term corporate climate outcomes, namely:

a. Risks to Regional infrastructure from climate impacts have been identified and mitigated through asset management, capital, and operational planning;

b. Fossil fuel use has been largely eliminated in corporate operations;

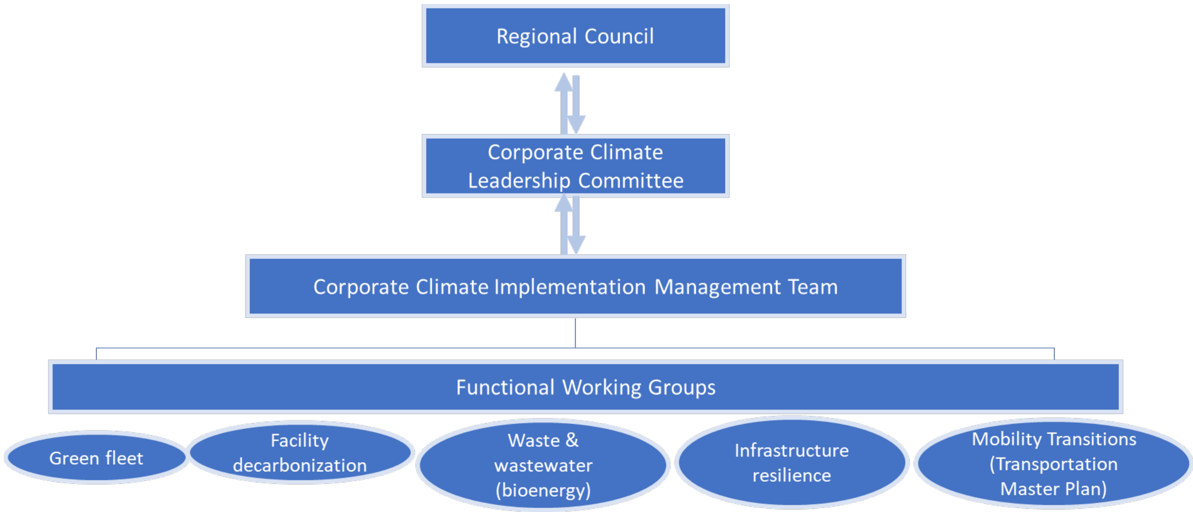
c. Non-energy emissions from Regional wastewater and waste management operations have been minimized; and

d. Transportation and transit infrastructure have been built to enable a decline in vehicular mode share, increase in the share of trips taken by active transportation and public transit, supported by compact and energy efficient urban development.

3.2 The carbon budget management framework, which is outlined in the CCAP, and operationalized through the annual Business Planning and Budget processes, serves to help decision-makers across departments and Regional Council understand the influence of operational and capital plans and budgets in terms of alignment with the long-term corporate climate outcomes listed above. Through a system of reporting and accountability linked to existing budget processes, the Region can demonstrate corporate leadership to the community-wide carbon transition and provide guidance and support to other organizations across the Region – both public and private sector – on their respective decarbonization journeys.

3.3 As outlined in Figure 2 below, staff are working to formalize a corporate climate governance and management structure to build a clearer line of accountability from Regional Council through to senior leadership, management, and operational staff. This framework will enable cross-departmental coordination, communication, and support for monitoring and reporting processes while enabling more collaborative projects and implementation. Working collaboratively through interdepartmental engagement enables portfolio-wide plans that mainstream GHG reductions into project planning.

Figure 2: Corporate Climate Governance and Management Framework



3.4 The Corporate Climate Leadership Committee, consisting of Commissioner and Director level staff, meet quarterly to provide interdepartmental leadership, oversight, and direction. The Corporate Climate Implementation Management Team will be led by the CAO's Office sustainability staff and consists of management-level staff from across key departments to provide strategic, technical, and financial support for development and implementation of corporate initiatives through a set of functional groups. Functional Working Groups will provide subject specific input to develop and accelerate transition plans, consult, and collaborate with inter-municipal working groups, while providing regular reports to the Implementation Management Team.

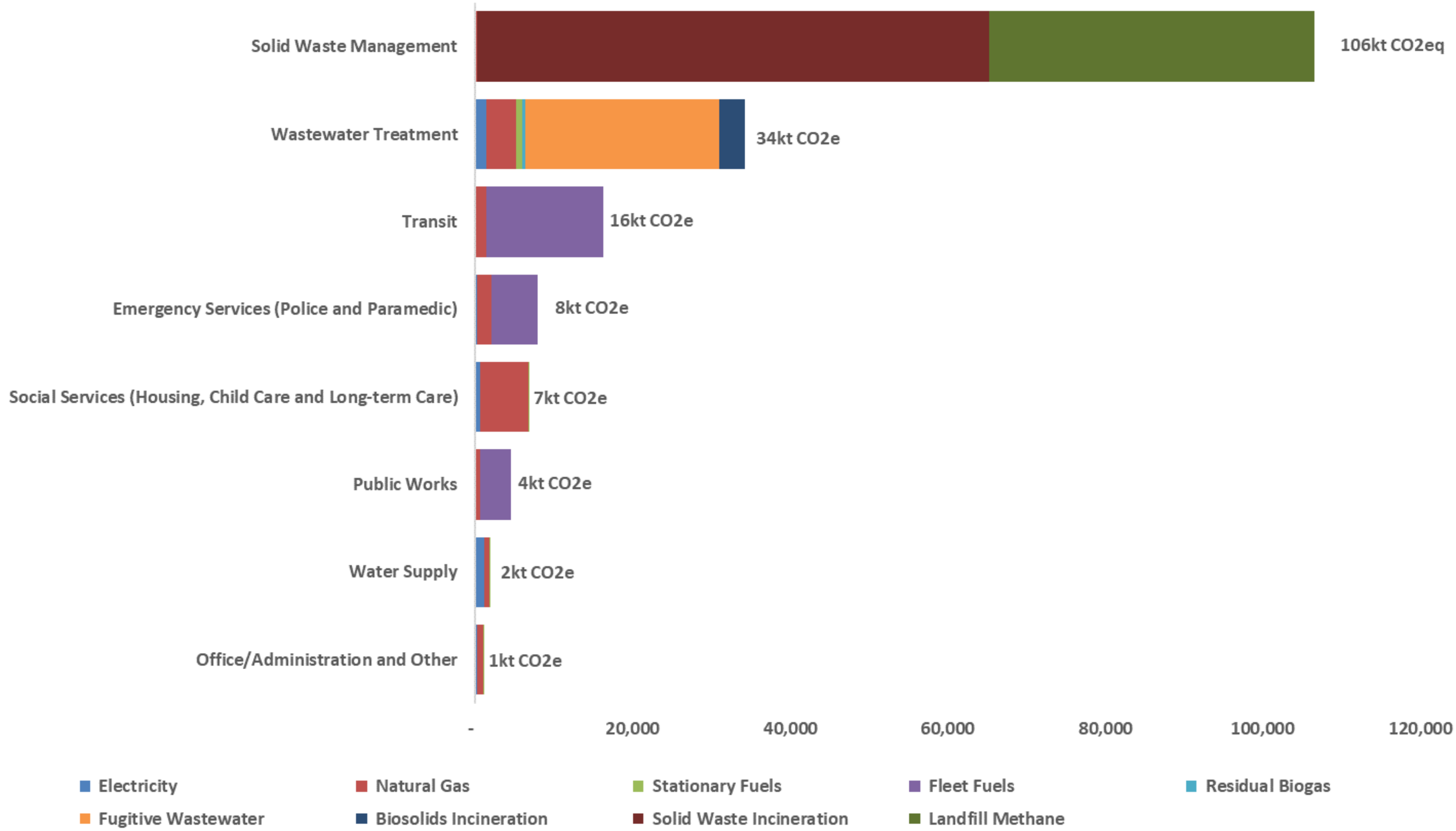
4. 2021 Corporate GHG Emissions Footprint

4.1 Durham Region's corporate emissions are calculated annually based on energy used in all owned and leased Regionally operated buildings (e.g., offices, long-term care homes, social housing, etc.), corporate fleet vehicles, water supply and sanitary sewerage treatment and distribution facilities, and traffic signals, among other operations. The inventory also includes non-energy GHG emissions associated with the Region's solid waste and wastewater management operations. The annual footprint is typically available by the second quarter of the following year (i.e., 2022 corporate GHG data will be compiled and validated towards the end of June 2023). Staff will provide Council with an update on 2022 corporate GHG emissions in the third quarter of 2023.

4.2 In 2021, corporate emissions were approximately 179,100 tonnes carbon dioxide equivalent (tCO2e, rounded), which is estimated to represent approximately three per cent of community-based emissions in Durham Region. Durham Region has one of the largest total corporate GHG footprints relating to operating activities within the boundaries of Durham Region, due largely to its role in delivering solid waste management and wastewater treatment services to the community.

4.3 Figure 3 below provides a breakdown of total 2021 corporate GHG emissions by operating area. The Figure shows the large portion of corporate GHG emissions related to solid waste management. Solid waste management emissions are almost entirely unrelated to energy consumption. The same holds true for GHG emissions from wastewater treatment operations, which largely consist of non-energy related emissions associated with treatment plant operations. In all other corporate operating areas, GHG emissions are largely associated with fossil fuel consumption in fleets (gasoline and diesel in vehicles) and facilities (natural gas for space and water heating in buildings).

Figure 3: 2021 Total Corporate GHG Footprint by Operating Area



Note: Totals may not add up due to rounding of numbers.

5. Corporate GHG Emissions Forecast to 2025 and 2030

5.1 The annual corporate GHG footprint is compared to the Region's 2019 baseline GHG footprint to evaluate the current state of progress towards Council endorsed GHG reduction targets for 2025 and 2030. Regional staff also develop a forecast of future corporate GHG emissions relative to Council-endorsed emissions reduction targets. This forecast is developed based on information provided by departments as part of the Region's annual business planning and budget process, which includes updates to the Region's five-year operating and 10-year capital budget forecast. The review of future initiatives is limited to only those that have quantifiable GHG emissions data available. Staff will continue to work to improve GHG emission quantification in the 5-year operating and 10-year capital plans as well as collaborating with project managers and key staff on carbon accounting and forecasting at the project-level.

5.2 Corporate emissions have decreased marginally from 2019 to 2021 (i.e., approximately two per cent) where corporate GHG emissions in 2021 continued to reflect the Region's COVID-19 response. The Durham York Energy Centre (DYEC) continued to experience increased volumes of residential waste associated with more people working from home and modified school and workplace operations as well as an increase in observed single-use plastics. Managing this increase in waste volume contributed to the higher-than-historical GHG emissions at DYEC in 2021. COVID-19 related operational changes and resultant GHG emission impacts were also seen in other areas, namely in Durham Region Transit (DRT) service modifications which reduced fleet fuel consumption.

5.3 Figure 4 below compares 2021 actual GHG data to the 2019 baseline as well as the forecasted 2025 and 2030 emissions levels both for total corporate GHG emissions, as well as a breakdown of data for energy-related emissions and non-energy related emissions (e.g., waste and wastewater management).

5.4 Based on the current carbon forecast in Figure 4, total corporate emissions are projected to be eight per cent below 2019 levels by 2025 (versus an approved target of 20 per cent) and 17 per cent below 2019 levels by 2030 (versus the target of 40 per cent reduction). When assessing corporate energy related GHG emissions only, the Region is much closer to aligning with the 2025 and 2030 targets, with the forecast showing a 13 per cent and 27 per cent GHG reduction for each respective target year.

The gap between forecasted corporate GHG emissions, and Council-endorsed targets has increased from last year's Council update report due in large part to delayed implementation of a long-term organics management solution (see Report 2022-COW-22).

Figure 4: 2019 Baseline and 2021 Actual GHGs by Sector and Interim Forecast Values

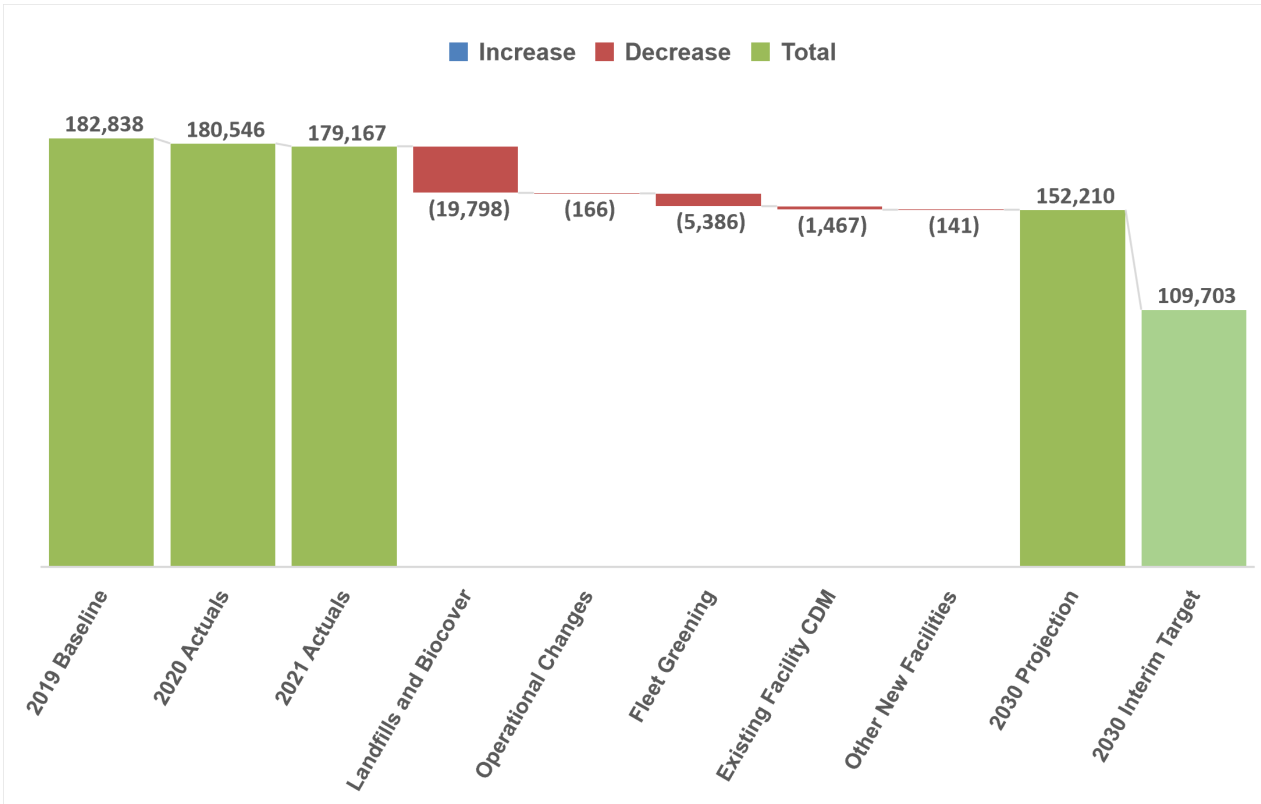
Sector	2019 Baseline	2021 Actuals	2025 Forecast	2030 Forecast
Energy Consumption				
Regional Facilities and Infrastructure Energy Emissions	21,900	20,400	19,000	18,700
% change in Regional Facilities and Infrastructure Energy Emissions from 2019 Baseline		-7%	-13%	-15%
Regional Fleet Energy Emissions	30,300	24,600	26,300	19,200
% change in Regional Fleet Energy Emissions from 2019 Baseline		-19%	-13%	-37%
Total Corporate Energy-related GHG Emissions	52,200	45,000	45,300	37,900
% change in Corporate Energy-related GHG Emissions from 2019 Baseline		-14%	-13%	-27%
Non-energy related GHG Emissions				
Solid Waste Management Non-energy emissions	103,800	106,300	95,800	86,600
Water and Wastewater Non-energy emissions	26,800	27,800	27,800	27,800
Total Corporate Non-energy related GHG Emissions	130,600	134,100	123,600	114,400
% change in Corporate Non-energy related GHG Emissions from 2019 Baseline		3%	-5%	-12%
Total Corporate GHG Emissions	182,800	179,100	168,900	152,300
% change in Total Corporate GHG Emissions from 2019 Baseline		-2%	-8%	-17%

Notes:

- GHG emission values subject to change through annual updates by way of improvements to data, refined quantification approaches and updates to emission intensity factors. As such, the baseline 2019 values presented in Figure 4 varies from the baseline values presented in the original CCAP.
- Values may not add due to rounding. Given inherent uncertainty of future DYEC operations with proposed changes to contracted Green Bin program and potential future MWP/AD facility, future values assumed as flatlined from 2019 values. Forecast values for wastewater fugitive emissions, as well as biogas combustion/flare and Duffin Creek WPCP assumed as flatlined from 2019 values.

5.5 Figure 5 shows a breakdown of the corporate GHG emission reduction forecast to 2030 by major initiative and demonstrates that the most significant reductions are expected to come from the Region's closed landfills (see Section 6.3 below), the transition to electric buses in the DRT fleet (see Section 6.7 below), and deep energy retrofits of existing facilities (see Section 6.10 below).

Figure 5: Corporate 2030 GHG Reduction Forecasts vs. Interim 2030 Target (tCO2e/year)2



6. Corporate Updates by Asset Class/Operating area

Waste Management

6.1 This source of GHG emissions is related to the management of residential solid waste on behalf of a growing region of more than 200,000 households. In 2021, reported corporate emissions relating to solid waste management equalled approximately 106,300 tCO_2e (rounded) or 59 per cent of total corporate emissions, down almost 1,700 tCO_2e from 2020 primarily due to a decrease in estimated methane production at the Region's closed legacy landfills.

6.2 As noted in Report #2021-A-3 – Attachment 4, energy from waste operations avoids greater GHG emissions that would have been emitted if this same waste had been trucked to the landfill that had previously been used for waste disposal.

6.3 The Region continues to be a leader in waste diversion among urban regional municipalities with a waste diversion rate of 63 per cent in 2021, unofficially ranking first among urban regional municipalities in Ontario. This is further validated by The Atmospheric Fund's 2019-2020 Carbon Emissions Inventory for the Greater Toronto and Hamilton Area; Durham Region's waste sector emissions are amongst the lowest as a portion of total community-wide emissions compared to municipal peers. The Region's solid waste management represents an example of strong corporate climate leadership.

6.4 Avoided GHG emissions associated with waste diversion programs (e.g., Blue Box recycling, green bin organics composting, and mixed electronics disposal) are not directly reflected in the corporate inventory, as they result in GHG emissions reductions for the broader community.

6.5 As detailed in Council Report #2022-COW-22, the procurement process for the Mixed-Waste Pre-Sort and Anaerobic Digestion facility was cancelled. Works Committee Report #2023-WR-03 notes that anaerobic digestion remains the preferred organics waste management option moving forward. Given the uncertainty associated with this planned facility, projected GHG emissions reductions associated with renewable natural gas (RNG) production have been removed from the corporate carbon forecast. Regional staff continue to explore this opportunity in the context of business plan development for the new facility and other regional facilities (e.g., wastewater treatment facilities) which may be capable of producing RNG. In addition, in early-2023 the Region completed a non-binding Request-for-Information (RFI) to solicit information regarding potential direct RNG procurement opportunities that would allow the Region to transact RNG for use within its managed natural gas program. Such opportunities will continue to be assessed to determine potential resultant GHG reduction impacts, administrative requirements, and resultant program budget impacts.

6.6 A feasibility study for the Oshawa Landfill Biocover Pilot was completed in 2022. Based on positive findings, the project is scheduled to commence construction in the second quarter of 2023. The project will install a soil/compost layer on top of the existing landfill to reduce fugitive methane emissions. Preliminary estimates indicate up to a 50 per cent reduction in methane emissions is possible. If successful, this approach could be applied to other closed landfill sites under the Region's control, where appropriate, and significantly reduce methane emissions from closed landfill sites.

6.7 As outlined in Report #2022-INFO-55 Regional Staff are exploring the feasibility of implementing a district energy system in Courtice that would utilize surplus heat from Regional facilities in the Courtice Energy Park (e.g., DYEC and the Courtice Water Pollution Control Plant) to supply new development anticipated in the Energy Park and Courtice Major Transit Station Area (MTSA). This work responds to commitments made under the DYEC Host Community Agreement signed in 2010 to "encourage and promote development within the Clarington Energy Business Park and other areas of Clarington to utilize district heating and cooling provided by the energy-from-waste Facility." If the feasibility study demonstrates potential for a district energy system, there may be opportunities to generate environmental attributes associated with the energy transfer that could help to reduce or offset GHG emissions from DYEC operations over the longer-term.

Water and Wastewater

6.8 This source of emissions is related to the treatment, storage, and pumping of drinking water and wastewater for the benefit of residents, businesses, and institutions across the Region. Combined, water and wastewater (including estimated net Durham share of Duffin Creek Water Pollution Control Plant) are the largest sources of corporate energy consumption and, in 2021, produced approximately 36,100 tCO_2e (rounded) or 20 per cent of total corporate emissions. These emissions are largely related to wastewater treatment at approximately 19 per cent of corporate emissions, which includes non-energy GHG emissions, with the remaining one per cent related to drinking water treatment and distribution.

6.9 Energy management programs and replacing equipment with more energy efficient models have limited the growth of emissions. Future potential initiatives under consideration include biogas optimization strategies and sewer heat recovery potential. The Water and Wastewater GHG Management Strategy, anticipated for completion in late-2023, will define long-term GHG targets and reduction strategies for the Region's water and wastewater systems. Initiatives identified through this strategy will be brought forward to Council as part of the annual Business Planning and Budget processes.

Fleet

6.10 Regional Fleet makes up 14 per cent of overall corporate emissions, but more than half of energy related emissions. With transportation also representing the largest share of community wide emissions, action by the Region to reduce its fleet related GHG emissions can serve as a leadership example for other public and private sector organizations to follow. However, Regional investment to enhance public transit service can increase corporate GHG emissions in absolute terms while significantly reducing community-based emissions (e.g., growth of fleet).

6.11 Report #2022-DRT-10 – E-Mission Zero – DRT Fleet Electrification Plan was reviewed by Council in June 2022 and referred to DRT's Servicing and Financing Strategy (Report #2023-F-5) which incorporated DRT's transition to a zero-fleet into its 10-year plan. The Plan outlines how DRT will transition its revenue and non-revenue fleet to zero-emission technologies by 2037, transitioning to procuring only electric buses starting in 2024. The Plan incorporates a multi-year phase in for zero emission bus fleet and associated infrastructure as part of the long-term servicing and financing strategy.

6.12 Electrification of the Region's LDV fleets (namely Region of Durham Paramedic Services (Paramedics), Durham Region Police Services (Police), Durham Region Transit (Transit or DRT), and Works) represents a key opportunity to further close the gap between forecasted GHG emissions and interim targets for 2025 and 2030. LDV models suitable for the Region's fleet groups are available, or soon forthcoming from major manufacturers, and the lifecycle costs of electric vehicles compared to internal combustion vehicles are becoming increasingly favourable. In 2022, Regional staff across the four fleet groups initiated development of a Light Duty Fleet Electrification Plan.

6.13 The Plan, included as Attachment #1 to this report, provides a high level strategy for transitioning the Region's light duty vehicle fleets to low and zero carbon options. It was developed with the support of Dunsky Energy Consulting (Dunsky), and in close cooperation with fleet managers for each of the Region's four fleet groups (Paramedics, Police, Transit, and Works). The scope of the Plan focuses on the existing fleet stock and includes more than 400 owned and leased vehicles across the four fleet groups, including the following vehicle types:

a. Sedans;

b. Minivans;

c. SUVs;

d. Pick-up trucks (up to ½-ton); and

e. Compact cargo vans.

6.14 The Plan does not include medium and heavy duty vehicles, or vehicles owned and operated by private companies who contract with the Region. Strategies related to LDV fleet expansion are not included in the Plan nor are potential electricity distribution system upgrades which will require further site-specific assessments to determine potential upgrade requirements and associated costs relating to distribution-level connectivity.

6.15 The Plan includes consideration of battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). BEVs are "pure" electric vehicles that only have an electric powertrain, whereas PHEVs plug in to charge and operate in electric mode for short distances (e.g., 30 to 80 kilometres), but also include a combustion powertrain for longer trips. (e.g., Chevrolet Volt, Toyota Prius Prime). The Plan does not include consideration of hybrid-electric vehicles (i.e., ones that do not plug-in to charge) nor hydrogen fuel cell electric vehicles, for which the market availability of vehicles is small within the timeframe of the Plan.

6.16 Dunsky utilized a fleet electrification optimization model to develop a roadmap for acquisition of replacement LDVs that considers:

a. imposed target years for full electrification;

b. barriers to electrification that stem from operational considerations;

c. BEV and PHEV model availability from major automobile manufacturers;

d. price forecasts for internal combustion engine vehicles (ICEVs), BEVs, and PHEVs from 2022 to 2040 for all vehicle segments; and

e. total cost of ownership including upfront capital costs, maintenance, fuel, and electricity costs, as well as carbon pricing.

6.17 The fleet electrification roadmaps were developed in cooperation with each fleet group to determine the optimal year for vehicle replacement based on vehicle total cost of ownership within the constraints of operational requirements. Although the lifecycle costs of vehicle ownership have been considered, the roadmaps and LDV transition targets of this report do not strictly minimize the Region's total cost of vehicle ownership. In some instances, vehicles are proposed for replacement with a BEV or PHEV option in advance of when current business case analysis would dictate, in order to achieve full fleet transitions according to staff-recommended targets.

6.18 The outcomes included matching EV uptake to specific needs, optimizing replacement schedules to meet financial and GHG objectives, and defining optimal charging equipment needs. The Plan identifies target years for 100 per cent electrification for LDVs in each of the four fleet groups, as outlined in Figure 6 below:

Figure 6: Fleet Electrification Scenarios

Fleet Group	Target Year for 100 per cent LDV Electrification	Notes
Works	2032	• Total of 107 LDVs currently • A total of 113 EV charging stations are expected to be required to support transition
Paramedics	2030	• Total of 13 LDVs currently • 14 EV charging stations are expected to be required to support transition
Police	2042	• Total of 294 LDVs currently • Operational requirements dictate an extended transition timeline than other fleet groups • Level 3 fast chargers will be required which have implications for facility design and electricity grid infrastructure and thus necessitates longer transition period
Transit	2032	• Total of 12 LDVs currently • 12 level 2 EV charging stations are expected to be required to support transition

6.19 The Region has been successful in securing several rounds of federal government funding for EV charging stations in collaboration with local area municipalities and other entities through the Zero Emission Vehicle Infrastructure Program (ZEVIP). With successful ZEVIP funding submissions to Natural Resources Canada (NRCan) through multiple rounds of program funding streams to support public, workplace, multi-unit residential building and/or light duty charging activities, the Region has already secured $200,000 to support the successful installation of 40 Level 2 charging stations across Regional facilities. Subject to favorable response for additional submissions made by the Region to NRCan, the Region may secure up to $1.34 million in added grant funding to support the implementation of an additional 77 Level 2 chargers and 18 Level 3 chargers across regional sites. Regional staff will continue to seek senior government funding to support the installation of EV charging infrastructure that will be required to support the implementation of this plan.

Regional Facilities

6.20 Regional buildings make up a relatively small share of overall corporate emissions (less than 10 per cent), but more than a quarter of energy related emissions. With buildings representing a much larger share of community-wide emissions (second only to transportation), Regional action to reduce its building related GHG emissions can serve as a leadership example for other public and private sector building owners to follow.

6.21 The Design, Construction and Asset Management (DCAM) group manages capital projects for Regional buildings across departments – both new construction and renovations. Work continues on the deep energy retrofits at DRLHC's King Charles Court property located at 155 King St. E. in Oshawa. Planning work for deep energy retrofits at 101 Consumers Drive in Whitby, as well as within the DRLHC senior's building portfolio (850 Green St. and 315 Colborne St. in Whitby, 655 Harwood Ave. in Ajax, and 1910 Faylee Cres in Pickering) is advancing. As communicated to Council in Report #2021-COW-35 it is expected that the DRLHC deep energy retrofits will be supported by significant external grant funding, such as through the Federation of Canadian Municipalities' (FCM) Sustainable Affordable Housing (SAH) program. Staff anticipate bringing an updated financial plan that includes potential FCM SAH funding forward to Council for approval later in 2023.

6.22 The DCAM group is also managing several major new construction projects that are designed to high levels of energy and GHG emissions performance. This includes several DRT Transit Facilities, Beaverton Supportive Housing, Clarington Police Complex Phase 2, Seaton Long-Term Care facility and the Region of Durham Paramedic Services (RDPS) Seaton facility, among others.

6.23 As presented in Report #2023-COW-18, the new Durham Standard will provide direction for low carbon new development and retrofits of Regional facilities. This standard will provide a framework for decision-making in terms of sustainability and resilience, space optimization, accessibility/inclusivity for facility-based capital projects with quantifiable outcomes.

6.24 As approved by Council through the recommendations presented in Report #2021-F-31, DCAM has initiated comprehensive energy audits across Regional facilities. This analysis will determine the measures recommended for each facility portfolio and provide the basis for the development of the GHG reduction plan and pathway for Regional buildings. The actions coming from this plan will be brought forward for consideration in future Business Plans and Budgets, prioritized by both reductions achieved and state of good repair needs.

7. Financial Implications

7.1 Financing for initiatives recommended in these plans will be requested through the annual Business Planning and Budget processes. Staff will continue to explore opportunities to leverage external funding from senior levels of government, the Independent Electricity System Operator (IESO), local utilities and other entities.

8. Conclusion

8.1 This report provides an update on progress with implementation of the CCAP, including a GHG emissions forecast for 2025 and 2030 by operating area. The report identifies key challenges, opportunities, and next steps to better align the corporate emissions forecast with Council approved GHG reduction targets.

8.2 Based on projects that are budgeted or included in the 10-year capital plan, staff are currently projecting an eight per cent reduction from the 2019 baseline by 2025 and a 17 per cent reduction by 2030. These reductions are largely attributable to the planned landfill biocover at the closed Oshawa landfill and DRT bus fleet electrification. There remains a large gap between forecasted corporate GHG emissions, and Council-endorsed targets. However, the forecasted gap is considerably smaller when looking at corporate GHG emissions related to energy consumption in facilities and fleet (forecasting a 27 per cent reduction versus the 2019 baseline, as compared to the 40 per cent target).

8.3 Several departments are developing portfolio-wide decarbonization plans for assets within their portfolio of responsibility, namely the DRT Fleet Electrification Plan adopted by Council in 2022; the Water and Wastewater Greenhouse Gas Emission Management Strategy that is currently in development, the Durham Standard that will be presented to Council in April 2023; and the Long-Term Waste Management Plan approved by Regional Council in 2022.

8.4 All four fleet groups can contribute to fast and notable GHG emissions reduction in support of the Region’s target of 40 per cent reduction in GHG emission by 2030 and 100 per cent by 2045, relative to the 2019 baseline. The Light Duty Fleet Electrification Plan that is included in this report for endorsement in principle shows that Works, Paramedics, and Transit may be able to cost-effectively transition to 100 per cent electric light duty vehicles as early as 2030 to 2032. Although the transition is slightly delayed for Police due in part to the number of Level 3 charger requirements, this is expected to be possible by the early 2040's. Further assessment of technical and financial feasibility of options will be undertaken as part of the 2024 and future business planning and budget cycles, including further in-depth assessments of distribution system and facility level impacts and costs.

8.5 The results of each of these Plans will be reflected in future updates to the corporate carbon forecast as the data becomes available.

8.6 This report has been reviewed by staff in Works, Finance, Social Services, Transit, DRPS, and RDPS and approved by Sandra Austin, Executive Director, Strategic Initiatives, 905-668-7711, extension 2449.

8.7 For additional information, contact: Ian McVey, Manager, Sustainability, at 905-668-7711, extension 3803.

9. Relationship to Strategic Plan

9.1 This report aligns with the following strategic goals and priorities in the Durham Region Strategic Plan:

- Goal #1 – Environmental Sustainability

  a. Accelerate the adoption of green technologies and clean energy solutions through strategic partnerships and investment; and
  b. Demonstrate leadership in sustainability and addressing climate change.

10. Attachment

Attachment #1: Durham Region Light Duty Fleet Electrification Plan

Respectfully submitted,

Original signed by

Sandra Austin
Executive Director, Strategic Initiatives

Original signed by

Elaine C. Baxter-Trahair
Chief Administrative Officer

Attachment 1

DURHAM REGION

Durham Region Light-Duty Fleet Electrification Plan

March 2023

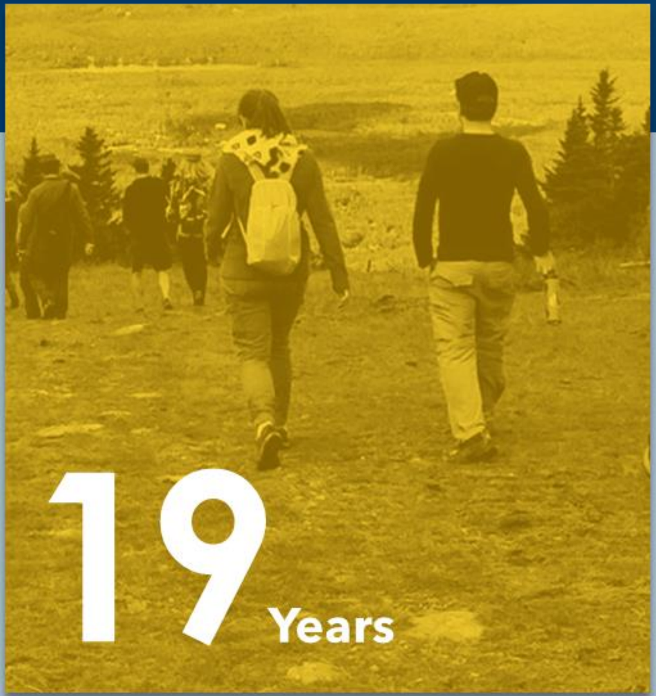
dunsky Energy + Climate

dunsky
Energy + Climate

ACCELERATING THE CLEAN ENERGY TRANSITION

ANALYSIS + STRATEGY

BUILDINGS | MOBILITY | INDUSTRY | ENERGY



dunsky
Energy + Climate

ACCELERATING THE CLEAN ENERGY TRANSITION

ANALYSIS + STRATEGY

BUILDINGS | MOBILITY | INDUSTRY | ENERGY

GOVERNMENTS | UTILITIES | CORPORATE + NON-PROFIT

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LEAD ANALYST

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SENIOR TECHNICAL ADVISOR

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List of Acronyms and Abbreviations

BEV	Battery Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
ICEV	Internal Combustion Engine Vehicle
HEV	Hybrid Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
TCO	Total Cost of Ownership
GHG	Greenhouse Gas
LDV	Light-Duty Vehicle
DRPS	Durham Region Police Service
RDPS	Region of Durham Paramedics Services
SUVs	Sports Utility Vehicles
EV	Electric Vehicle
E-FLEET	Dunsky's Fleet Electrification Model
IRR	Internal Rate of Return
ROI	Return on Investment
L2	Level 2
DCFC	Direct Current Fast Charger
ZEVIP	Zero-Emission Vehicle Infrastructure Program
EVSE	Electric Vehicle Supply Equipment
EVEMS	Electric Vehicle Energy Management System
CAPEX	Capital Expenditures
OPEX	Operational Expenditures

1. Introduction

Background and Objectives

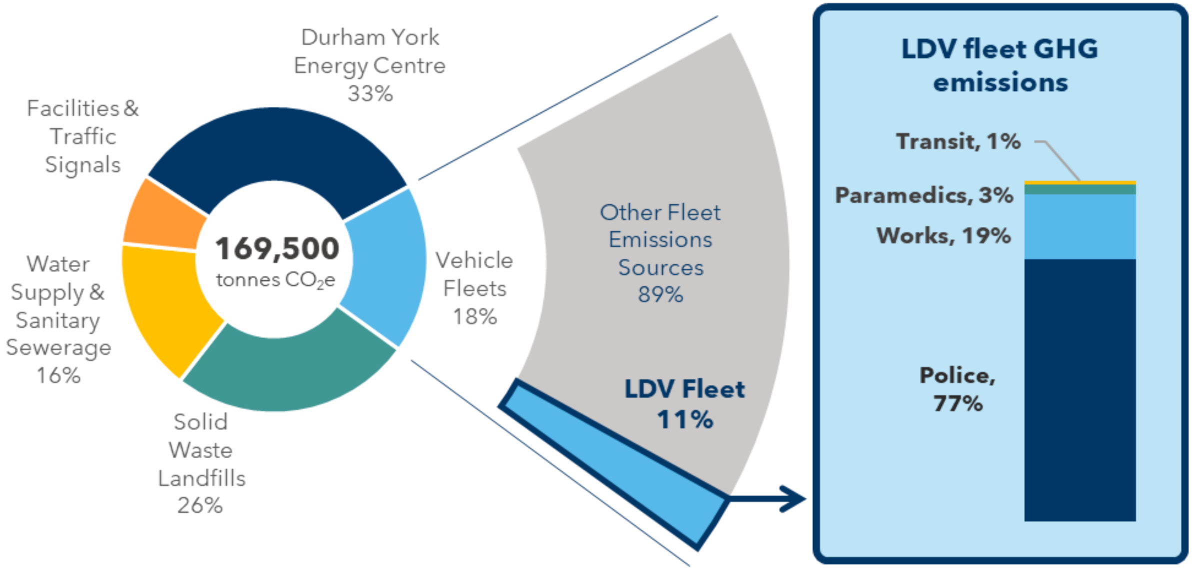
Background

- Durham Regional Municipality has committed to **net-zero greenhouse gas (GHG) emissions by 2045**, as well as the following interim targets:
  - 2025: 20% below 2019 levels
  - 2030: 40% below 2019 levels
- In support of this goal, the Region is interested in determining how to better align the 10-year light-duty vehicle (LDV) **replacement cycle** of its **four fleet groups** with this target
- Currently, the Region's vehicle fleets contribute to **18%** of total corporate GHG emissions

Objectives

- Dunsky was retained by Durham Region to **model several possible fleet electrification scenarios** that ensure electrification of Durham's existing LDV fleets is achieved as **cost-effectively as possible** based on currently available information
- Ensure electric vehicle options considered for each role within the fleet can meet existing **operational requirements**

Durham Region's Corporate GHG Emissions in 2019*



Our modelling suggests that **11%** of the Region's Vehicle Fleet-related GHG emissions stem from LDVs. The remaining emissions are expected to stem from medium- and heavy-duty vehicles that tend to be heavier fuel users.

*2019 GHG emissions breakdown as reported in Durham Region's Climate Change Action Plan (CCAP) has since been updated based on methodology adjustments

Scope

The study considers plug-in EVs, specifically:

- **Battery Electric Vehicles (BEVs):** "pure" electric vehicles that have only an electric powertrain and that plug in to charge (E.g. Tesla Model 3, Chevrolet Bolt, Nissan Leaf)
- **Plug-in Hybrid Electric Vehicles (PHEVs):** hybrid vehicles that can plug in to charge and operate in electric mode for short distances (e.g. 30 to 80 km), but that also include a combustion powertrain for longer trips. (E.g. Chevrolet Volt, Toyota Prius Prime)

The following are excluded from the analysis:

- **Hybrid Electric Vehicles (HEVs):** do not plug in to charge and are considered internal combustion engine (ICE) vehicles
- **Hydrogen Fuel Cell Electric Vehicles (FCEVs):** market assumed to be small within the timeframe of the study

Our study examines LDVs within each of Durham's four fleets, including:

- Works
- Police (DRPS)
- Paramedics (RDPS)
- Transit

LDVs in-scope include:

- Sedans
- Minivans
- Sports utility vehicles (SUVs)
- Pick-up trucks (up to ½-ton)
- Compact cargo vans

E-FLEET Model Features

Dunsky's proprietary **E-FLEET model** was leveraged to support the development of a fleet electrification roadmap for each of Durham's four existing LDV fleets. The model contains the following features to assist with long-term fleet electrification planning:

- **Optimization algorithm:** determines the optimal year to convert each vehicle in the fleet to an EV based on cost-effectiveness and target years for fleet electrification
- **EV availability timeline**: anticipated year by which BEV and PHEV models are expected to be fairly readily available across each vehicle segment taking into account both announced and anticipated vehicle models
- **EV price forecasts:** Dunsky's forecasts for the cost of internal combustion engine vehicle (ICEV), BEV, and PHEV replacements over time across all vehicle segments
- **Total Cost of Ownership (TCO) calculations:** upfront purchase costs, charging infrastructure costs, maintenance costs, fuel and electricity costs, and carbon pricing are all considered as our model assesses the most cost-effective year to electrify each vehicle (vehicle resale value and service upgrades are excluded)

EFLEET

Vehicle Fleet Electrification at the Lowest Cost

Match

EVs in all vehicle segments to your specific needs and use cases

Optimize

timing to meet your financial and GHG objectives

Define

your optimal charging equipment needs

Plan

a comprehensive fleet conversion strategy over time

E-FLEET Model Assumptions

- ICEVs are transitioned to EVs when it is **cost-effective** to do so or as required to meet a **target year for electrification**
  - This includes **early retirements** of ICEVs when it is deemed cost-effective to do so
- Cost-effectiveness is evaluated based on the **TCO** of each vehicle taking into account each vehicle's defined **retirement age**, as well as its **unique usage patterns**
  - Upfront vehicle, fuel/electricity, maintenance and carbon pricing costs are included in our TCO analysis
- **Interim ICEVs replacements** are taken into account and are scheduled according to each vehicle's defined retirement age
- **PHEV replacements** are recommended when a vehicle is expected to meet its average daily energy requirements using the energy stored on-board in the battery
- We have assumed **one-to-one** replacements of ICEVs to EVs and **like-for-like** replacements of vehicle models

Scenario Selection

Several fleet electrification scenarios were selected to model different pathways to 100% fleet electrification for each of Durham's four fleets. Scenarios were selected through discussions with Durham Region staff.

Target Year for 100% Electrification	Fleets	Notes
2030	• Works • Paramedics • Transit • Police	Aligned with the Region's goal to move towards 100% of new LDV purchases zero-emission between 2026 and 2030
2035	• Works • Paramedics • Transit • Police	An extended target for all four fleets
2040	• Police*	A secondary extended target for Police (demanding duty cycles require thoughtful transition planning)
2045	• Works • Paramedics • Transit • Police	Aligned with the Region's target of net-zero by 2045
No target year	• Works • Paramedics • Transit	A scenario driven by the business case for fleet electrification; EV replacements are not constrained by a target year for electrification and are instead only replaced when cost-effective to do so

*The "No target year" scenario for police was swapped with a 100% by 2040 scenario, however, we will present select outputs of a "No target year" scenario for police to highlight the strong business case for electrification

Durham Region's Light-Duty Vehicle Fleet

Segment		Example	Works	Police	Paramedic	Transit
Car	ICEV	Ford Taurus, Chevrolet Malibu, Chevrolet Impala		40	1	2
	HEV	Ford Fusion Hybrid		8		
Minivan	-	Dodge Grand Caravan	11	27		1
SUV	ICEV	Chevrolet Equinox, Chevrolet Tahoe, Ford Escape	4	36	12	9
	PHEV	Hyundai Tucson PHEV	9			
Cargo Van	Compact	Ford Transit Connect	15	2		
Pick-Up Truck	Mid-Size	Chevrolet Colorado	1	4		
	1/2-Ton	Ford F-150, Chevrolet Silverado	67			
PPV Sedan	ICEV	Dodge Charger		59		
	HEV	Ford Fusion Hybrid		5		
PPV SUV	ICEV	Ford Explorer		64		
	HEV	Ford Explorer Hybrid		34		
PPV Pick-Up Truck	-	Ford F-150		15		
Total			**107**	**294**	**13**	**12**

2. Summary of Findings

Selecting a Path Forward – Works, Paramedics and Transit

	100% by 2030	100% by 2035	100% by 2045	No Target Year
Incremental financial benefits over ICEV baseline?	✓	✓	✓	Not recommended for action – used for illustrative purposes to highlight business case for electrification across each fleet
Aligned with target of net-zero by 2045?	✓	✓	✓	
Aligned with 40% reduction in GHG emissions by 2040?	✓	✓	✓	
Pace of GHG emissions reductions?	**Fast**	**Moderate**	**Slow**	
Degree of uncertainty around EV availability to meet target?	**Low**	**Low**	**Low**	

Selecting a Path Forward – Police

	100% by 2030	100% by 2035	100% by 2040	100% by 2045
Incremental financial benefits over ICEV baseline?	✗	✓	✓	✓
Aligned with target of net-zero by 2045?	✓	✓	✓*	✓*
Aligned with 40% reduction in GHG emissions by 2040?	✓	✓	✓	✓
Pace of GHG emissions reductions?	Fast	Moderate	Slow	Slow
Degree of uncertainty around EV availability to meet target?	Moderate	Low	Low	Low

*We have modelled a 38% reduction in GHG emissions relative to a 2024 baseline, however, we anticipate this to equate to 40% relative to a 2019 baseline given improvements in vehicle efficiency

Scenarios for Electrification: Summary Slide Interpretation

The following four slides summarize the key inputs and outputs for each fleet electrification scenario explored across the four fleets in this memo. This slide outlines how to interpret each category of inputs and outputs that is presented.

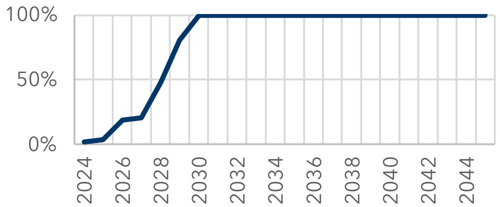
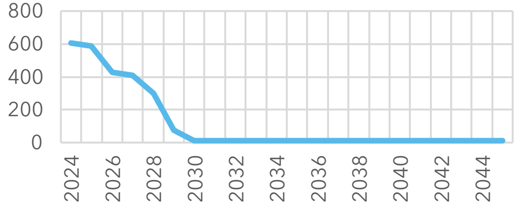
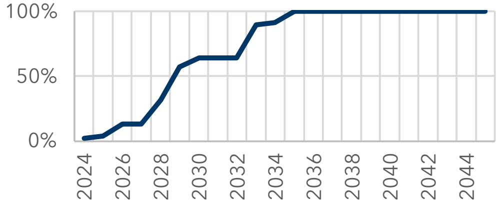
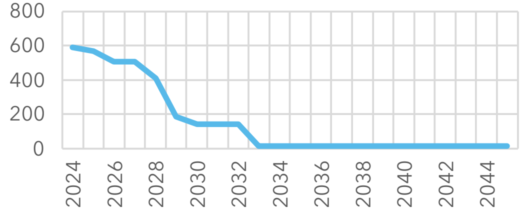
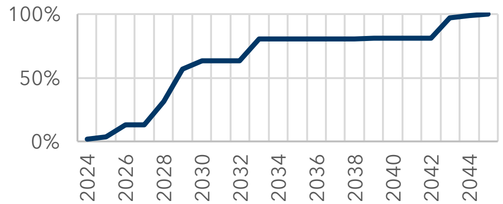
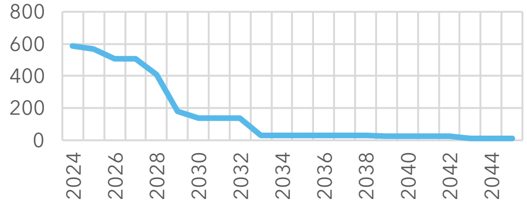
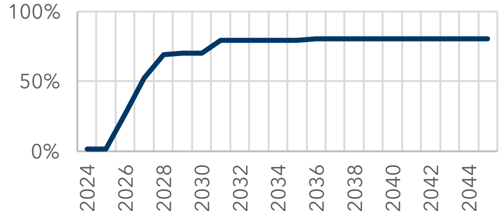
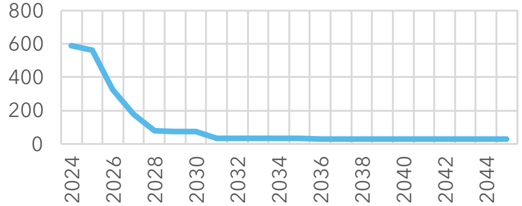
Inputs

- **Electrification Target Year:** the year by which 100% of the fleet is to be converted to an electric model (BEV or PHEV)
- **First ICEV to EV Annual Replacement Limit:** input reflects the limit on the number of ICEVs in the fleet that can be converted to an EV model each year and is intended to promote a manageable pace of change; fewer constraints placed on "No Target Year" scenario to highlight business case

Outputs

- **EV Fleet Share:** the percentage of the fleet that is electric (BEV or PHEV) year-over-year
- **Incremental Cost/Benefit:** indicator used to reflect whether the fleet electrification scenario is expected to result in financial costs (–) or benefits (+) over the ICEV baseline
- **Annual GHG Emissions:** the annual tonnes of GHG emissions measured in (CO_2e) from all vehicles in the fleet (ICEV and EV)

Works: Scenarios for Fleet Electrification

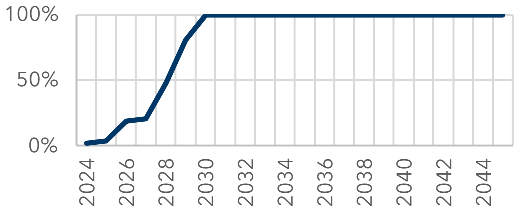
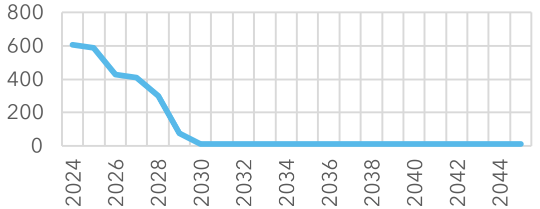
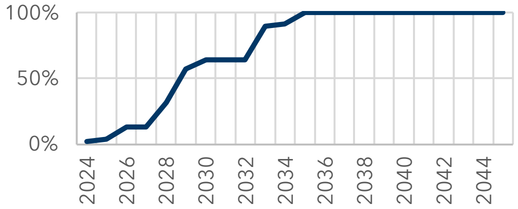
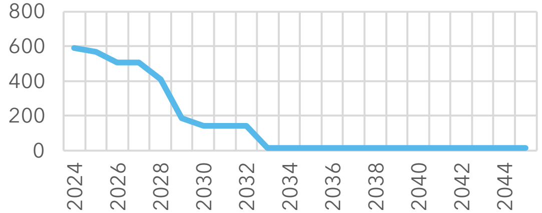
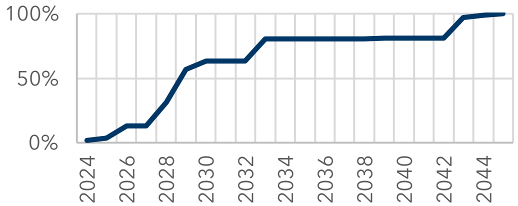
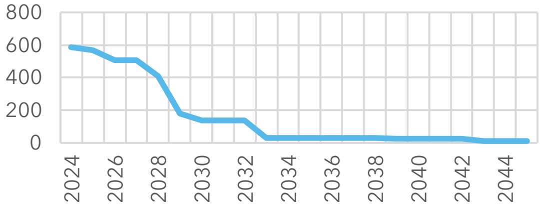
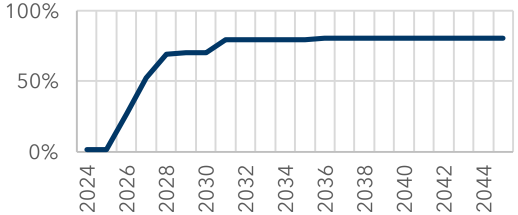
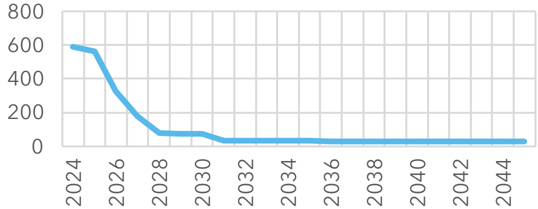
INPUTS		OUTPUTS		
Electrification Target Year	**First ICEV-to-EV Annual Replacement Limit**	**EV Fleet Share**	**Incremental Cost/Benefit***	**Annual GHG Emissions** (tonnes CO_2e)
Scenario 1: 100% by 2030	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2030 to 30+ vehicles in 2030 to ensure all vehicles are transitioned by target year		+	
Scenario 2: 100% by 2035	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2028 to a max of 25 vehicles per year in 2029-2035 to reflect the historic max purchases per year		+	
Scenario 3: 100% by 2045	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2028 to a max of 25 vehicles per year in 2029-2045 to reflect the historic max purchases per year		+	
Scenario 4: No target year	• Two vehicles per year between 2024-2025 • 25 vehicles per year in 2026-onwards to reflect the historic max purchases per year • Ramp-up period excluded to highlight business case		+	

*Financial benefits of modelled fleet electrification scenario over ICEV baseline

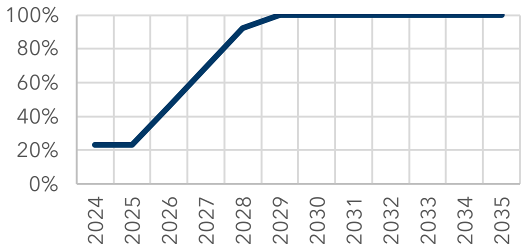
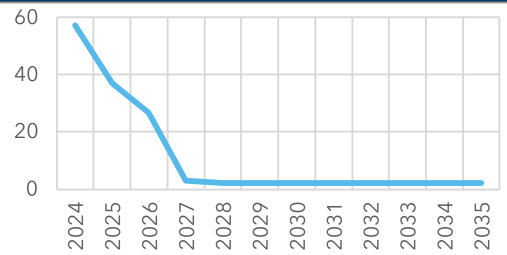
Summary of Findings

Paramedics: Scenarios for Fleet Electrification

dunsky

INPUTS		OUTPUTS		
Electrification Target Year	**First ICEV-to-EV Annual Replacement Limit**	**EV Fleet Share**	**Incremental Cost/Benefit***	**Annual GHG Emissions** (tonnes CO_2e)
Scenario 1: 100% by 2030	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2030 to 30+ vehicles in 2030 to ensure all vehicles are transitioned by target year		+	
Scenario 2: 100% by 2035	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2028 to a max of 25 vehicles per year in 2029-2035 to reflect the historic max purchases per year		+	
Scenario 3: 100% by 2045	• Two vehicles per year between 2024-2025 • Ramping up over 2026-2028 to a max of 25 vehicles per year in 2029-2045 to reflect the historic max purchases per year		+	
Scenario 4: No target year	• Two vehicles per year between 2024-2025 • 25 vehicles per year in 2026-onwards to reflect the historic max purchases per year • Ramp-up period excluded to highlight business case		+	

Transit: Scenarios for Fleet Electrification

<table>
<tr><th colspan="2">INPUTS</th><th colspan="3">OUTPUTS</th></tr>
<tr><th>Electrification Target Year</th><th>First ICEV-to-EV Annual Replacement Limit</th><th>EV Fleet Share</th><th>Incremental Cost/Benefit*</th><th>Annual GHG Emissions (tonnes CO_2e)</th></tr>
<tr><td>Scenario 1:
100% by 2030</td><td>• Three vehicles per year to reflect a uniform rate of adoption</td><td>
</td><td>+</td><td>
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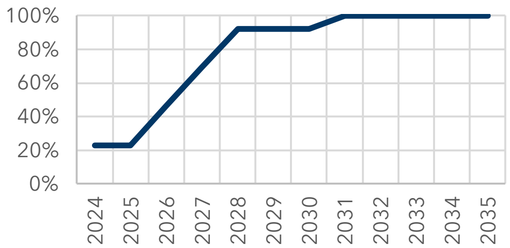
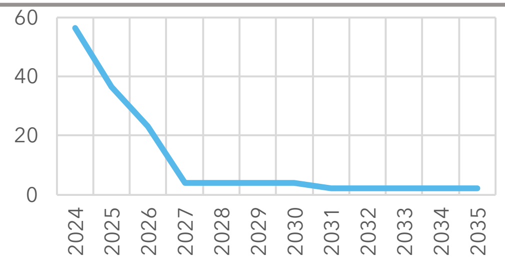
<tr><td>Scenario 2:
100% by 2035**</td><td>• Three vehicles per year to reflect a uniform rate of adoption</td><td>
</td><td>+</td><td>
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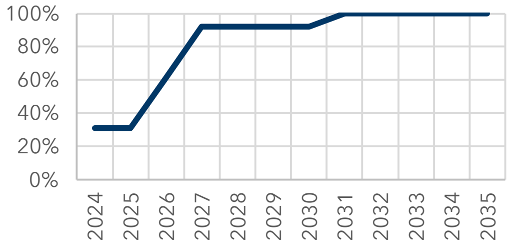
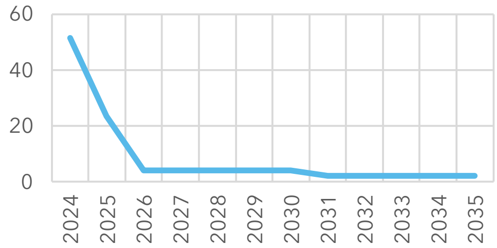
<tr><td>Scenario 4:
No target year</td><td>• Increased to four vehicles per year to highlight business case if the Region were to pursue a greater number of replacements per year</td><td>
</td><td>+</td><td>
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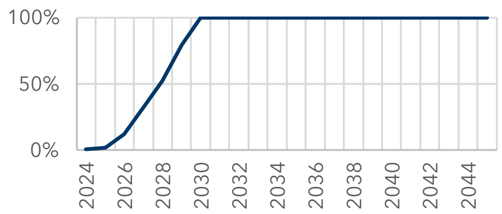
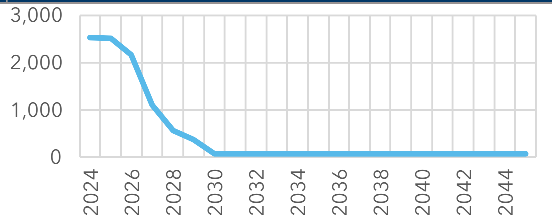
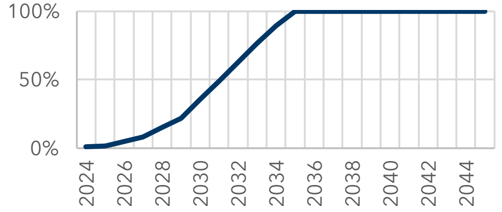
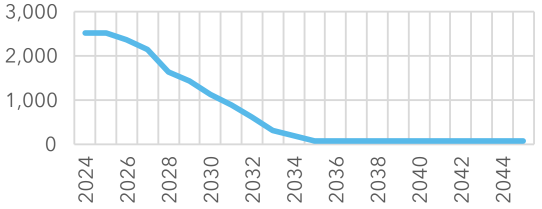
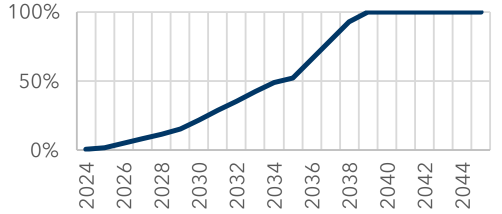
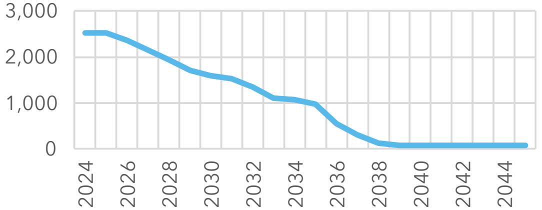
Summary of Findings

Police: Scenarios for Fleet Electrification

<table>
<tr><th colspan="2">INPUTS</th><th colspan="3">OUTPUTS</th></tr>
<tr><th>Electrification Target Year</th><th>First ICEV-to-EV Annual Replacement Limit</th><th>EV Fleet Share</th><th>Incremental Cost/Benefit*</th><th>Annual GHG Emissions (tonnes CO_2e)</th></tr>
<tr><td>Scenario 1: 100% by 2030</td><td>• Two vehicles per year between 2024-2025
• Ramping up over 2026-2030 to 30+ vehicles in 2030 to ensure all vehicles are transitioned by target year</td><td>
</td><td>–</td><td>
</td></tr>
<tr><td>Scenario 2: 100% by 2035</td><td>• Two vehicles per year between 2024-2025
• Ramping up over 2026-2029 to a max of 40 vehicles per year in 2030-2035 to reflect the historic max purchases per year</td><td>
</td><td>+</td><td>
</td></tr>
<tr><td>Scenario 3: 100% by 2040</td><td>• Two vehicles per year between 2024-2025
• Ramping up over 2026-2034 to a max of 40 vehicles per year in 2035-2040 to reflect the historic max purchases per year</td><td>
</td><td>+</td><td>
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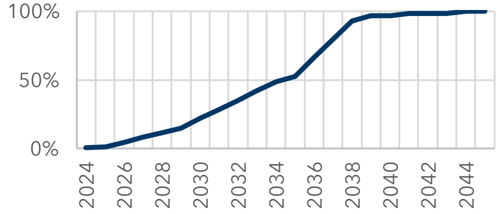
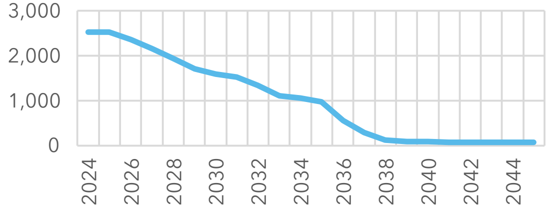
<tr><td>Scenario 4: 100% by 2045</td><td>• Two vehicles per year between 2024-2025
• Ramping up over 2026-2034 to a max of 40 vehicles per year in 2035-2045 to reflect the historic max purchases per year</td><td>
</td><td>+</td><td>
</td></tr>
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Summary of Findings

Charging Infrastructure Summary

- Charging infrastructure recommendations have been developed with the aim of minimizing incremental electricity load at each of Durham's facilities by **right-sizing** the charging level to meet a vehicle's needs and making use of **power-sharing**, where possible
- Charging infrastructure that is already planned and has received funding through **ZEVIP** will be leveraged to support the vehicles included in this assessment
- Our cost estimates include all-in hardware and installation of charging ports but exclude service upgrades

Charger Power Level	Estimated Cost/Port	Total # Ports - Works: New	Total # Ports - Works: ZEVIP*	Total # Ports - Paramedics: New	Total # Ports - Paramedics: ZEVIP	Total # Ports - Transit: New	Total # Ports - Transit: ZEVIP	Total # Ports - Police: New	Total # Ports - Police: ZEVIP	Total
DCFC 100 kW	$75,000			2				182		**184**
DCFC 50 kW	$45,000			2				6		**8**
DCFC 25 kW	$25,000	1						93		**94**
L2 Dedicated 6.7 kW 40A	$8,660	11	**4**	3				11		**29**
L2 Two-Share 6.7 kW 40A	$5,330	13	**9**		**2**		**4**	2		**30**
L2 Three-Share 6.7 kW 40A	$4,220	15	**6**							**21**
L2 Four-Share 6.7 kW 40A	$3,660	39	**9**	4		6	**2**			**60**
Total	-	79	**28**	11	**2**	6	**6**	294	**-**	**426**

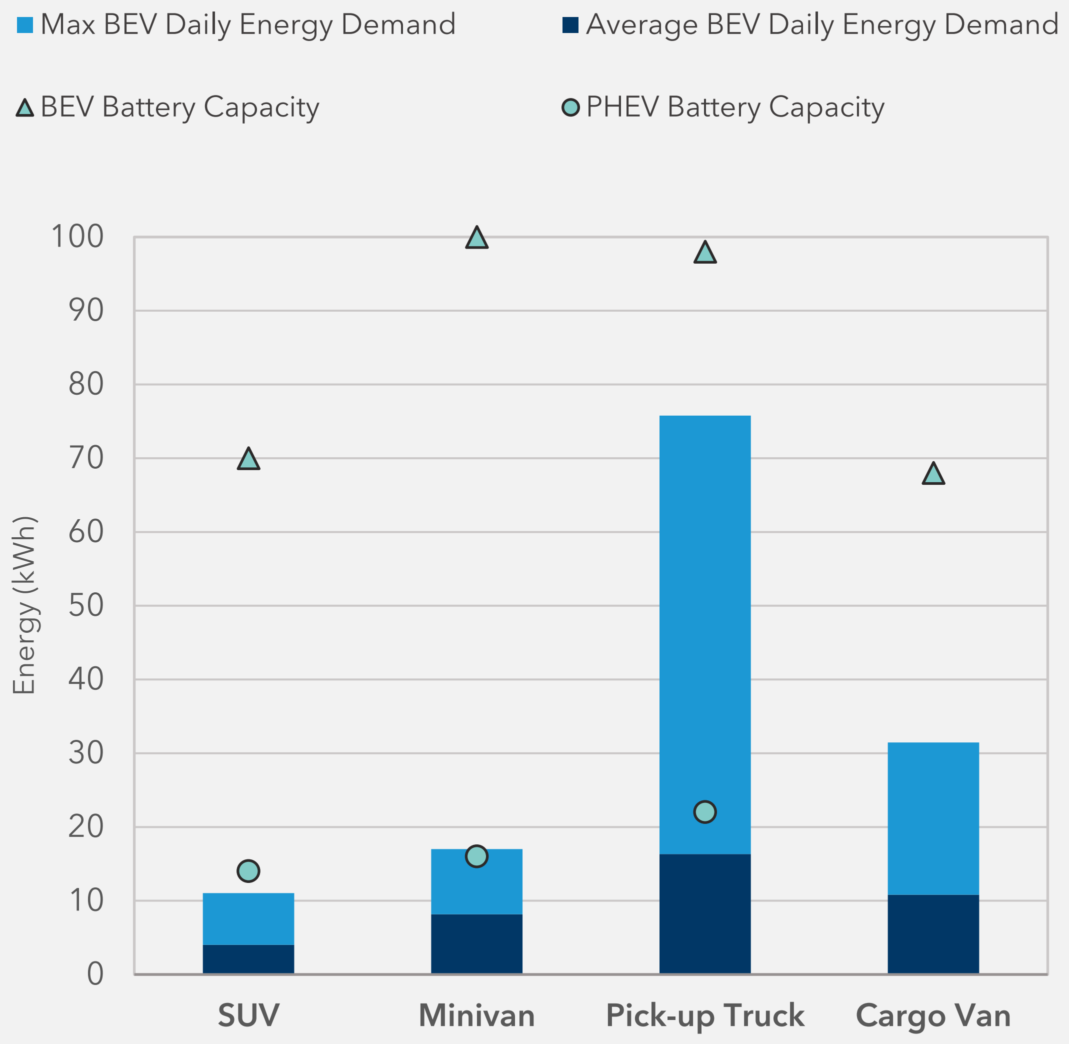
*ZEVIP charger totals include those already installed and those planned through the Region's ZEVIP Round 3 application

Key Takeaways

- All scenarios (except police fleet by 2030) are **cost-effective** (i.e., are expected to result in incremental financial benefits over ICEV baseline) based on available data
- All scenarios are aligned with **net-zero by 2045** and are expected to meet the interim target of a 40% reduction in GHG emissions by 2030 relative to a 2019 baseline
- **100% by 2030** is a viable pathway to accelerate GHG emission reductions in the Works, Paramedics and Transit fleets
- A more **moderate scenario** for the Police fleet may be preferred
- A **proactive vehicle procurement strategy** will be necessary to implement the recommended pathways to fleet electrification
- More than **426 charging ports** will be required to support this transition, 36 of which are already installed and/or planned; electrical capacity assessments and **detailed electrical designs** should be pursued in the near term to support the deployment of EV charging infrastructure across the Region's facilities

3. Fleet Daily Energy Demands

Works



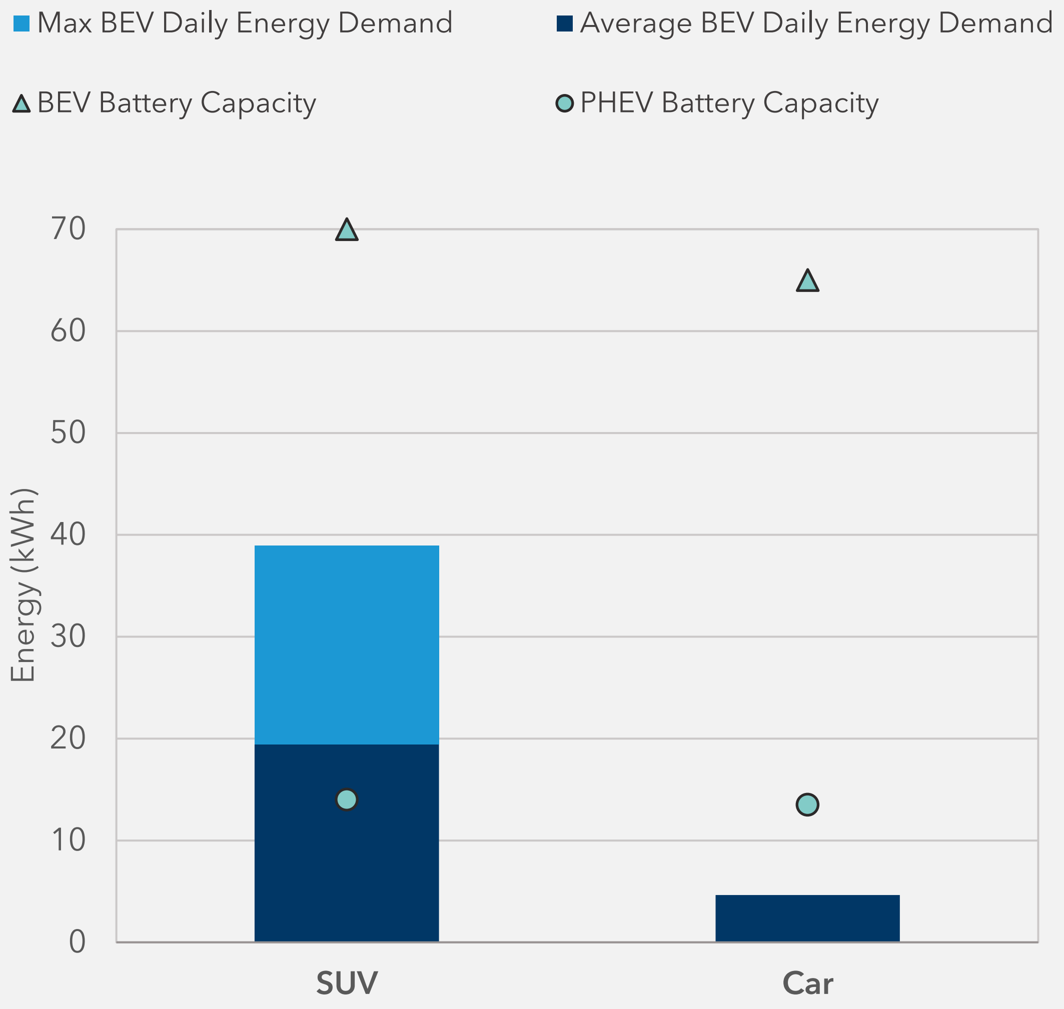
The charts above depict the average and maximum daily energy demands across each fleet for each vehicle segment using both BEV and PHEV powertrains.

Taking into account the average daily usage patterns of vehicles (both in terms of the distance travelled and power draw of auxiliary equipment while idling), we expect all vehicles in the Works LDV fleet to be able to meet their daily operational requirements using a BEV **without the need for mid-day charging** (not factoring in the impact of extreme temperatures on range).

Many vehicles in the Works fleet can also meet their average daily energy requirements using a PHEV. In cases where vehicles are expected to meet their daily energy requirements making exclusive use of the energy stored in a PHEV's battery pack, it has been recommended as the powertrain of choice. In these instances, we can expect PHEVs to generate **similar GHG emissions reductions to a BEV at a lower upfront cost**.

Fleet Daily Energy Demands

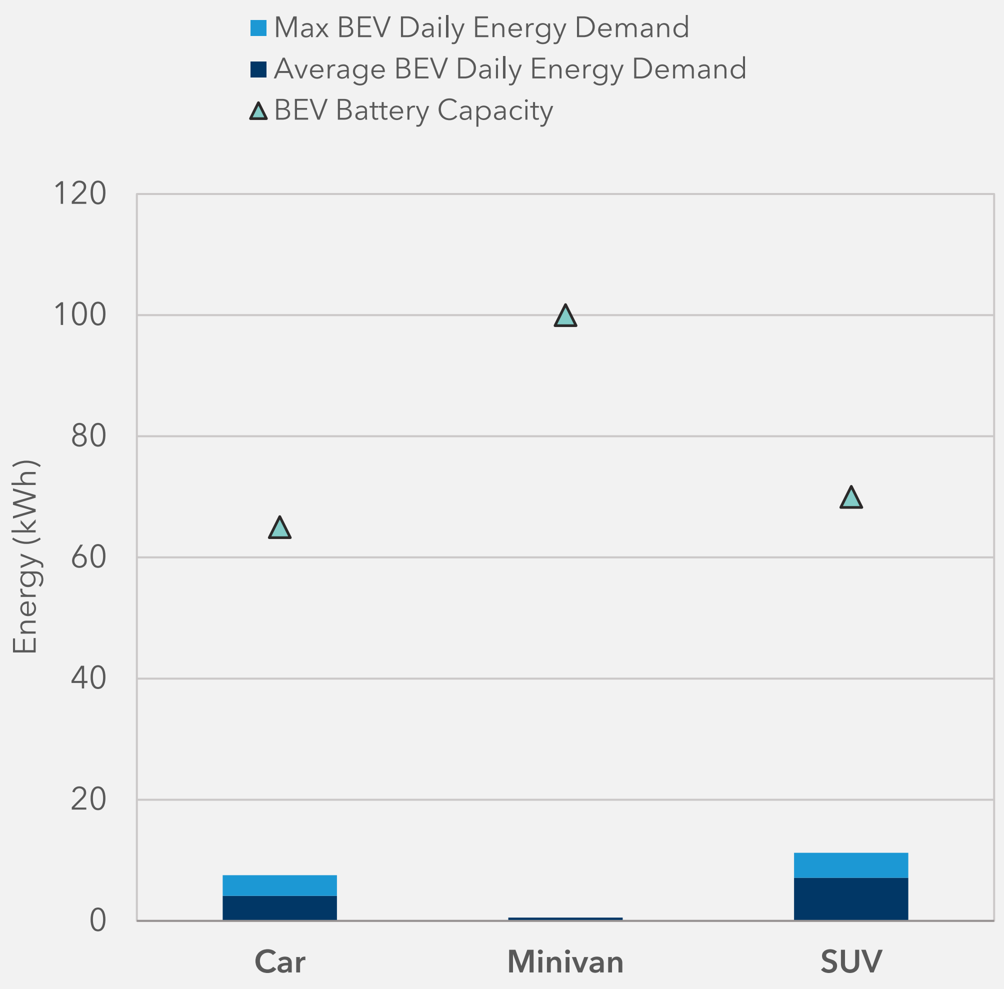
Paramedics



If we assume that paramedics vehicles are in operation **250 working days per year**, we can expect all vehicles in the fleet to meet their daily operational needs using a BEV **without the need for mid-day charging**. There is, however, uncertainty around how many days these **occasional use** vehicles are in use, as this data has not historically been tracked by the department.

In instances where a PHEV is the recommended powertrain, the department must carefully consider its daily range requirements. When the typical daily energy requirements of a paramedics vehicle is expected to **exceed the expected electric range of a PHEV** (SUV = 60 km; car = 50km), then the department should consider **switching its vehicles to a BEV powertrain** in order to achieve the desired scale of GHG emissions reductions. If a vehicle's daily energy requirements exceed the energy stored in the battery pack, the internal combustion engine will be used, generating greater GHG and other air pollutant emissions.

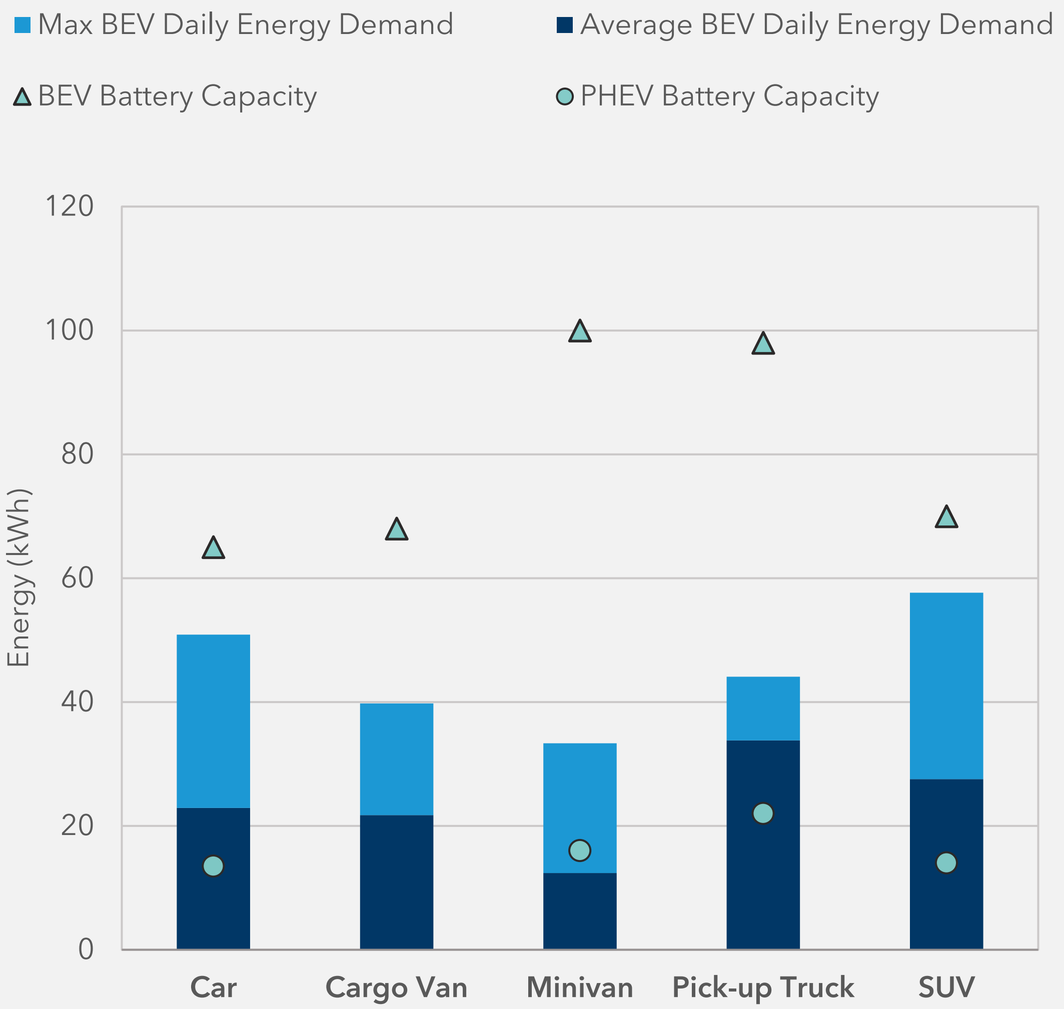
Transit



The extremely low daily energy demands of transit vehicles can be attributed to the fact that these are **occasional-use vehicles**. While the graph to the left depicts their daily energy requirements by dividing their annual usage over 250 working days per year, this is not necessarily expected to be the reality of the fleet.

Due to the uncertainty around the average number of days these vehicles are in operation per year, or the daily range and idling requirements of these vehicles when they are in use, we have **forced all transit vehicles to BEV (as opposed to PHEV) conversions** in our modelling to ensure that the desired outcomes are achieved with respect to GHG emissions reductions.

Police



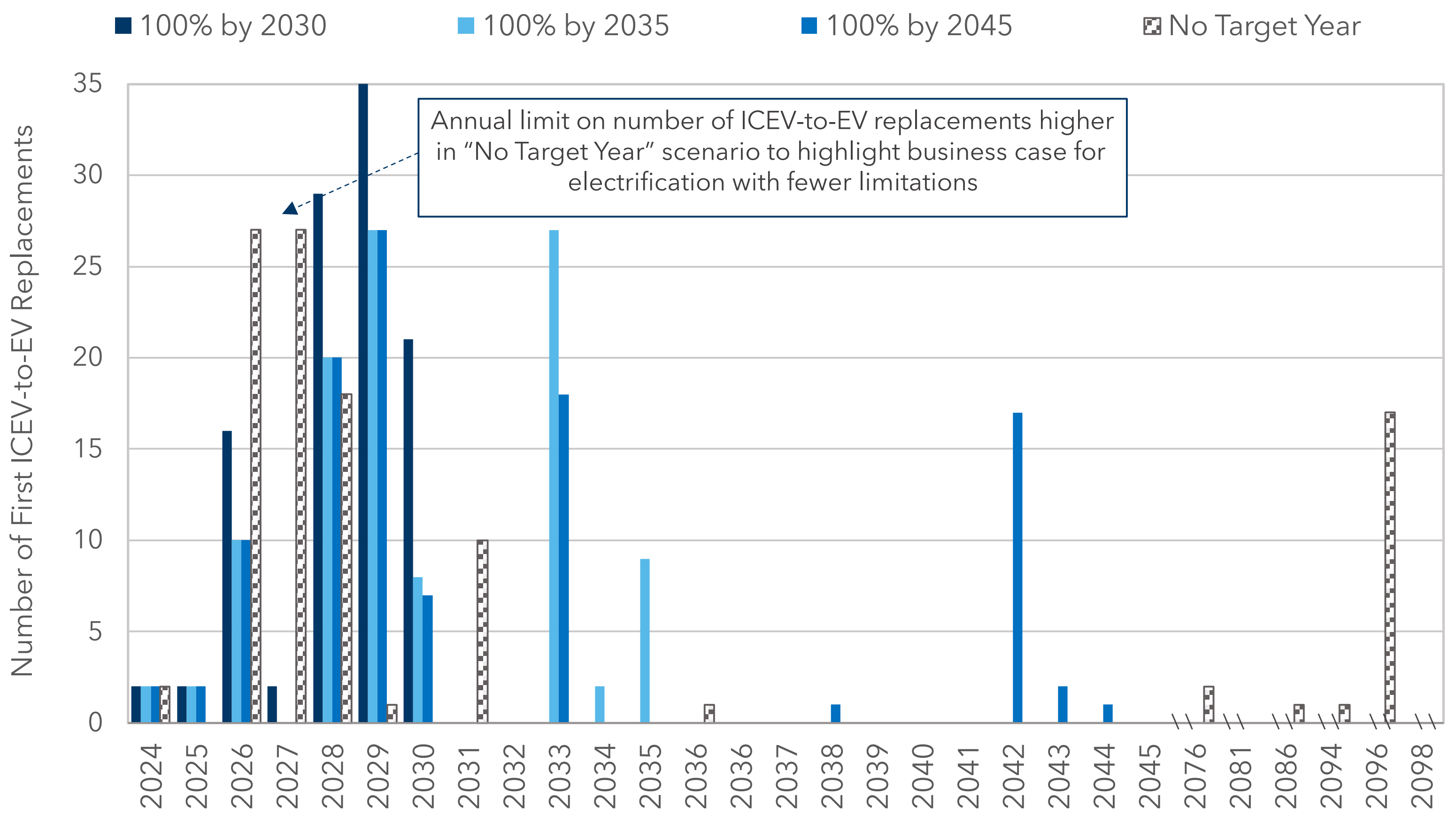
Due to the heavy usage of the police department's LDV fleet, several vehicles in the fleet will need to **leverage BEV technology** in order to achieve the full GHG emission benefits of electrification. A portion of vehicles in the fleet will exceed the battery capacity of PHEVs and will require the internal combustion engine on board those vehicles.

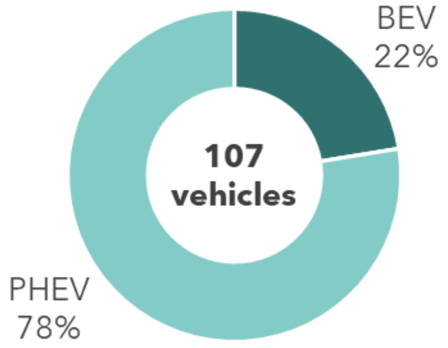
While all vehicles in the fleet are expected to meet their daily energy requirements without mid-day charging using a BEV, the back-to-back nature of shifts within the police departments will put **pressure on fast charging between shifts**, or staggering vehicle use across shifts.

4. Roadmaps to Light-Duty Fleet Electrification

Works

The chart below depicts the number of first ICEV-to-EV replacements, highlighting the **pace of fleet electrification** across each of the four scenarios examined. Vehicles are recommended for EV replacements when it is **cost-effective** to do so, or in order to meet a defined **fleet electrification target.**





Breakdown of powertrains at 100% electrification of the current (2023) Works fleet across all scenarios

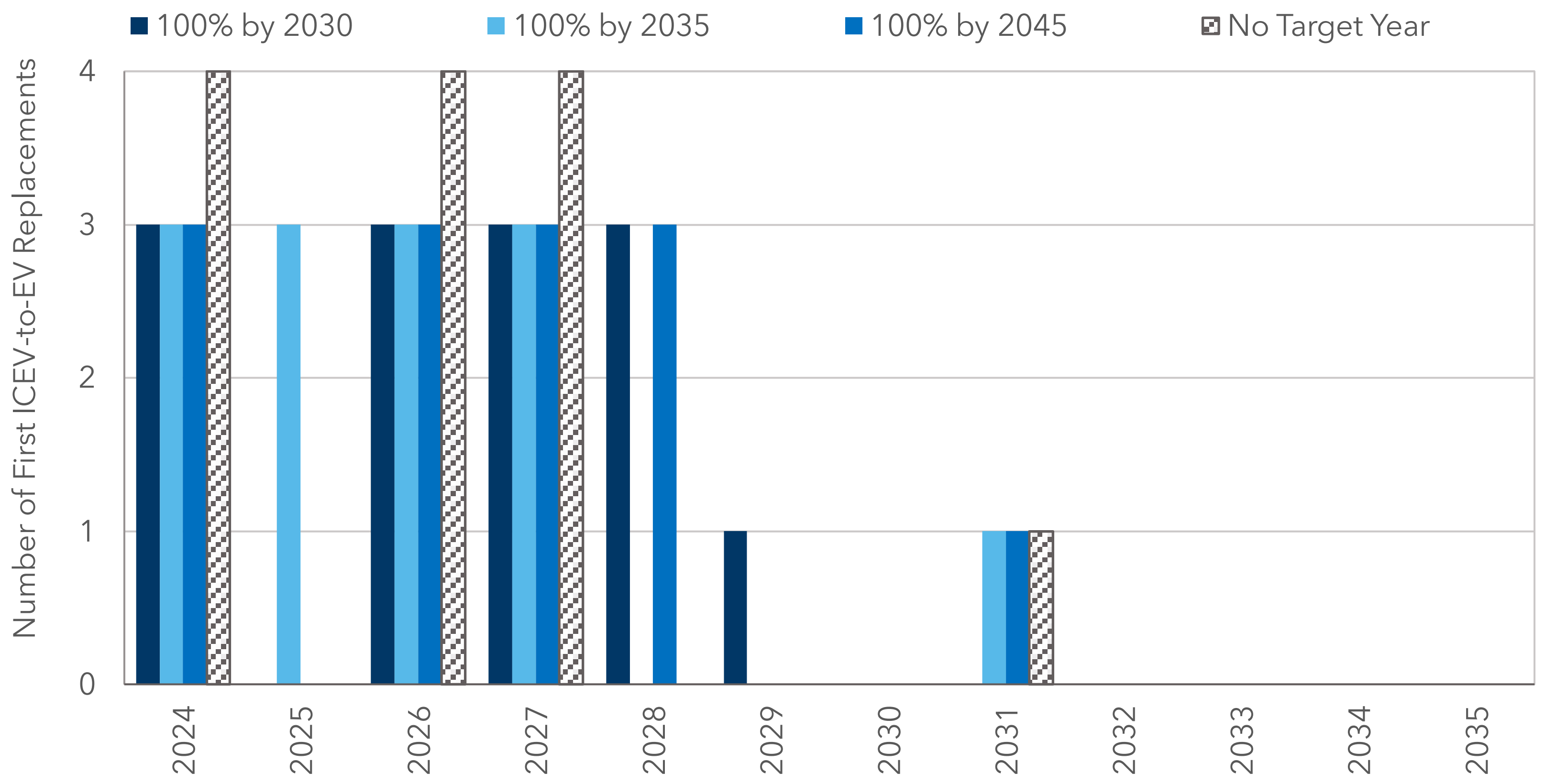
Even when no target year is set for electrification, **the vast majority of EVs are transitioned to electric by 2035**, highlighting the cost-effectiveness of EVs over ICEVs for most vehicles in the Works fleet. There are 22 vehicles that are pushed out to the later years of each scenario which have a weak business case for electrification due to low usage.

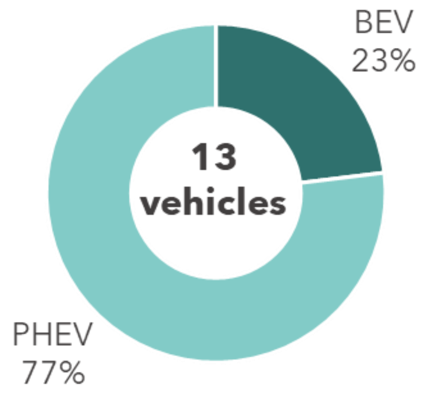
Over ¾ of vehicles in the fleet are expected to be able to meet their daily energy requirements using a PHEV, thereby achieving a similar magnitude of GHG emissions reductions as BEVs at a lower upfront cost.

Paramedics

Modelling results of the 100% by 2035 and 100% by 2045 scenarios are identical, and as such, we will only present detailed results for the 100% by 2035 scenario in the remainder of this memo.

Even when we do not set a target year for electrification, **all vehicles are recommended to be transitioned to EVs by 2032**, demonstrating the expected cost-effectiveness of EVs over ICEVs for the Paramedics fleet.



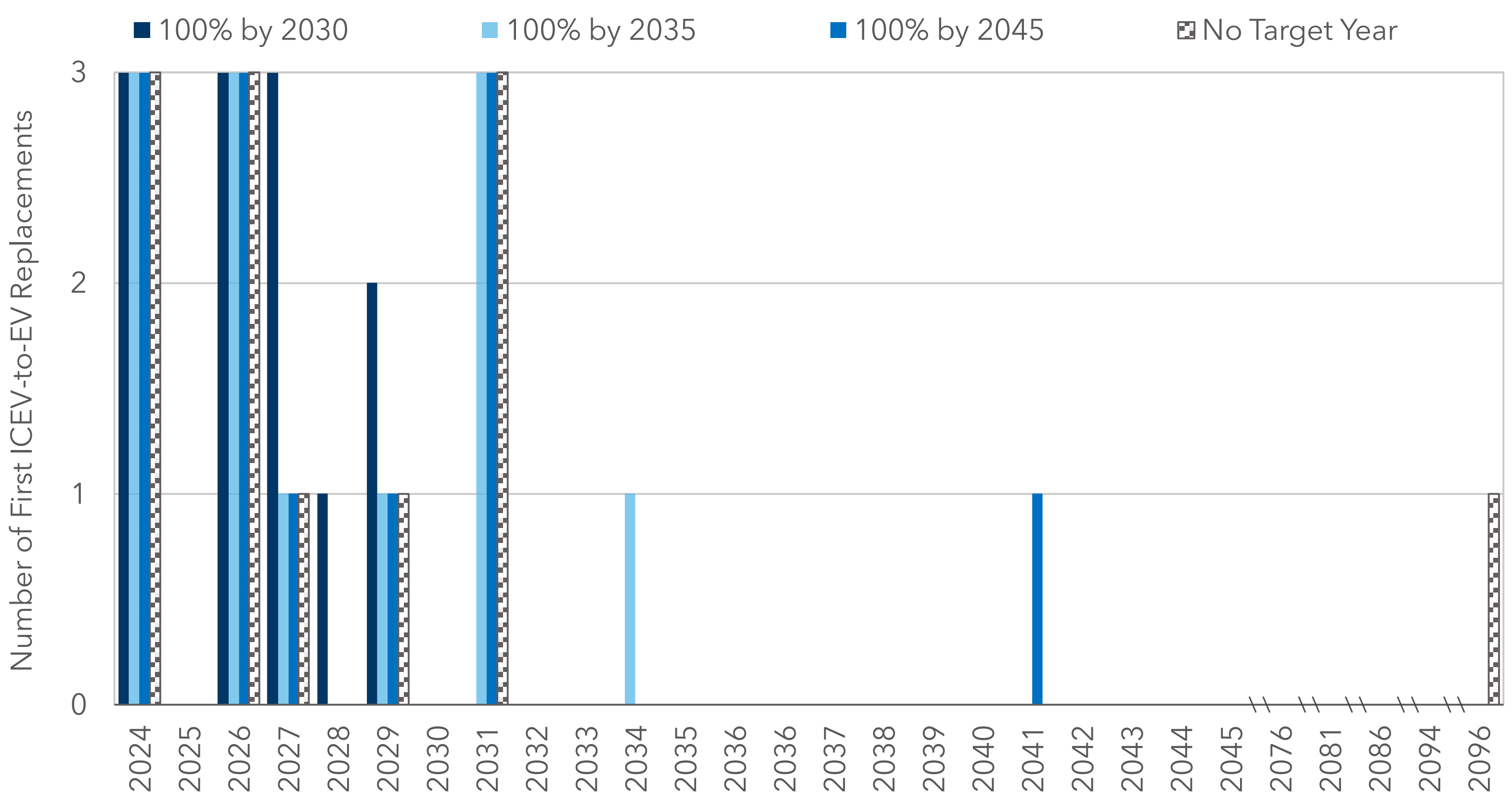


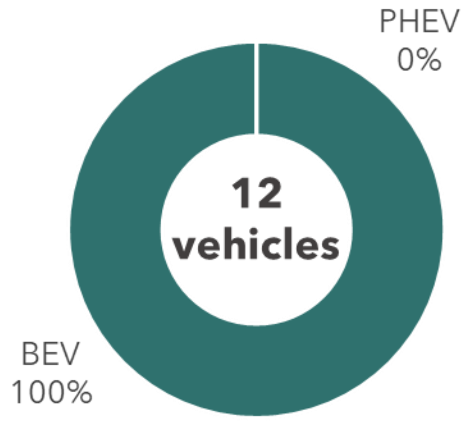
Breakdown of powertrains at 100% electrification of the current (2023) Paramedics fleet across all scenarios

Supervisory LDVs are included in the Paramedics' fleet roadmap, which are sometimes required to make **long-distance** trips to **remote regions** with little notice. As EV charging is still not deployed at scale in some of the remote areas within Durham Region, staff may want to consider holding onto ICEVs as occasional use vehicles to provide backup capacity and assurance that the department will be prepared to respond to emergencies when they arise.

Transit

As is made clear by the large spikes in first ICEV-to-EV replacements between 2024-2032 across all scenarios, and the uniform spikes in a single remaining EV replacement near the final years of the 100% by 2035, 100% by 2045 and No Target Year scenarios, it is clear that there is a **strong business case for electrification** for all but one vehicle in the transit fleet.





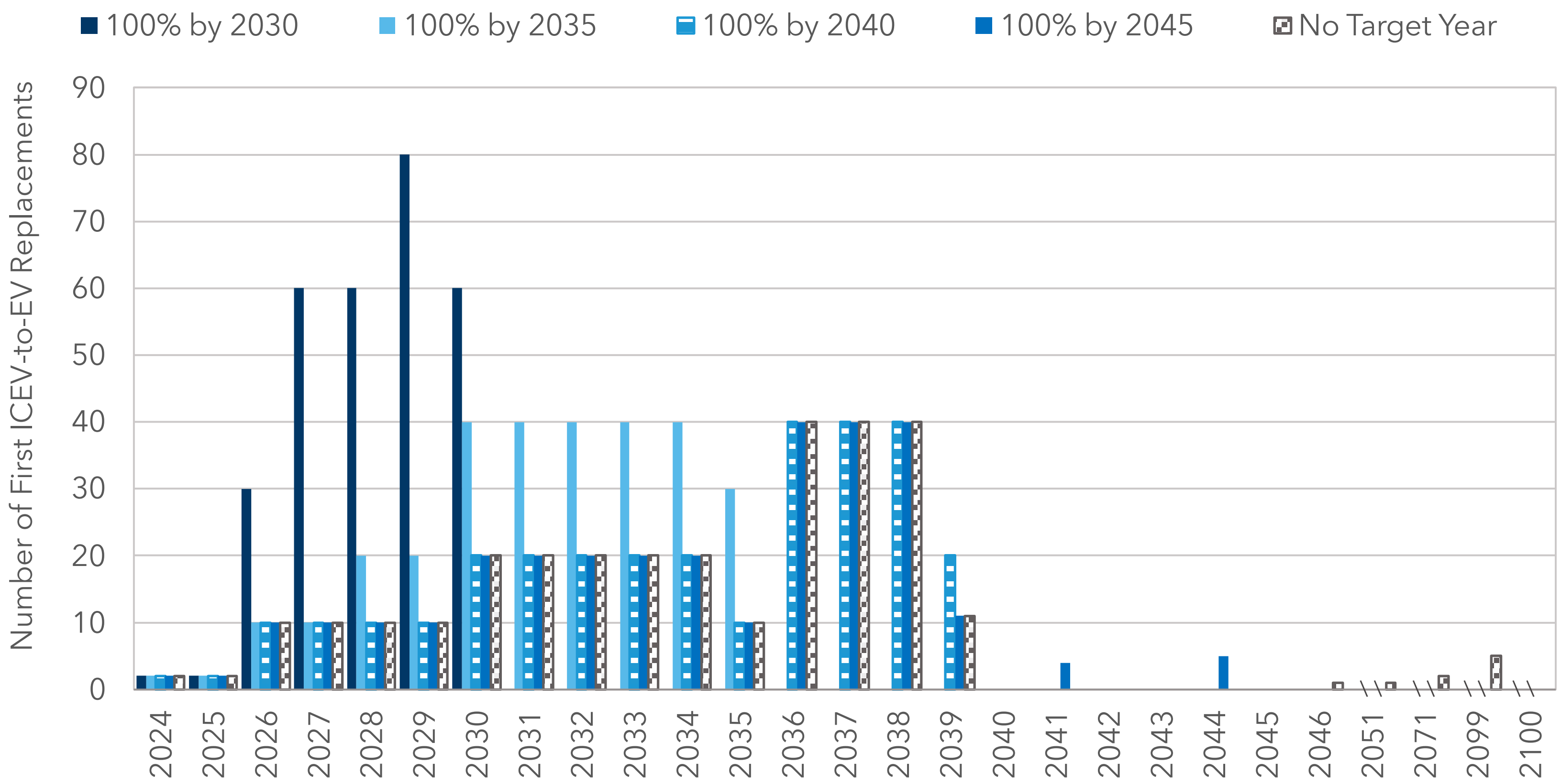
Breakdown of powertrains at 100% electrification of the current (2023) Transit fleet across all scenarios

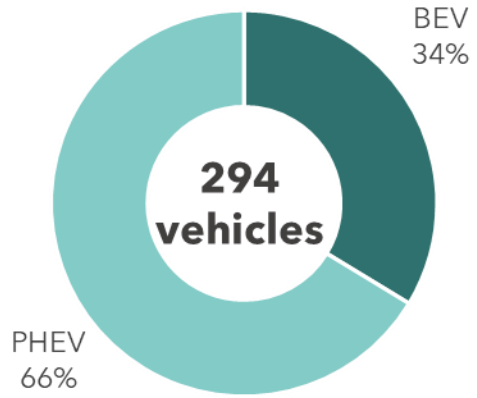
We have recommended all vehicles in the transit fleet be replaced with a **BEV** due to our understanding of the nature of the operation of these vehicles. While their overall annual usage is low, they are expected to be used fairly significantly on the days when they are put into use and are therefore at risk of exceeding the battery capacity of a PHEV, and thus not achieving the desired magnitude of GHG emissions reductions.

Police

We see a very **strong business case** for electrification across the vast majority of vehicles in the Police fleet. In the No Target Year scenario in which replacements are only recommended when it is cost -effective, the electrification of only nine vehicles in the fleet is pushed out beyond 2039.

Modelling results for the 100% by 2040 and 100% by 2045 scenarios are **almost identical**, except for the electrification of nine vehicles that are pushed out into 2041 and 2044 under the 100% by 2045 scenario.





Breakdown of powertrains at 100% electrification of the current (2023) Police fleet across all scenarios

Given the relatively large number of vehicles in the police fleet, and the request for a 2024-2025 ramp-up period limiting the number of EV conversions to two per year, a **large number of EV conversions are required in 2026- 2029** to meet a 100% by 2030 target. The number of recommended annual replacements under this target in many cases exceeds the historic maximum number of vehicles replaced in any given year by the fleet (54, as per the vehicle inventory data provided by the department).

5. Charging Infrastructure Strategy

Principles

Our charging infrastructure recommendations have been developed with the following principles in mind:

- **A one-to-one ratio of charging ports to vehicles.** Rather than sharing charging ports across multiple vehicles, it is recommended to install a dedicated charging port for each vehicle to minimize staff time coordinating sequential charging of vehicles and minimize the risk of any one vehicle being left uncharged. Instead, the overall installed electrical capacity can be shared across multiple vehicles through various approaches to power-sharing or load management.

- **Right-size the power of charging infrastructure.** Optimizing the power (kW) and level of charging (e.g., Level 2 or DCFC) to meet an EV's daily energy requirements can help minimize load impacts at facilities, thereby reducing demand charges and the need for expensive electrical upgrades.

- **Employ power-sharing across charging ports, where possible.** Similarly, employing load management strategies like power-sharing the electrical capacity from a single circuit across multiple ports can help minimize the need for service upgrades and is well-suited for vehicles with low daily energy demands.

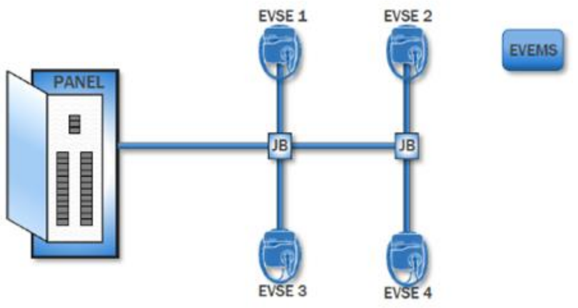


Image credit: AES Engineering

Circuit sharing: Multiple EVSE on a single circuit, with control using an Electric Vehicle Energy Management System (EVEMS) to ensure capacity is not exceeded

Works – Number of EV Chargers at 100% Electrification

- It is expected that most vehicles in the Works department will have 16 hours of downtime between shifts; we have used a conservative estimate of **10 hours** to charge
- Vehicles that can't leverage power-sharing due to a lack of other EVs available for sharing at a facility are automatically assigned a dedicated L2
- For some of these facilities, other electrical configurations may be viable and could provide equivalent charging performance at slightly lower costs – this should be considered in detailed design
- Numbers in **bold** represent EV chargers that have been installed (Round 2) or are pending approval for funding through ZEVIP (Round 3); we have not accounted for public EV chargers installed through Round 1 of ZEVIP, but these may be leveraged in off-hours
- The incremental electricity load was calculated by taking into account the number of vehicles at each facility and their maximum power draw based on each vehicle's assigned charger power rating

	Ajax WSP	Ajax/Pickering Depot	Beaverton WSP	Bowmanville WSP	Construction HQ	Corbett Creek WPCP	Courier HQ	Courtice WPCP	Duffin Creek WPCP	Durham Tourism HQ	Facilities Security	Harmony Creek WPCP	Lake Simcoe WPCP	Newcastle WPCP	Orono Depot	Oshawa WSP	Oshawa/ Whitby Depot	Scucog Depot	Sunderland Depot	Traffic	Uxbridge WPCP	Uxbridge WSP	Waste	Water Billing HQ
DCFC 25 kW																		1						
L2 Dedicated 6.7 kW 40A	1			**1**	1		1	1		1	1	1	1	1	**2**			**1**					1	1
L2 Two Share 6.7 kW 40A	2	**2**		2			2								**1**/1	**2**	**2**/2		**2**		2	2		
L2 Three Share 6.7 kW 40A			3			3			**3**								3	**3**		3			3	
L2 Four Share 6.7 kW 40A	**4**/8	**2**/2			4	4									**1**/3		**2**/14							4
Incremental Electricity Load (kW)	**34**	**13**	**7**	**13**	**13**	**13**	**13**	**8**	**7**	**7**	**7**	**7**	**7**	**7**	**27**	**7**	**47**	**38**	**7**	**7**	**7**	**7**	**13**	**13**

Paramedics – Number of EV Chargers at 100% Electrification

dunsky

- There is some **uncertainty** around the typical **charging windows** of LDVs in the paramedics' fleet. These vehicles are used on an **as-needed basis** for the following purposes:
  - Admin
  - Supervisory
  - Emergency response
- Informed by engagement with RDPS, a conservative **8 hours** of downtime between shifts was assumed for nine out of the 13 vehicles, and **0.5 hours** for four response and supervisory vehicles (all of which have been identified as needing DCFC).

	Whitby 4040 Anderson Street	Sunderland 1050 Durham Regional Road
DCFC 100 kW	2	-
DCFC 25 kW	2	
L2 Dedicated 6.7 kW 40A	2	-
L2 Two Share 6.7 kW 40A	**2**	2
L2 Four Share 6.7 kW 40A	4	-
Incremental Electricity Load (kW)	277	7

*Numbers in **bold** represent EV chargers that have received funding through ZEVIP

Transit – Number of EV Chargers at 100% Electrification

- Given that the transit LDV fleet is made up of occasional-use vehicles, there is some **uncertainty** around the typical charging window of these vehicles.
- We assumed an **8-hour period** of downtime between shifts for charging.
- With a four-way shared 6.7 kW charger, this means vehicles would receive 1.65 kW of dedicated power (13 kWh over an 8-hour period), translating to **approximately 65 km of additional range per LDV overnight**.
- We have not accounted for planned and installed public and workplace EV chargers at Westney, but these may be leveraged during off-hours.

	Westney	Raleigh
DCFC 25 kW	-	-
L2 Dedicated 6.7 kW 40A	-	-
L2 Two Share 6.7 kW 40A	2	**4**
L2 Four Share 6.7 kW 40A	4	**2**
Incremental Electricity Load (kW)	15	15

Police – Number of EV Chargers at 100% Electrification

- Many vehicles in the Police fleet are double shifted and so it is expected that they will have little time to charge between shifts; for this reason, we have developed our charging infrastructure recommendations assuming that vehicles will only have **0.5 hours** to charge
- Given the large number of high-powered DCFC that have been recommended, we suggest the department **examine opportunities to increase the charging windows** between shifts through operational or logistical changes
- Near term **electrical capacity assessments** will be critical at facilities where electricity demand stemming from EVs is especially high; electrical upgrades can take several months, and in some cases years, to complete

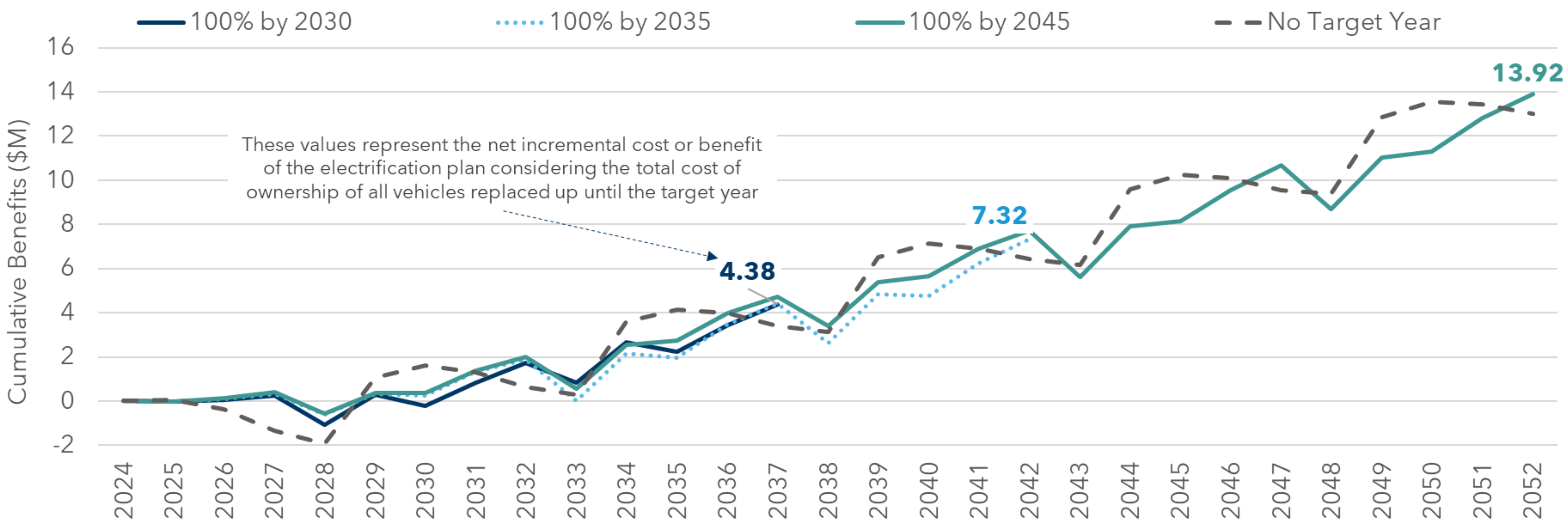
	Division 15	Division 16	Division 17	Division 18	Division 19	Division 20	Division 21	Division 22	Division 31	Division 32	Division 33	Division 34	Division 35	Division 36	Division 38	Division 50	Division 51	Division 53	Division 60	Division 61	Division 81
DCFC 100 kW	18	23	36	26	30	1	1	8	9		8	3	1	2	1	3		1	7	2	2
DCFC 50 kW		2				3		1													
DCFC 25 kW	4	4	12	6	12	26		9		1	1	4				1	5	7	1		
L2 Dedicated 40A		1	1		1			4				1				2	1				
L2 Two Share 40A			1	1																	
Incremental Electricity Load (kW)	**2,000**	**2,557**	**4,219**	**2,913**	**3,607**	**1,475**	**100**	**1,302**	**900**	**50**	**850**	**507**	**100**	**200**	**100**	**363**	**257**	**450**	**750**	**200**	**200**

6. Financial Considerations

Works

The graph below shows the **cumulative incremental benefits** of the optimal electrification plan over a baseline all ICEV replacement scenario. The following are included in our cost estimates: vehicle costs (ICEVs in the baseline scenario and both EVs and interim ICEV replacements in the EV scenario), charging infrastructure costs, fuel/electricity costs, maintenance costs and carbon pricing. Vehicle resale values and service upgrades have been excluded.* All costs are represented in **nominal $CDN**. See the Appendix for additional details related to our cost assumptions.

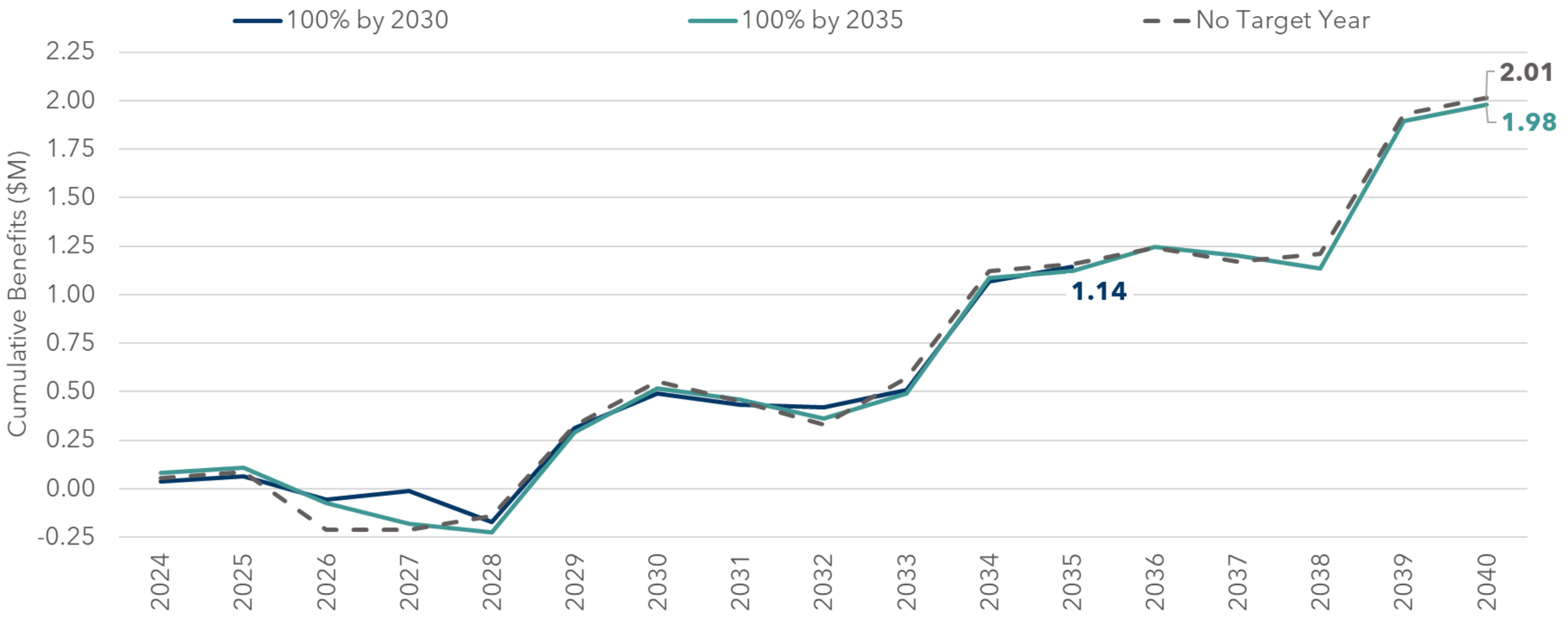
Within a **five-year time horizon**, all of the scenarios examined for the existing Works fleet are expected to result in net **incremental financial benefits** over a baseline ICEV scenario.



*Note that the resale value of vehicles has been excluded from our financial analysis due to uncertainty around future residual values of EVs; while some sources (KBB and Edmunds) suggest that EV resale values may currently be lower than their ICEV counterparts, we expect the used EV market to grow and thus, we expect Durham to be able to secure some revenue from resale
Charging infrastructure costs reflect 100% of the cost of chargers not approved for funding through ZEVIP, 50% of those approved through ZEVIP (Round 3), and 0% of those already installed

Paramedics

Starting in 2028, a transition to EVs results in exclusively **incremental financial benefits** over an ICEV baseline across all scenarios examined for the Paramedics fleet.



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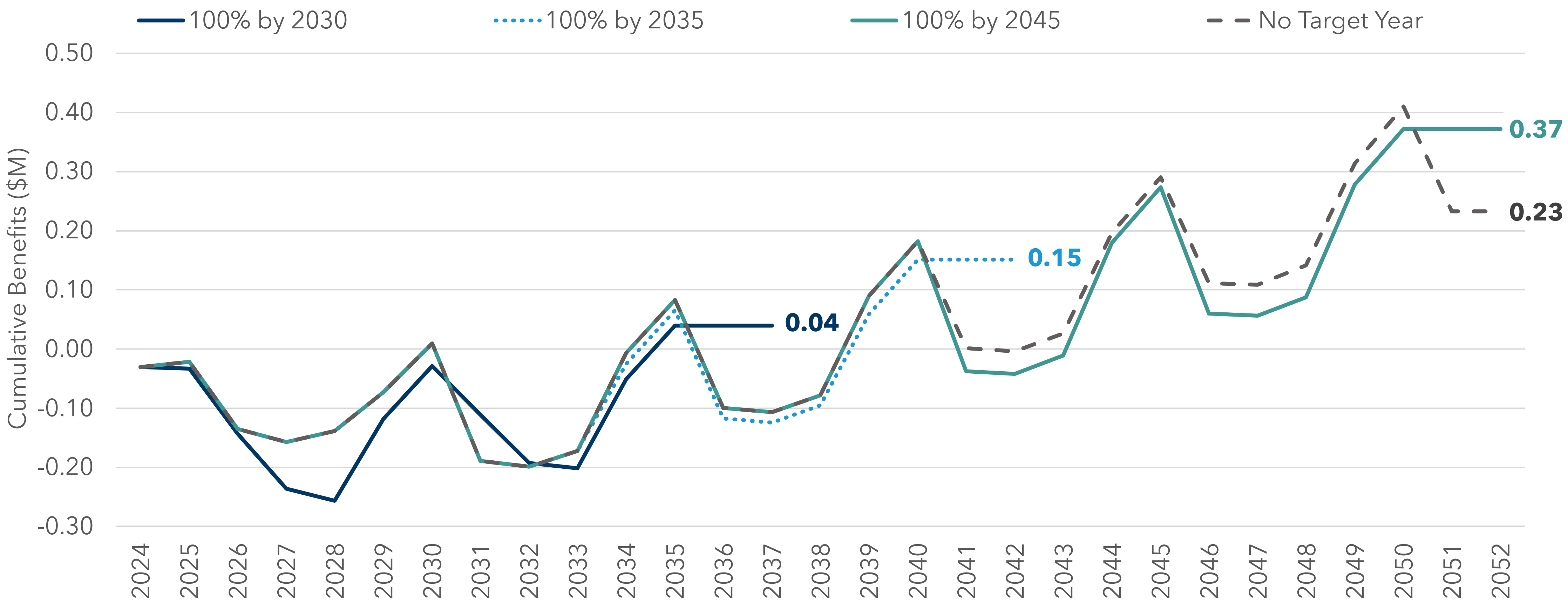
Charging infrastructure costs reflect 100% of the cost of chargers not approved for funding through ZEVIP, 50% of those approved through ZEVIP (Round 3), and 0% of those already installed

Transit

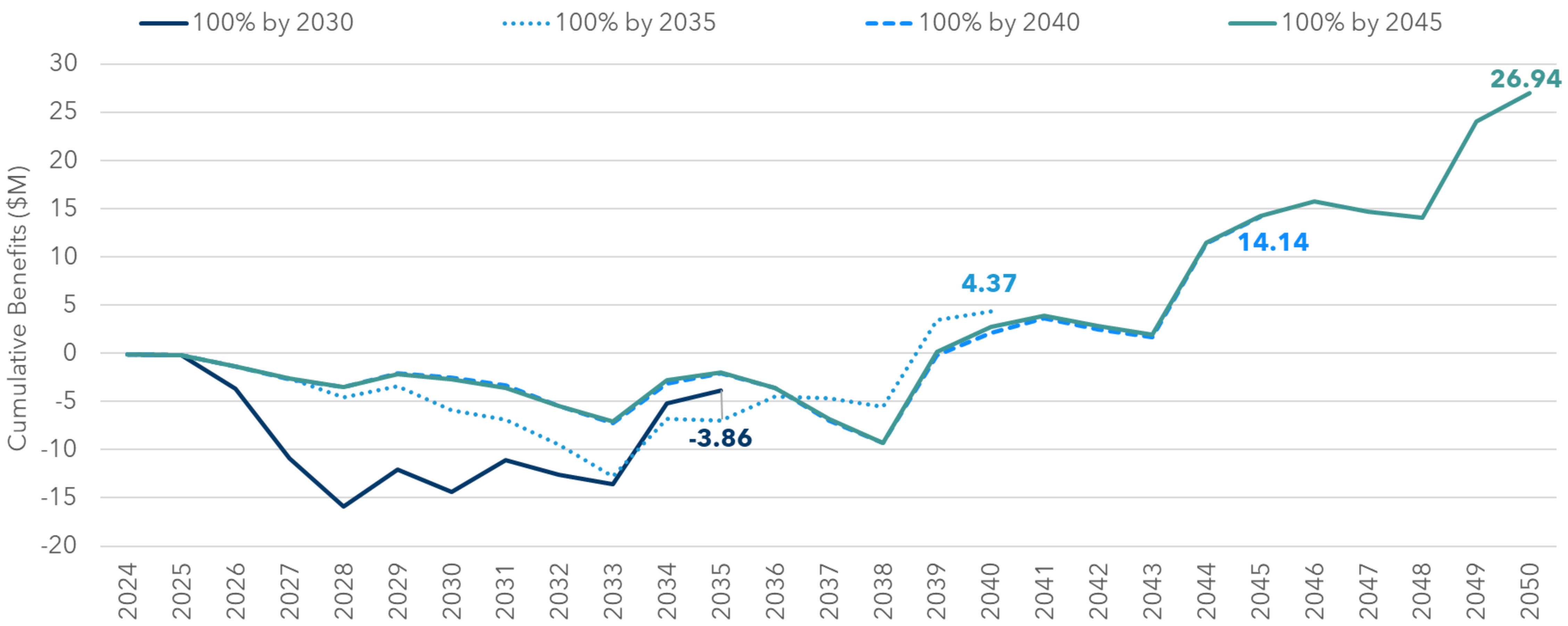
The small size of the Transit fleet results in proportionately **greater annual variation** in the cashflow, however, there are expected to be **net incremental financial benefits** over an ICEV baseline across all fleet electrification scenarios examined.



*Note that the resale value of vehicles has been excluded from our financial analysis due to uncertainty around future residual values of EVs; while some sources (KBB and Edmunds) suggest that EV resale values may currently be lower than their ICEV counterparts, we expect the used EV market to grow and thus, we expect Durham to be able to secure some revenue from resale
Charging infrastructure costs reflect 100% of the cost of chargers not approved for funding through ZEVIP, 50% of those approved through ZEVIP (Round 3), and 0% of those already installed

Police

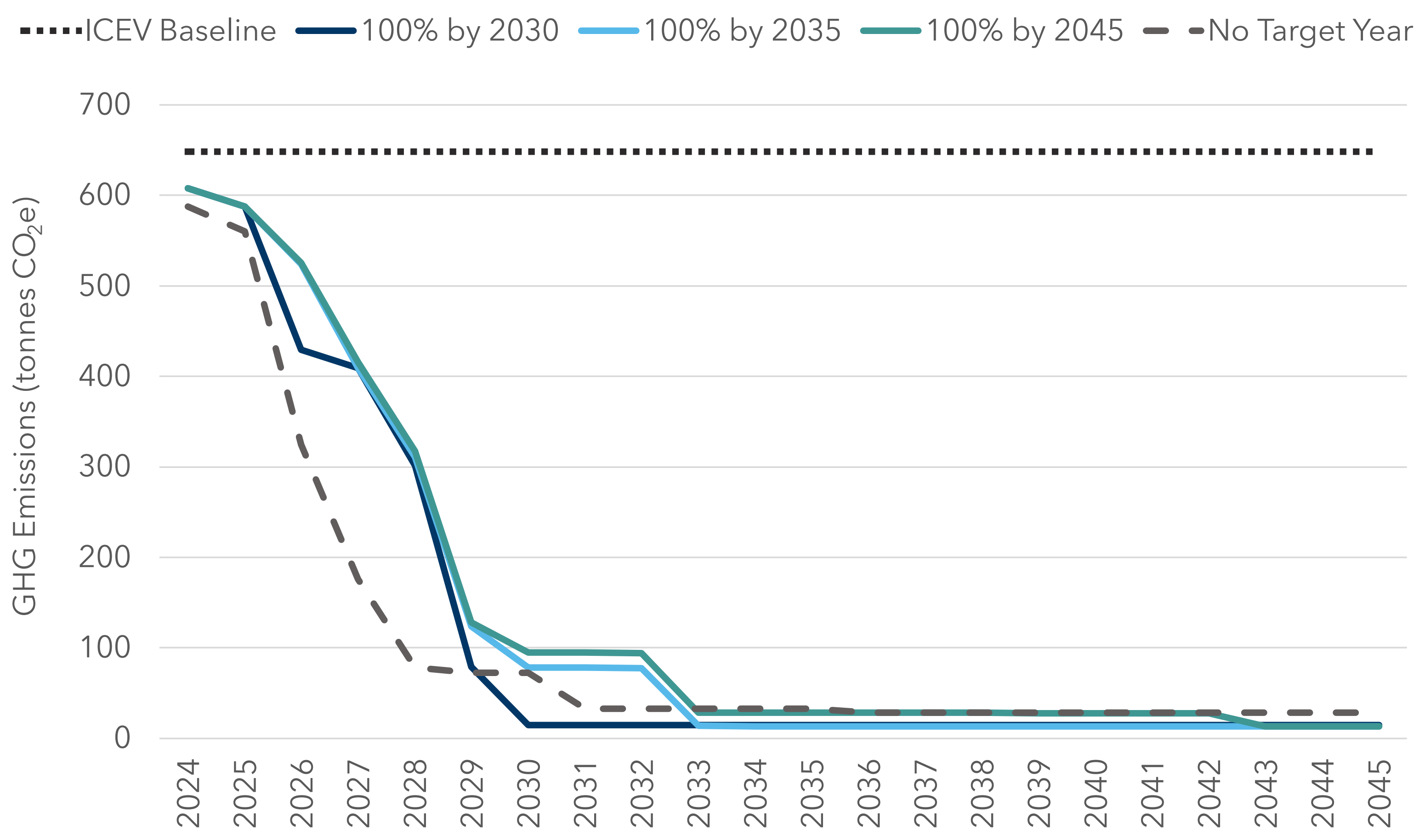
Under the 100% by 2030 scenario, a transition to EVs will result in a **net incremental cost** to the Region. By extending the target year for electrification, financial benefits are expected to materialize.



*Note that the resale value of vehicles has been excluded from our financial analysis due to uncertainty around future residual values of EVs; while some sources (KBB and Edmunds) suggest that EV resale values may currently be lower than their ICEV counterparts, we expect the used EV market to grow and thus, we expect Durham to be able to secure some revenue from resale

7. GHG Emissions Reductions

Works



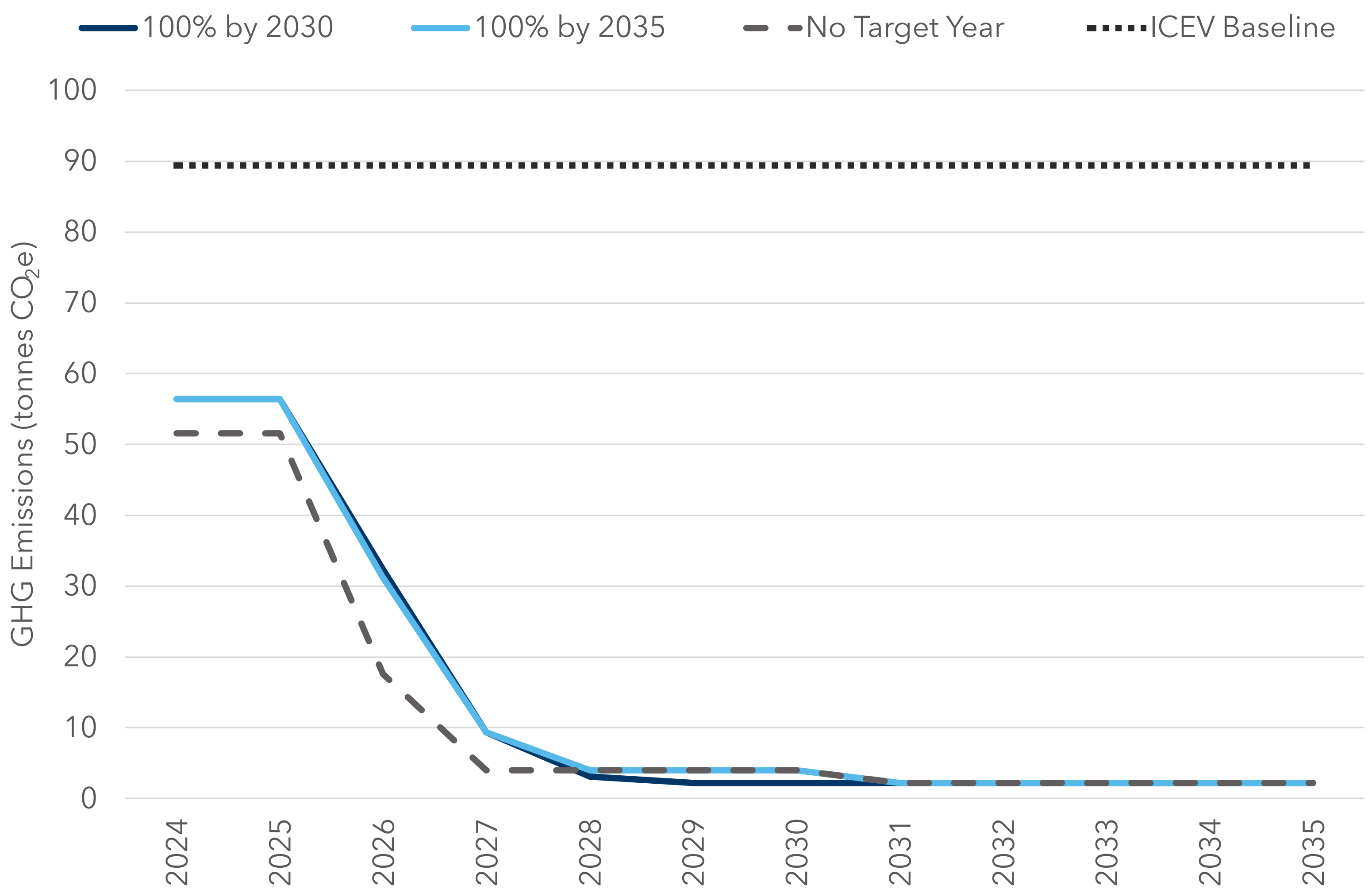
GHG emissions reductions across all scenarios that we've modelled for the Works department can contribute to fast and notable GHG emissions reductions in support of the Region's target of a 40% reduction in GHG emissions by 2030 and 100% by 2045 (relative to a 2019 baseline).

The fleet electrification pathways we have modelled lead to GHG emissions reductions of **78-98% by 2030** in comparison to an ICEV baseline. **Across all fleets and scenarios, a 98% reduction in GHG emissions can be achieved at 100% fleet electrification.**

Given that the "No Target Year" scenario had a higher annual limit on the number of first ICE-to-EV conversions, a faster rate of GHG emissions reductions is achieved under that scenario in earlier years thanks to a faster rate of EV conversions that are ultimately driven by the positive business case for electrification.

*Our modelling assumes the carbon intensity of electricity in Ontario remains at its current level of 25 g CO2e/kWh over the entire study period. Several factors may impact this in the coming years. For one, the planned refurbishment of nuclear power plants in Ontario will lead to a change in the province's electricity generation mix. Second, the Government of Canada is currently considering the implementation of a Clean Electricity Regulation which would require electricity generation across Canada to result it net-zero GHG emissions by 2035.

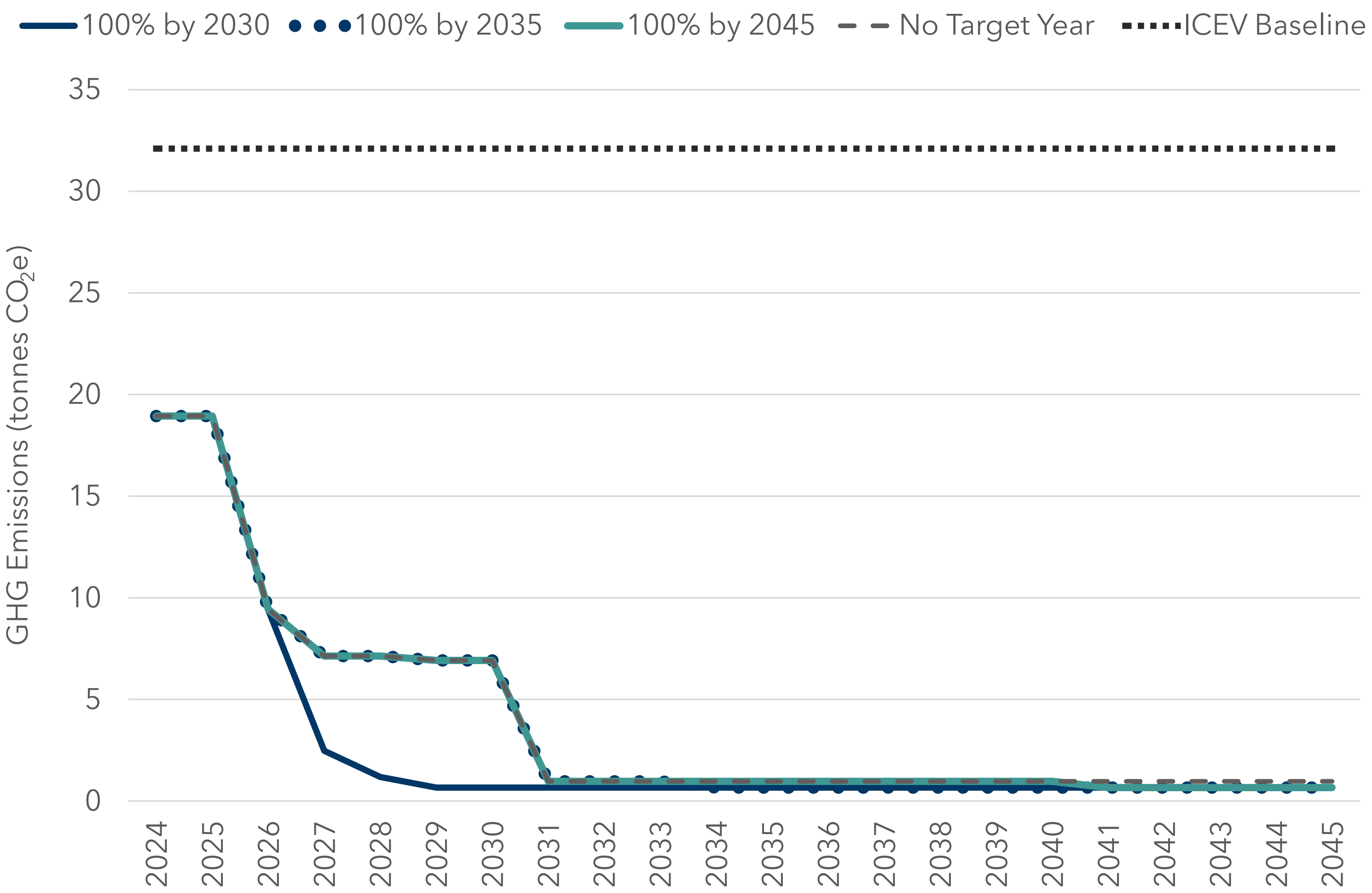
Paramedics



The fleet electrification pathways we have modelled for the Paramedics fleet can lead to GHG emissions reductions of **96-98% by 2030** in comparison to an ICEV baseline.

A **quick drop in GHG emissions in 2024** is expected thanks to the conversion of 3-4 vehicles in the fleet to electric models. Unlike the Works and Police fleets, we were not requested to account for a ramp-up period with limited EV conversions in the first two years of the plan.

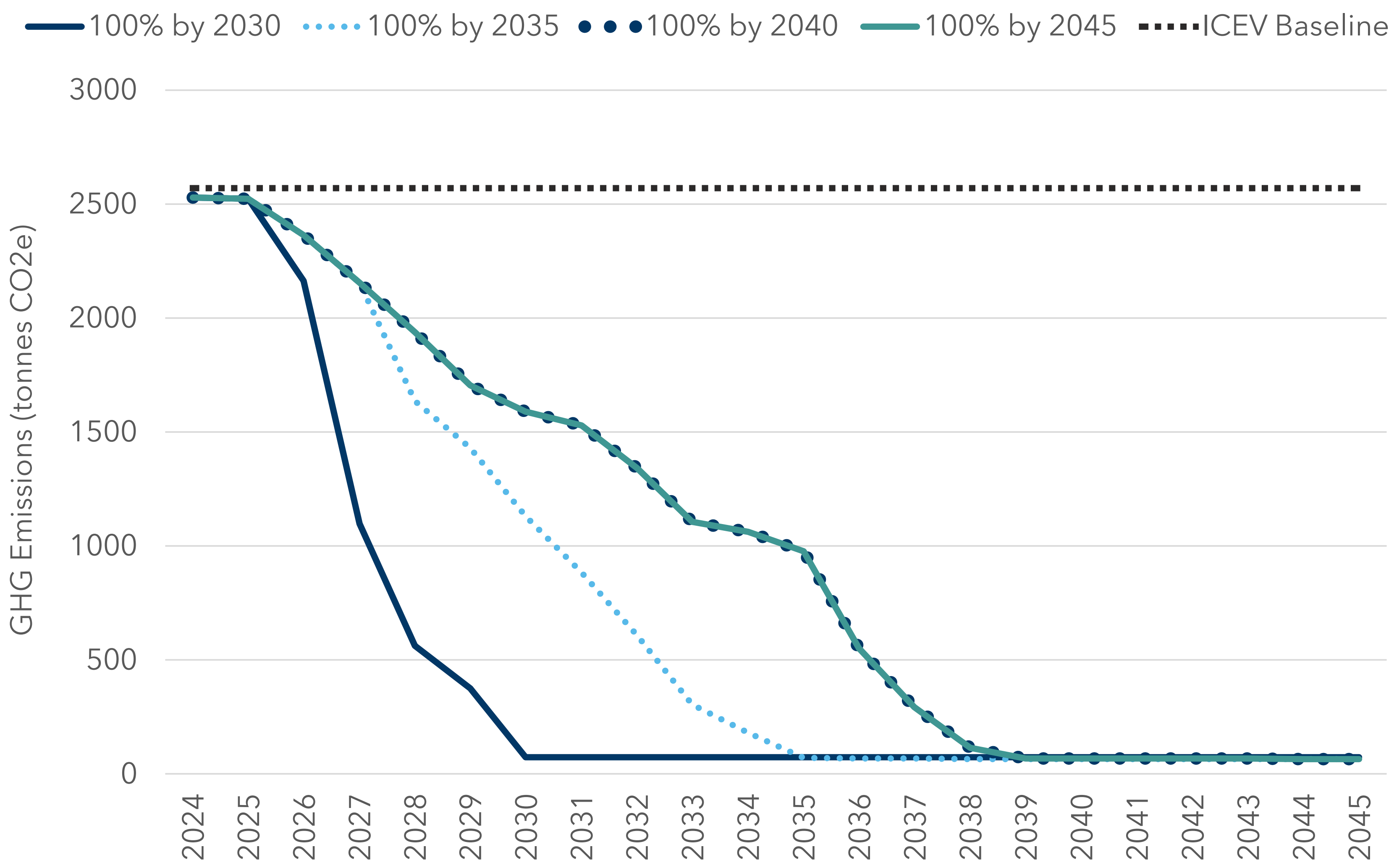
Transit



The fleet electrification pathways we have modelled for the Transit fleet can lead to GHG emissions reductions of **78-98% by 2030** in comparison to an ICEV baseline.

Given, however, the small size of the transit LDV fleet, this represents a relatively small portion of overall GHG emissions at Durham Region.

Police

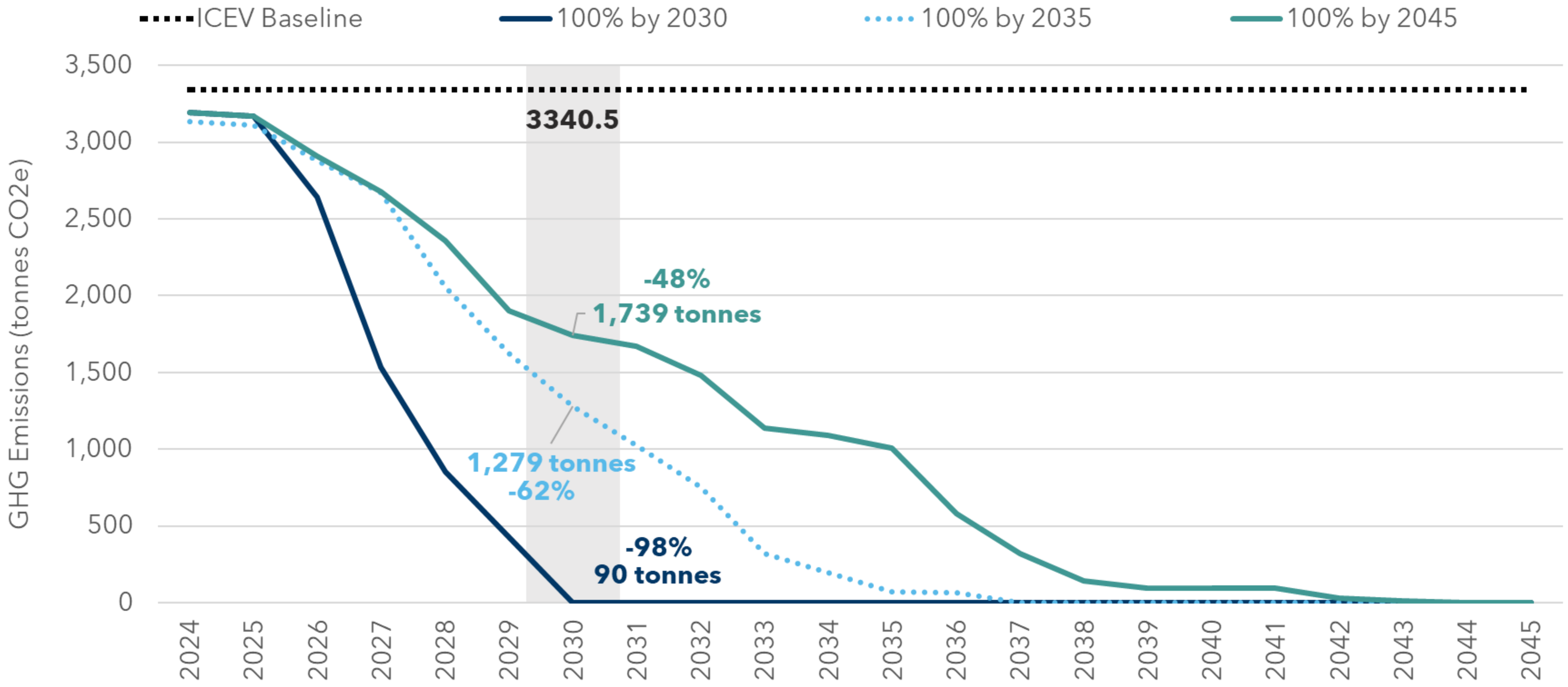


The fleet electrification pathways we have modelled for the Police fleet can lead to GHG emissions reductions of **38-97% by 2030** relative to an ICEV baseline.

Among all of Durham's LDV fleets, Police has the **highest GHG emissions** due in large part to its LDV fleet size. Given the difference in the pace of GHG emissions reductions from one scenario to another, this should be kept top of mind when selecting the optimal pathway for Police fleet electrification.

Total Fleet GHG Emissions by Target Year

The figure below depicts the total GHG emissions reductions across **all four existing light-duty fleets** under different target years for electrification (assuming a single scenario is selected for all four fleets). We have highlighted the forecasted annual GHG emissions in 2030 and the percentage reduction relative to an ICEV baseline.



8. Conclusions

Key Takeaways

- **Cost-effective fleet electrification is possible**. We expect three out of four of Durham Region's fleet groups to be able to cost-effectively transition to light-duty EV options by as early as 2030 (Works, Paramedics, Transit). While a cost-effective transition to EVs is somewhat delayed for the Police fleet due in part to the number of high-powered DCFCs required, this is expected to be possible under a 100% by 2035 target.
- **On-target emissions reductions are possible.** All scenarios are aligned with net zero by 2045 (except for the No Target Year) and are expected to meet the interim target of a 40% reduction in GHG emissions by 2030 relative to a 2019 baseline.
- **100% by 2030 is a viable pathway to accelerate GHG emission reductions in the Works, Paramedics and Transit fleets**.
- **A more moderate scenario for the Police fleet may be preferred**, due to greater uncertainty regarding EV availability to suit specific fleet needs.
- **A proactive vehicle procurement strategy will be necessary to implement the recommended pathways to fleet electrification.** Strong demand and constrained production may initially limit the Region's ability to procure certain vehicles. The Region should be proactive and place pre-orders as soon as possible.

Key Takeaways (cont'd)

- **Electrical capacity assessments and detailed electrical designs should be pursued in the near term to support the deployment of EV charging infrastructure across the Region's facilities.** EV charging infrastructure should be installed in advance of an expected EV delivery date to ensure that vehicles are able to be operated and charged on-site without delay. More than 426 charging ports will be required to support this transition, 36 of which are already installed and/or planned. Thoughtful electrical designs that leverage load management strategies like power-sharing can help minimize the need for costly electrical infrastructure upgrades, which have not been included in this analysis. Given that site-specific assessments still need to be undertaken, the Region should remain flexible to allow for alterations to the trajectory of the preferred pathway for each fleet. As much as possible, the Region should leverage funding secured through Natural Resources Canada's Zero-Emission Vehicle Infrastructure Program to support the installation of chargers that will be needed in the near term to support an electric LDV fleet.
- **The roadmaps we have presented in this memo are an important first step, but departments should follow up with detailed implementation plans.** The roadmaps we have developed show how Durham can get to 100% fleet electrification and reflect preliminary costing based on a certain point in time. Detailed plans should be developed at the fleet and facility level to determine site-level impacts and costs.
- **Our analysis represents a snapshot in time.** Plans should be re-examined annually to reflect future market conditions.

Appendix

Police Fleet Electrification Case Studies

Town of Bridgewater, NS

- Piloting a Tesla Model 3 dual motor extended version as a traffic enforcement vehicle (no silent patrolman/barrier)
- **Started October 2022**
- Planning to next try a **Ford truck – some staff do not like the low seating**

Charging experience

- Charging at office
- Car is used for **two 8-hour shifts**, plugged in at 3am and is ready by 7am
  - Battery is always charged for morning shift (takes ~4h)
  - Charge to 90% per manufacturer recommendations
- Have budgeted about **$100/year** in electricity costs for charging
- Issue with **summer heat** – accessory battery was found to drain if car not used for ~2 days (A/C comes on when hot to protect the computer)
  - Solution was to take car for short drive to recharge

Appendix

Police Fleet Electrification Case Studies

New York City, USA

- Ordered **184 Ford Mustang Mach-Es**; 148 were outfitted for police use
- Total fleet size is 6,200 light-duty vehicles
- City Commitment of **100% electric by 2035**
- Charging is a key area of inquiry for the pilot

"Law enforcement EV use is a powerful step towards reducing climate-changing greenhouse gases, lowering the risk of respiratory illnesses, reducing noise, and ending a long reliance on fossil fuels. Protecting people and the environment at the same time are important goals for the future of public safety."

– NYC Sherriff Joseph Fucito

Ville de Repentigny, QC

- Piloting a modified **Ford Mustang Mach-E**
- Started **April 2022**
- Components designed by Cyberkar (did not come with police package)

City of Saanich, BC

- Staff recommended a **pilot** to City Council in December 2022
- Council asked Staff to report back with further information on potential cost savings

Detailed Fleet Electrification Plan

- **An Excel spreadsheet will accompany the memo and highlight on a per-vehicle basis the following information across each fleet and scenario:**
  - Vehicle key (identifier), make, model, year, primary facility (for charging purposes)
  - Annual usage
  - Annual idle
  - First retirement year
  - First ICE-to-EV optimal replacement year: recommended year for electrification based on modelling results
  - First ICE-to-EV optimal replacement type: recommended vehicle type for electrification (i.e. BEV or PHEV) based on modelling results
  - Forecasted replacement vehicle costs
  - BEV daily energy demands
  - Recommended charger type

EV Availability Timelines

Segment	BEV Availability Year	PHEV Availability Year	Example Vehicle Models
Car	2021	2021	• Hyundai Ioniq, Chevrolet Bolt
SUV	2021	2021	• VW ID4, Ford Escape PHEV, Toyota BZ4X
Minivan	2024	2021	• Chrysler Pacifica PHEV (available) / EV (announced)
1/2-Ton Pick-Up Truck	2024	2026	• Ford F-150 Lightning • Chevrolet Silverado (expected 2024/2025)
Mid-Size Pick-Up Truck	2025	2026	• Anticipated (e.g., Ford Maverick)
Cargo Van	2025	N/A	• Ford E-Transit • GM Brightdrop Zevo
PPV: Sedan	2026	2026	• Anticipated
PPV: SUV	2027	2028	• Chevrolet Blazer
PPV: Pick-Up Truck	2027	2028	• Anticipated (e.g., Ford Lightning)

Appendix

Model Inputs and Assumptions

Parameter	Source	Notes
Electricity Price Forecast	Durham Fuel Price Forecast (Feb 2023)	Individual price forecasts developed for each fleet to represent range in facility price structures Excludes fixed $/kW costs that would not change as a result of additional electricity load stemming from EVs
Gasoline Price Forecast	Durham Fuel Price Forecast (Jan 2023)	Gasoline prices forecast developed using EIA cost forecasts for crude oil (Brent) in 2023 and 2024 and subsequently escalated annually at a rate of 3% Price reflects Toronto Rack price, distributor margin, provincial road tax, federal excise tax and HST (carbon pricing factored in separately) Distinction made between bulk/wholesale and retail/pump prices
Carbon Pricing	Federal schedule for carbon pricing	$80/tonne CO_2 in 2024 rising $15 per year to a max of $170/tonne CO_2 in 2030
Carbon Intensity of Grid Electricity Generation	Canada Energy Regulator - Provincial and Territorial Energy Profiles - Ontario	25 g CO_2e/kWh
Average Gasoline Carbon Intensity	NIR Part 2 Table A16 1-14	2609 g CO_2e/L burned
ICEV Price Forecast	Durham Region supplemented by online sources for vehicle MSRPs, as needed	Assuming no change in cost over study period; excludes upfitting costs
EV Price Forecast	Dunsky	Leveraging what we know about existing PHEV and BEV MSRPs we forecast in EV costs overtime in response to changing battery prices using Dunsky's internal battery price forecast; excludes upfitting costs
EV Charger Costs	Dunsky	Assuming a fixed hardware cost of $2,000 per L2 and $1/Watt cost for installation; service upgrades excluded
Maintenance Costs	Durham Region data	See next slide

Maintenance Cost Assumptions

Segment	Works ($/km)	Paramedic ($/km)	Transit ($/km)	Police ($/km)
Car - ICE	-	$0.26	$0.16	$0.13 - $ 0.33
Car - HEV	-	-	-	$0.07 - $0.17
SUV	$0.89	$0.16 – $0.48	$0.05	$0.07 - $0.37
SUV - HEV	-	-	-	$0.22 – $0.28
SUV - PHEV	$0.89	-	-	-
Minivan	$0.44 - $0.76	-	$0.31	$0.12
Mid-Size Pick-Up Truck	$0.24	-	-	$1.61
1/2-Ton Pick-Up Truck	$0.21 - $0.61	-	-	$0.10 - $0.26
Cargo Van	$0.29	-	-	$0.14

BEV and PHEV maintenance costs were assumed to be **50%** those of an equivalent ICEV

(Source: Consumer Reports)

Study Limitations

- We have assumed **no change in fleet size** over the study period.
- We have assumed **like-for-like replacement of vehicles** (e.g., a sedan is replaced with an equivalent zero-emission sedan).
- **Extended retirement ages** have not been considered; instead, our E-FLEET model recommends a replacement as soon as a vehicle reaches its stated retirement threshold.
- Vehicle usage data that has been incorporated into our modelling reflects data reported by individual departments. This data has not been checked for accuracy and may reflect some manual reporting errors. Data completeness varied from one department to another. The most complete dataset was provided by the Works department which was able to leverage **telematics devices** installed on its vehicles to provide a complete and accurate picture of its vehicles' typical operations.
- We have assumed no change in **ICEV efficiency** over the study period.
- We have assumed that vehicles that can meet their daily energy requirements (driving and idle) using a **PHEV** will run exclusively off the electrical engine onboard the vehicle. Depending on how these vehicles are used, it's possible that the full magnitude of GHG emissions we have attributed to PHEVs may not be realized.
- Our ICEV cost assumptions reflect **no change in price** over the study period.
- EV prices are forecasted only according to changes in **battery prices**.
- Electrical service upgrades and vehicle residual values have been excluded from our financial analysis.

Annual Capital and Operating Budgets ($M) – Works

These tables present the annual CAPEX (upfront vehicle costs and EV chargers) and OPEX (fuel/electricity, maintenance, carbon pricing) requirements up until the target year for both the ICEV baseline and the proposed fleet electrification roadmap under each scenario.*

100% by 2030 ($M)		2024	2025	2026	2027	2028	2029	2030
ICEV Baseline	CAPEX	3.13	0.00	1.30	0.37	0.00	3.08	0.05
	OPEX	0.80	0.82	0.83	0.85	0.87	0.88	0.90
Fleet Electrification Plan	CAPEX	3.18	0.13	1.38	0.37	1.68	2.27	1.14
	OPEX	0.74	0.73	0.65	0.65	0.54	0.33	0.30

100% by 2030 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ICEV Baseline	CAPEX	3.13	0.00	1.30	0.37	0.00	3.08	0.05	1.27	0.37	0.04	3.08	0.00
	OPEX	0.80	0.82	0.83	0.85	0.87	0.88	0.90	0.90	0.91	0.92	0.93	0.93
Fleet Electrification Plan	CAPEX	3.18	0.13	1.32	0.24	1.17	2.59	0.58	0.67	0.29	2.54	1.56	0.79
	OPEX	0.74	0.73	0.70	0.72	0.65	0.45	0.42	0.42	0.43	0.30	0.30	0.31

100% by 2045 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
ICEV Baseline	CAPEX	3.13	0.00	1.30	0.37	0.00	3.08	0.05	1.27	0.37	0.04	3.08	0.00	1.32	0.37	0.00	3.08	0.04	1.27	0.42	0.00	3.08	0.00
	OPEX	0.80	0.82	0.83	0.85	0.87	0.88	0.90	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.01	1.02
Fleet Electrification Plan	CAPEX	3.18	0.13	1.27	0.24	1.17	2.60	0.51	0.72	0.23	2.08	1.69	0.41	0.70	0.23	1.93	1.74	0.41	0.65	0.28	2.75	1.50	0.45
	OPEX	0.74	0.73	0.70	0.72	0.64	0.45	0.42	0.42	0.43	0.32	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.34	0.32	0.32	0.32

*The No Target Year scenario has been excluded as this scenario was provided for illustrative purposes only – it is not recommended for implementation

Annual Capital and Operating Budgets ($M) – Paramedics

These tables present the annual CAPEX (upfront vehicle costs and EV chargers) and OPEX (fuel/electricity, maintenance, carbon pricing) requirements up until the target year for both the ICEV baseline and the proposed fleet electrification roadmap under each scenario.*

100% by 2030 ($M)		2024	2025	2026	2027	2028	2029	2030
ICEV Baseline	CAPEX	0.81	0.00	0.00	0.29	0.00	0.52	0.29
	OPEX	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Fleet Electrification Plan	CAPEX	0.80	0.00	0.17	0.31	0.23	0.11	0.18
	OPEX	0.07	0.08	0.06	0.04	0.04	0.04	0.04

100% by 2035 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ICEV Baseline	CAPEX	0.81	0.00	0.00	0.29	0.00	0.52	0.29	0.00	0.00	0.29	0.52	0.00
	OPEX	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12
Fleet Electrification Plan	CAPEX	0.75	0.00	0.23	0.46	0.11	0.07	0.14	0.13	0.18	0.24	0.00	0.00
	OPEX	0.07	0.08	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

*The No Target Year scenario has been excluded as this scenario was provided for illustrative purposes only – it is not recommended for implementation

Annual Capital and Operating Budgets ($M) – Transit

dunsky

These tables present the annual CAPEX (upfront vehicle costs and EV chargers) and OPEX (fuel/electricity, maintenance, carbon pricing) requirements up until the target year for both the ICEV baseline and the proposed fleet electrification roadmap under each scenario.*

100% by 2030 ($M)		2024	2025	2026	2027	2028	2029	2030
ICEV Baseline	CAPEX	0.31	0.06	0.00	0.00	0.00	0.31	0.06
	OPEX	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fleet Electrification Plan	CAPEX	0.35	0.07	0.13	0.12	0.04	0.20	0.00
	OPEX	0.02	0.02	0.01	0.01	0.01	0.01	0.01

100% by 2035 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ICEV Baseline	CAPEX	0.31	0.06	0.00	0.00	0.00	0.31	0.06	0.00	0.00	0.00	0.31	0.00
	OPEX	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Fleet Electrification Plan	CAPEX	0.35	0.06	0.13	0.04	0.00	0.27	0.00	0.23	0.04	0.00	0.20	0.00
	OPEX	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

100% by 2045 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
ICEV Baseline	CAPEX	0.31	0.06	0.00	0.00	0.00	0.31	0.06	0.00	0.00	0.00	0.31	0.06	0.00	0.00	0.00	0.31	0.06	0.00	0.00	0.00	0.31	0.06
	OPEX	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fleet Electrification Plan	CAPEX	0.35	0.06	0.13	0.04	0.00	0.27	0.00	0.23	0.04	0.00	0.18	0.00	0.21	0.04	0.00	0.18	0.00	0.25	0.04	0.00	0.15	0.00
	OPEX	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

*The No Target Year scenario has been excluded as this scenario was provided for illustrative purposes only – it is not recommended for implementation

Annual Capital and Operating Budgets ($M) – Police

These tables present the annual CAPEX (upfront vehicle costs and EV chargers) and OPEX (fuel/electricity, maintenance, carbon pricing) requirements up until the target year for both the ICEV baseline and the proposed fleet electrification roadmap under each scenario.

100% by 2030 ($M)		2024	2025	2026	2027	2028	2029	2030
ICEV Baseline	CAPEX	9.45	1.98	2.86	0.00	0.00	9.45	1.98
	OPEX	2.77	2.83	2.89	2.95	3.01	3.08	3.14
Fleet Electrification Plan	CAPEX	9.62	2.05	6.67	8.33	6.57	7.42	6.31
	OPEX	2.75	2.80	2.58	1.84	1.44	1.31	1.08

100% by 2035 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ICEV Baseline	CAPEX	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98
	OPEX	2.77	2.83	2.89	2.95	3.01	3.08	3.14	3.17	3.19	3.22	3.25	3.28
Fleet Electrification Plan	CAPEX	9.62	2.05	4.22	1.60	2.68	9.15	5.63	5.31	4.21	5.21	5.51	4.32
	OPEX	2.75	2.80	2.73	2.60	2.29	2.17	1.97	1.76	1.55	1.29	1.21	1.12

100% by 2040 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
ICEV Baseline	CAPEX	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98
	OPEX	2.77	2.83	2.89	2.95	3.01	3.08	3.14	3.17	3.19	3.22	3.25	3.28	3.31	3.34	3.37	3.40	3.44
Fleet Electrification Plan	CAPEX	9.62	2.06	4.22	1.60	1.33	8.77	3.20	4.58	3.11	3.04	6.55	2.23	6.13	5.44	4.52	2.57	0.30
	OPEX	2.75	2.80	2.73	2.60	2.49	2.38	2.34	2.31	2.18	2.01	1.99	1.93	1.56	1.33	1.18	1.15	1.03

100% by 2045 ($M)		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
ICEV Baseline	CAPEX	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98	2.86	0.00	0.00	9.45	1.98
	OPEX	2.77	2.83	2.89	2.95	3.01	3.08	3.14	3.17	3.19	3.22	3.25	3.28	3.31	3.34	3.37	3.40	3.44	3.47	3.51	3.55	3.58	3.62
Fleet Electrification Plan	CAPEX	9.62	2.05	4.22	1.60	1.34	8.89	3.30	4.58	2.87	2.80	6.49	2.47	6.28	5.21	4.69	2.29	1.67	3.93	3.46	3.21	2.30	0.00
	OPEX	2.75	2.80	2.73	2.60	2.50	2.38	2.34	2.31	2.18	2.01	1.99	1.93	1.55	1.32	1.17	1.15	1.16	1.16	1.17	1.18	1.20	1.07