EV Primer - Municipal Fleet Transition .docx

Town of Orangeville
Fleet Transition Analysis

November 2020

Introduction

The Town of Orangeville relies on its fleet of vehicles to maintain roads, provide bylaw enforcement, manage water and wastewater services, keep parks and facilities maintained and provide many other services throughout the community. These vehicles are essential; however, the Town recognizes that existing fleet operations generate greenhouse gas (GHG) emissions, contributing to climate change. In response, the Town has begun to investigate alternative options to increase the efficiency and reduce GHG emissions, energy consumption and costs associated with corporate fleet operations.

This document provides background information on the low-carbon technologies that are currently available for fleet vehicles and a financial overview, outlining how electric vehicles (EVs) can be integrated into the Town's fleet.

Background

The Town of Orangeville is exploring the incorporation of EVs into its corporate fleet. EVs have been identified as a key component for decarbonizing both public and private fleets. The EV market is growing rapidly as costs have become more affordable. Various levels of governments across Canada have committed to increasing EV adoption through policy and management decisions. Increasingly, corporations are using EVs in their fleets to maintain the quality of fleet operations, build resilience, reduce fleet expenses and fulfill environmental commitments (CAP, 2018).

Management decisions associated with the Town's fleet and equipment offer a significant opportunity to reduce corporate GHG emissions. Many of the tasks performed by the Town's fleet vehicles could be accomplished by an electric alternative. As Town vehicles come to the end of their service life and are replaced, it is suggested by staff that electric alternatives should be considered moving forward.

Electric Vehicle Trends

The Federal Government has identified the electrification of Canada's transportation sector as being a key step in transitioning to a low-carbon future. This has been demonstrated through the ambitious federal targets set for EV sales, reaching 10% of light-duty vehicles sales by 2025; 30% by 2030; and 100% by 2040 (NRCan, 2019). Municipalities across the country have started to incorporate EVs into their municipal fleets to support provincial and federal targets, while reducing corporate emissions and saving on operating costs.

Although EVs currently have higher capital costs compared to their gasoline-powered counterparts, they are more economical to operate and maintain. Battery prices have dropped significantly over last few years and are projected to continue, with multiple studies forecasting that EVs will cost the same or less than the equivalent internal combustion engine (ICE) vehicles by the mid-2020s (Bloomberg New Energy

Finance, 2020). As prices become more comparable, projections[1] show a rapid increase in EV sales within the next few years, which the Town should begin to prepare for.

Types of EVs

EVs run partially or entirely by a rechargeable battery which powers an electric motor. EVs can be recharged by plugging into the electricity grid. Since they use no or minimal fossil fuel, EVs have extremely low tailpipe GHG emissions. There are two main types of EVs:

- **Battery Electric Vehicles (BEV)** are entirely powered by an electric battery and motor and must be plugged into the electricity grid to fully recharge.
- **Plug-In Hybrid Electric Vehicles (PHEV)** use an electric battery and motor which are recharged by plugging into the electricity grid, but also have the support of a small internal combustion engine when the battery is running low.

BEVs can typically travel between 200-400 kilometres between charges. PHEVs have a smaller battery pack than BEVs but can still travel on average 40-80 kilometres without any assistance from the ICE (Municipal Climate Change Action Centre, 2020). Therefore, a PHEV can be used for typical daily commutes without using any fuel, while still providing an extended range for longer trips if required. For fleet vehicle use in Orangeville, BEVs would cover the required range for daily usage. However, PHEVs may also be considered, especially as technology continues to develop for medium and heavy-duty vehicles.

The range of EVs available on the market is rapidly increasing. The number of light-duty passenger EV models available on the Canadian market increased from 10 in 2015 to 48 in 2019. (CAP, 2020). Many leading automotive manufacturers have plans to release more models, with some planning to entirely reposition themselves as EV-only producers (CAP, 2018). In Canada, 2017 saw a 68% increase in total EV sales nationally and a 120% increase in Ontario. The province held the highest rate of EV ownership in 2018 (CAP, 2018). Given the advantageous market conditions, falling battery costs and the plans of leading automobile manufacturers, transitioning corporate fleets to BEVs or PHEVs is becoming increasingly cost-effective and strategic for municipalities (NRCan, 2018).

EV Charging Infrastructure

EV charging infrastructure is a fundamental step for fleet electrification and must be considered early on in the EV planning process. Strategic consideration must be given when determining the locations of charging stations, the electrical infrastructure required, and the type of chargers selected for fleet use.

There are three main types of EV chargers currently available in Ontario (see Figure 1). Level-2 chargers are recommended for corporate fleet use, as this will allow for fleet vehicles to be fully charged overnight but does not require additional electrical loading capacity or infrastructure, as most Level-3

[1] The Bloomberg New Energy Finance Electric Vehicle Outlook 2020 report considers the influence that COVID-19 has and will have on the EV market and continues to project increased sales of EVs by 2023, being less impacted than the combustion vehicle market.

chargers do. Additionally, some PHEV models are not yet compatible with Level-3 stations. Moving forward, the consideration for installing Level-3 chargers may become required as new technology emerges and heavy-duty vehicles are able to be transitioned to electric, requiring a greater voltage charging station.

Below is an overview of each station type:

Level-1:

A Level-1 charger is a regular 120-volt household plug that utilizes an adapter to charge an electric vehicle. Most PHEVs can be recharged overnight using a Level-1 charger. However, this is the slowest type of charger and can take upwards of 12 hours (or 5-8km/hour) to fully charge a battery.

Level-2:

A Level-2 charger uses a 240-volt plug to quickly charge an EV. The charging stations installed across from Town Hall are Level-2 chargers. These charging stations can fully charge an EV in 5-10 hours. This style of charger utilizes a standard connector adopted by Canadian and American electric vehicle manufacturers for cross-compatibility. This type of charger should be installed in areas that fleet vehicles would be parked overnight in order to ensure vehicles are fully charged each morning (i.e. the Operations Centre).

Level-3

Level-3 chargers, also referred to as DC Fast Chargers, are the fastest charging option for EVs, making long-distance commutes easier. Using high voltages to charge the batteries, EVs can be topped up to 80% battery life in as little as half an hour. Unfortunately, not every EV is compatible with the fast charging Level-3 infrastructure at this point. Level-3 chargers are the most expensive to purchase and install and often require additional electrical loading capacity infrastructure in many cases.

Figure 1: Types of EV Charging Stations

From left to right: Level-1 Charger; Level-2 Charger; Level-3 Charger
Source: Municipal Climate Change Action Centre, 2020

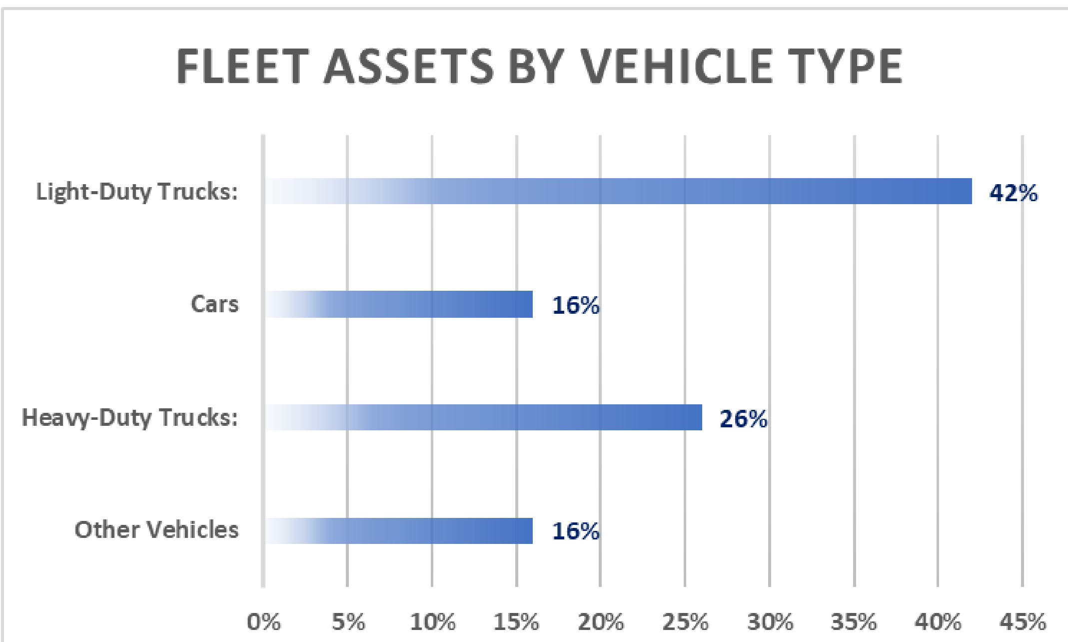
Orangeville's Corporate Vehicle Fleet

Corporate fleet vehicles have defined service lives which creates a formal window of opportunity to consider new options. Orangeville purchases and maintains a wide range of fleet vehicles ranging in type and size. When looking at the Town's fleet (excluding Orangeville Police or Fire), 16% is made up of light-duty cars and 42% is light-duty trucks and vans. Another 26% are medium- and heavy-duty trucks (see Figure 2). The remaining fleet vehicles include the Town's street sweeper, snowplows and other types of specialized equipment.

Looking at the short-term forecast, focus will be placed only on the fleet vehicles where EV alternatives are readily available. The vehicles that are of particular interest for this analysis are light-duty passenger vehicles that current EV technology would be able to meet the usage requirements.

Options for electric medium- and heavy-duty vehicles are currently limited, however technology is rapidly developing, with several pick-up truck models to be on the Canadian market by 2021. Ongoing monitoring of these developments will identify opportunities to transition to EVs as the technology becomes accessible and reliable. Meanwhile, processes such as fleet utilization (tracking the usage and needs of a vehicle), and right-sizing would support the reduction of GHG emissions as well as save on both operating and capital costs.

Figure 2: Percentage of Fleet Assets by Vehicle Type



Further, the transition to EVs for the Town's light-duty passenger vehicles can be used as a pilot to determine the feasibility of deploying EVs across the Town's fleet and ensure compatible charging infrastructure is installed. Table 1 summarizes the vehicles that would be most appropriate for the short-term transition to EVs based on vehicle usage, type and mileage.

Table 1: Town Fleet Vehicles to Prioritize for EV Replacements (2019)

Vehicle	Division	Kilometers Travelled Annually	Replacement Year	Estimated Life Expectancy	Budgeted Replacement Cost
2015 Kia Rio Hatchback	Public Works	7,892	2022	5-10	$15,000
2015 Nissan Micra	Bylaw	4,661	2022	5-10	$25,000
2015 Nissan Micra	Bylaw	4,569	2022	5-10	$25,000
2015 Nissan Micra	Buildings	1,543	2022	5-10	$25,000
2015 Nissan Micra	Buildings	3,029	2022	5-10	$25,000
2015 Nissan Micra	Buildings	1,818	2022	5-10	$25,000

Financial Analysis

Generally, EVs are associated with environmental benefits and GHG emissions reduction. However, there are also potential cost-saving opportunities that come with transitioning corporate fleet vehicles to electric alternatives.

In order to determine how EVs can be a cost-effective option for the Town's fleet, the lifecycle costs of applicable EVs have been compared with conventional fuel-use vehicles that are currently included in Orangeville's fleet. A lifecycle analysis includes the initial capital cost, the operating cost including fuel/energy and maintenance and any recovery or costs at end of service life[2].

Capital Costs:

Typically, EVs have higher upfront capital costs, but still can demonstrate cost savings over the lifecycle of the vehicle. The unit cost of both BEVs and PHEVs is approximately $10,000-$30,000 higher than comparable internal combustion engine alternatives. The higher unit costs of EVs is directly linked to the cost of the battery, which accounts for one third of the total cost (Bloomberg New Energy Finance, 2020). The cost of Lithium-ion batteries has declined exponentially in the last decade and are projected to continue to decline moving forward. Several studies have concluded that the cost of purchasing an EV will be at par or lower than an ICE vehicle by 2025 (Bloomberg New Energy Finance, 2020).

Both federal and provincial incentives are expected to continue to be released in order to meet EV targets, making the transition to EVs more attainable. Currently the Federal Government's Zero Emission Vehicle Infrastructure Program (iZEV) provides up to 50% of capital and installation costs for charging infrastructure[3] and incentives up to $5,000[4] per EV purchased (Transport Canada, 2020)[5]. Tables 2 and 3

[2] This analysis is operating on the assumption that end of service life costs are comparable to those of an internal combustion vehicle, as dealerships now collect batteries for reuse in Canada.

[3] The Town applied in partnership with Dufferin County to the iZEV for 3 dual Level-2 charging stations for fleet vehicle use.

[4] Through the iZEV Program, BEVs and longer-range PHEVs are eligible for an incentive of $5,000, and shorter-range PHEVs are eligible for an incentive of $2,500.

[5] Municipal governments are currently limited to a maximum of 10 incentives in any calendar year during the Program.

summarize the difference in MSRP costs between BEV and PHEV models to their comparable conventional fuel-engine vehicles with the iZEV incentive included.

Table 2: 2019/2020 BEVs MSRP

Make	Model	MSRP ($CAD)	Comparable Fuel Vehicle	MSRP ($CAD)	Difference in Cost	Cost Difference with iZEV Incentive
Chevrolet	Bolt	$44,998	Spark	$14,298	$30,700	$25,700
Honda	Clarity	$42,760	Fit	$22,891	$19,869	$14,869
Hyundai	Ioniq E	$41,499	Kona	$21,249	$20,250	$15,250
Hyundai	Kona E	$44,999	Kona	$21,249	$20,250	$15,250
Kia	Niro	$44,995	Niro	$26,845	$18,150	$13,150
Kia	Soul EV	$42,595	Soul	$21,195	$21,400	$16,400
Nissan	Leaf SV	$44,298	Micra	$14,298	$30,000	$25,000

Source: plugndrive.ca

Table 3: 2019/2020 PHEVs MSRP

Make	Model	Typical MSRP ($CAD)	Comparable Fuel Vehicle	MSRP ($CAD)	Difference in Cost	Cost Difference with iZEV Incentive[6]
Chrysler	Pacifica	$48,671	Pacifica	$37,995	$10,676	$5,676
Ford	Fusion	$33,693	Fusion	$26,272	$7,421	$ 4,921
Ford	Escape PHEV	$36,155	Escape	$26,965	$9,190	$4,190
Honda	Clarity	$46,306	Accord	$30,506	$15,800	$13,300
Hyundai	Ioniq	$33,749	Sonata	$26,999	$6,750	$4,250
Kia	Niro	$35,995	Niro	$26,845	$9,150	$6,650
Kia	Optima	$43,995	Optima	$28,495	$15,500	$13,000
Toyota	Prius	$28,650	Corolla	$19,150	$9,500	$7,000

Source: plugndrive.ca

Charging Station Costs:

Since Level 1 charging stations are slowest type of charger and can take upwards of 12 hours (or 5-8km/hour) to fully charge a battery, it is advised that Level 2 or 3 chargers are considered for the Town's fleet use. Level 2 charging stations are available in either wall-mounted or pedestal installations. Installing a wall mount charging station connected to the buildings' electrical system is the least expensive solution. Installing a pedestal charging station is slightly more expensive, but more convienent in most cases. The unit costs for each option typically ranges from $3,000 to $10,000 (FLO Incorporated, 2018). Level 2 charging stations are relatively simple pieces of equipment and generally do not require regular maintenance.

Level 3 charging stations typically cost between $30,000-55,000 (FLO, 2018). As noted earlier, these stations are currently the fastest form of EV charging available, providing a full charge in about 30 minutes (Partners in Project Green, 2016). The installation costs associated with Level 3 chargers are also higher, as additional infrastructure is generally needed to support the electrical loading capacity

[6] PHEVs with a battery capacity of at least 15 kWh or range of 50 km are eligible for the full $5,000 incentive, PHEVs with lower battery capacity are eligible for a $2,500 incentive.

required for the stations (Municipal Climate Change Action Centre, 2020). Table 6 outlines the charging capacities and typical costs associated with each type of station.

Table 6: Charging Station Details and Costs

Type of Infrastructure	Input Voltage	Typical Power Transfer	Charging Speed	Unit Cost	Installation Cost	Total Project Cost	Total Cost with iZEV Incentive[7]
Level 2 Charger[8]	Split phase 240 VAC or three-wire 120/208 VAC	3.6 kW to 7.2 kW	18 - 36 km/h	$10,000	$10,000	$20,000	$10,000
Level 3 Charger	3P 208 VAC or 3P 480 VAC or Split phase 240 VAC	25 kW to 50 kW	126 - 250 km/h	$55,000	$50,000	$105,000	$55,000

Source: FLO, 2018

Operating Costs:

Despite the high upfront costs associated with transitioning to EVs, research shows that looking at the total cost of ownership, purchasing an EV can cost less than ICE vehicles. This is a result of lower fuel and maintenance costs and potentially longer lifespans of the vehicles. The expected maintenance cost reduction for each EV is due to the elimination of servicing needs for engine and transmission oils, coolant systems, ignition systems, oil filters, air filters and fuel filters (FLO Incorporated, 2018).

EVs are vastly more energy efficient than conventional gasoline-powered vehicles, being particularly efficient in stop-and-go driving in urban settings. EVs use approximately 77% of their supplied energy to propel the vehicle, whereas only 12-30% of the energy converted by a gasoline-powered vehicle is used to propel the vehicle (City of Edmonton, 2018).

To add, the cost of electricity per kilometre is much lower than litre of gasoline used per kilometre. An EV costs approximately 2-3¢/km (assuming rate of 13¢/kWh), compared to a typical 4-cylinder ICE vehicle at 7-8¢/km (assuming rate of $1.00/L) (NRCan, 2018). Based on usage statistics from existing Level 2 charger installations, 8 hours of charging uses approximately 50kWh of energy, for a cost of $6.40 per full charge when the electricity price is 12.8¢/kWh [9] (FLO Incorporated, 2018). By choosing locations that the EVs can be parked at overnight, fleet vehicles will be charged overnight during off-peak time of use periods when electricity costs are lowest.

Additionally, with projections of fuel prices and the federal carbon tax projected to increase over the next few years, the cost savings potential will also increase by transitioning to EVs moving forward. Considering the average annual mileage of the selected light-duty vehicles, it can be estimated that replacing each vehicle would result in an annual cost savings of 70% from fuel use reduction. Table 4 and

[7] NRCan's contribution through this Zero Emission Vehicle Infrastructure Program covers up to fifty percent (50%) of total project costs, with limitations of $10,000 per Level 2 charger and $50,000 per Level 3 charger.
[8] It is common that a Level-2 charging station is one unit with two connectors available for two parking spots.
[9] Used current fixed rate of 12.8¢/kWh from Orangeville Hydro

5 summarize the general cost savings and GHG emissions reduction associated with each BEV and PHEV model.

Table 4: 2019/2020 BEVs

Make	Model	kWh/100 km	Range (km)	Level 2 Charge Time (hrs)	Energy Cost Annually	Fuel Cost Equivalent	Average Annual GHG Emissions (CO_{2e})	Gas Car Emissions Equivalent (CO_{2e})
Chevrolet	Bolt	18.0	417	9	$365	$2,245	145kg	4,400kg
Hyundai	Ioniq E	15.5	274	4	$315	$2,480	125kg	4,860kg
Hyundai	Kona	16.8	415	9	$340	$2,490	135kg	4,880kg
Kia	Niro	18.6	385	9	$380	$2,490	150kg	4,880kg
Kia	Soul	18.6	391	10.5	$380	$2,245	150kg	4,400kg
Nissan	Leaf	18.7	363	8	$395	$2,480	125kg	4,860kg

Source: plugndrive.ca

Table 5: 2019/2020 PHEVs

Make	Model	kWh/ 100km	L/100 km	Range (km) Electric /Combined	Level 2 Charge Time (hrs)	Energy Cost Annually	Fuel Cost Equivalent	Average Annual Emissions (CO_{2e})	Gas Car Emissions Equivalent (CO_{2e})
Chrysler	Pacifica	25.8	8.0	51/835	2	$640	$2,970	740kg	5,780kg
Ford	Fusion	20.5	5.6	42/940	2.6	$636	$2,480	737kg	4,860kg
Ford	Escape	19	5.6	77/475	2.5	$385	$2,480	155kg	4,860kg
Honda	Clarity	17.7	4.5	47/961	2.3	$460	$2,480	425kg	4,860kg
Hyundai	Ioniq	19.7	5.1	42/853	2.25	$600	$2,480	680kg	4,860kg
Kia	Niro	20.3	5.9	47/937	2.7	$600	$2,480	680kg	4,860kg
Kia	Optima	15.8	4.3	40/995	2	$515	$2,490	635kg	4,860kg

Source: plugndrive.ca

Environmental and Social Benefits

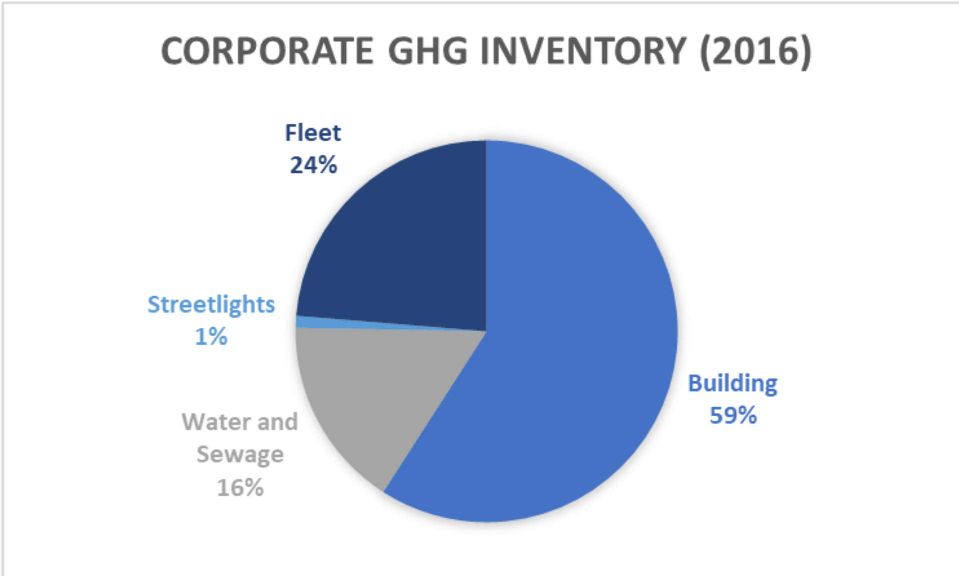
Reducing Corporate Greenhouse Gas (GHG) Emissions:

The Town has recognized the importance of reducing local GHG emissions through its commitments to the Partners for Climate Protection (PCP) program and the Global Covenant of Mayors for Climate and Energy (GCoM). Each program requires the Town to develop ambitious GHG emission reduction targets and action plans to reduce both community and corporate emissions. In order to meet these commitments and limit local contributions to climate change, decision-making processes at the Town should consider low carbon alternatives across the corporation.

Additionally, the endorsement of the Town's Sustainable Neighbourhood Action Plan (SNAP) committed to encouraging emission reductions across the corporation and community. The Town of Orangeville's 2016 corporate GHG emission inventory reveals that fleet vehicles are responsible for 24% of the Town's total emissions, with a total of 674 tCO_{2e}/yr (see Figure 3).

In 2019, light-duty fleet vehicles accounted for 14% of total vehicle fleet emissions (101 tCO_{2e}), offering a feasible opportunity to reduce corporate emissions through the transition of fleet vehicles to low-carbon options. Converting fleet vehicles to EVs is expected to reduce the GHG lifecycle emissions from each replaced vehicle by up to 80% (Pembina Institute, 2019).

Figure 3: Greenhouse Gas Emissions (tCO_{2e}) by Sector



Air Quality

Traditional ICE vehicles emit various air pollutants including carbon monoxide, black carbon, nitrogen oxides, volatile organic compounds and particulate matter. A study out of the University of Toronto found that air pollution is much higher surrounding urban roads, with over 80% of nitrogen monoxide and 60% of black carbon found to be coming from local traffic at near-road sites (University of Toronto, 2019). These tailpipe emissions have been found to have considerable health impacts in urban areas, adversely affecting human lung and cardiac health. Research also shows that children, senior residents and individuals with pre-existing health conditions are all particularly vulnerable to health impacts resulting from traffic-related air pollution (University of Toronto, 2019).

Among the many benefits associated with EVs, improved air quality resulting from the reduction of tailpipe emissions is one that is particularly motivating for urban areas. While Orangeville does not experience the same magnitude of vehicle traffic as the City of Toronto does, the areas surrounding downtown roads and major roadways have been found to have reduced air quality in comparison to its surrounding rural areas (MOECP, 2020).

Other Considerations

Energy Resiliency

Studies and historical events have found that EVs can help to build community resiliency and assist with recovery during emergency situations. For instance, in times of extreme weather events, blackouts, or technology failure, EVs have been utilized to provide electricity to homes, elevators and even to charge various types of technology for communication (Nissan, 2019). By taking advantage of electricity as a fuel source, Orangeville can build resiliency into its fleet system by decreasing reliance on one form of vehicle fuel. Emerging technologies including solar-powered charging stations, diversifying energy supply and increased battery storage will further support the resiliency of fleet vehicles.

Reduce Noise Pollution

In residential areas, engines tend to be the primary contributors to traffic noise levels. With EVs creating virtually no engine noise, the reduction of noise pollution from vehicles in urban and residential settings can be significantly reduced.

Right-Sizing

Recently, new technologies have been used by Canadian municipalities to gain more detailed and robust data on their fleet usage. Historically, municipalities tend to use manual logbooks and tracking sheets for mileage and fuel consumption for each vehicle. However, since these methods are reliant on the consistency of the operator, data gaps are to be expected. Telematics is a new method being used to track fleet data, usually provided through third party arrangement. Telematics tracks a variety of data inputs, directly from the vehicles on-board diagnostics systems. The advantage of these systems is that they can track vehicle and fuel usage in real-time providing up to date information for fleet managers, removing the human error factor (NRCan, 2018).

By gaining more information on the Town's fleet vehicles, fleet management could more efficiently right-size the number and type of vehicle required to provide the set level of services. Additionally, by determining the utilization of all fleet vehicles using telematics, the capital investments needed for transitioning to EVs and the required infrastructure could be better understood.

Leadership and Recovery

The Town has an opportunity to demonstrate how successful deployment of EVs can be achieved in Orangeville while supporting corporate goals and values. By integrating EVs into visible roles throughout the fleet and establishing reliant charging infrastructure, the Town will not only reduce corporate emissions but also increase exposure and awareness of emerging EV technology across the community.

Additionally, when planning for economic recovery from the COVID-19 pandemic, returning to 'business as usual' will not result in long-term corporate resilience. Taking a 'build-back-better' approach by focusing on community well-being, will not only minimize the likelihood of future risks, but also increase the Town's ability to cope and respond. Recovery policies that have been developed in response to COVID-19 impacts have included investing in low-carbon and decentralised electricity systems (OECD, 2020). By investing in low-carbon alternatives, starting with light-duty fleet vehicles, the Town can build corporate resiliency, while showcasing corporate values and goals for a more sustainable and resilient future.

References

AECOM. 2017. City of Minneapolis Electric Vehicle Study. <https://lims.minneapolismn.gov/Download/RCA/2361/10_Municipal%20Fleet%20Electric%20Vehicle%20Study.pdf>

City of Calgary. 2017. Calgary’s Electric and Low-Emissions Vehicles Strategy. <https://engage.calgary.ca/electric-vehicle-strategy>

City of Edmonton. 2018. Edmonton's Electric Vehicle Strategy. <https://www.edmonton.ca/city_government/documents/PDF/EdmontonElectricVehicleStrategy.pdf>

City of North Vancouver. 2018. Electric Vehicle Strategy. <https://www.cnv.org/-/media/city-of-north-vancouver/documents/electric-vehicles/electric-vehicle-strategy-september-2018.ashx?la=en>

Clean Air Partnership (CAP). 2018. Coningsby, L and Behan, K. Building the corporate business case for electric vehicles. < https://www.cleanairpartnership.org/wp-content/uploads/2018/11/CAP-EV-Business-Case.pdf>

Clean Air Partnership (CAP). 2020. Stefanova, D. Fleet electrification – challenges and opportunities. <https://www.cleanairpartnership.org/fleet-electrification-challenges-and-opportunities/>

FLO Incorporated. 2018. The benefits of offering public EV charging services. <https://charging-station.flo.ca/white-paper/benefits-public-electric-vehicle-charging-services/>

FLO Incorporated. 2020. City of Kingston Case Study. <https://www.flo.com/en-CA/resources/business/case-studies/>

Fraser Valley Regional District. 2015. Electric Vehicle Business Case. <http://www.westcoastelectricfleets.com/wp-content/uploads/2016/01/FVRD-Electric-Vehicle-Business-Case-Nov-2015.pdf>

Ministry of Environment, Conservation and Parks (MOECP). 2020. Ontario's Air Quality Health Index. < http://www.airqualityontario.com/aqhi/locations.php>

Municipal Climate Change Action Centre (MCCAC). 2020. Electric Vehicle Knowledge Guide. <https://mccac.ca/app/uploads/EVM-Guidebook-1.pdf>

Natural Resources Canada (NRCan). 2018. Greening Government Fleets: Best Practices. <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/transportation/NRCan_GreeningGovFleets_e.pdf>

Nissan Motor Corporation. 2019. Powering resilience: How EVs can help communities bounce back after a disaster. < https://global.nissannews.com/en/releases/release-b8a1567ee6066d582c91ef8f1d0b47ad-190920-00-e>

Partners in Project Green. 2016. Charge Up Ontario. <https://www.partnersinprojectgreen.com/wp-content/uploads/2017/01/PPG_Charge-Up-Ontario_EVSE-Report-UPDATED-MARCH_1_2017.pdf>

Pembina Institute. 2019. Powering the Future. <https://www.pembina.org/reports/powermyride-factsheet.pdf>

Transport Canada. 2020. iZEV Program. <https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles>

University of Toronto. 2019. Evans, G. Near-Road Air Pollution Pilot Study Final Report. Southern Ontario Centre for Atmospheric Aerosol Research. <https://tspace.library.utoronto.ca/handle/1807/96917>