



WEST HANTS REGIONAL MUNICIPALITY
Municipal Climate Change Acton Plan (MCCAP) Agenda
April 12, 2023 – 11:00am
Council Chambers / Zoom

- 1.0 Call to Order and Identification of Designates**
- 2.0 Approval of Agenda and Additions**
- 3.0 Approval of Minutes**
- 4.0 New Business**
 - 4.1 Recommendation: Federation of Canadian Municipalities Community Building Retrofit (John Ogilvie)
 - 4.2 Recommendation: Council Declaration of International Compost Week (Kristyn Remme)
 - 4.3 Information: Planning & Development Fleet Conversion (John Ogilvie)
 - 4.4 Discussion: Coastal Protection Act Regulations (Chair Jannasch)
 - 4.5 Discussion: High School Science Fair Projects (Chair Jannasch)
- 5.0 Business Arising from the Minutes**
 - 5.1 Update: NS Sustainable Communities Challenge Fund (John Ogilvie)
 - 5.2 Update: Committee Name (John Ogilvie)
 - 5.3 Update: Green Business Initiative (John Ogilvie)
- 6.0 Roundtable Discussion**
- 7.0 Next Meeting Date – September 13, 2023?**
- 8.0 Adjournment**



WEST HANTS REGIONAL MUNICIPALITY REPORT

Information <input type="checkbox"/>	Recommendation <input checked="" type="checkbox"/>	Decision Request <input type="checkbox"/>	Councilor Activity <input type="checkbox"/>
--------------------------------------	--	---	---

To: Municipal Climate Change Action Plan (MCCAP) Committee

Submitted by: _____
John Ogilvie, Climate Action Coordinator

Date: April 12, 2023

Subject: Federation of Canadian Municipalities (FCM) Community Building Retrofit Funding

LEGISLATIVE AUTHORITY

West Hants Regional Municipality (WHRM) Greenhouse Gas (GHG) Emission Local Action Plan, Action Items 1.1, 2.1, and 5.4

RECOMMENDATION

...that the MCCAP Committee recommend to Committee of the Whole to recommend that Council approve in principle funding 20% as the Municipal contribution of an application to the FCM Community Building Retrofit Initiative to support a feasibility study, up to a maximum Council contribution of \$40,000, to be funded through the Regional Operating Reserve.

BACKGROUND

Property <input type="checkbox"/>	Public Opinion <input type="checkbox"/>	Environment <input checked="" type="checkbox"/>	Social <input type="checkbox"/>	Economic <input checked="" type="checkbox"/>	Councilor Activity <input type="checkbox"/>
-----------------------------------	--	---	---------------------------------	--	--

The Federation of Canadian Municipalities (FCM) offers community buildings retrofit funding through its Green Municipal Fund. This funding can be used to perform feasibility studies and capital upgrades that target emission reductions over the short and long term. The funding can be used for one facility or a portfolio of facilities – but at least one community facility must be part of the application.

Action item 1.1 of the Local Action Plan is to perform internal building conditions surveys. Through the summer of 2022, Will Chapple and I performed those surveys for Municipal

facilities including the Windsor Community Centre (78 Thomas St.), Brooklyn Fire Station and Civic Centre (995 Hwy 215), Hants Aquatic Centre (306 Stannus St.), and Municipal water/wastewater utility facilities. These facilities were chosen because they are large sources of corporate emissions and/or are frequently used by the public – making them highest priority. Other Municipal facilities will be part of the building conditions surveys in the future. The surveys and resulting data are a preliminary understanding of existing inefficiencies and opportunities for improvement. Action item 2.1 is to switch fuel sources for heating and cooling to electric heat pumps. Many Municipal facilities still rely on oil-fired boilers for heat, and some lack air conditioning altogether. Action item 5.4 is to make current and future renewable energy investments and sustainability practices visible and known to the community.

DISCUSSION

Municipally owned buildings constitute the second largest source of emissions in the corporate portfolio, making up 39% (1,387 tonnes) of total corporate emissions. Council has a goal to reduce annual emissions by 45% by 2030; in addition to the ongoing greening of the Nova Scotia power grid, WHRM must reduce emissions by 35.3 tonnes by 2030 to meet the goal. Addressing building inefficiencies is a relatively easy and cost-effective way to achieve major reductions through insulation, lighting improvements, and fuel switching among other upgrades. Some of these actions are being completed over time, but external funding such as the FCM Community Buildings Retrofit fund would accelerate the process.

The available funding for feasibility studies comes in the form of a grant, up to 80% of eligible costs. Studies can be performed on 1 building to a maximum of \$65,000, or a portfolio of buildings to a maximum of \$200,000, where the average cost per building does not exceed \$65,000. The portfolio can include a combination of Municipal buildings and non-profit owned buildings in the Region. The study is a prerequisite to applying to the FCM for capital funding for building retrofits and could be used in the future for other applications. The study must look at reducing emissions by at least 50% within 10 years and by at least 80% (near net-zero) within 20 years, and the implementation of co-benefits are encouraged. Using the Windsor Community Centre as an example, a feasibility study could investigate improving efficiency and eliminating oil heat while also addressing accessibility issues – another upcoming Provincial requirement.

I circulated a survey to Directors and staff that are involved in day-to-day building use, to gain more perspective on the need for building renovations. The facilities suggested for feedback in the survey were: Windsor Community Centre (78 Thomas St.), Brooklyn Fire Station and Civic Centre (995 Hwy 215), and the Falmouth Wastewater Facility for solar generation (48 Falmouth Connector) – with a note that other water/wastewater utility facilities could also be included. I also left a question open for further suggestions; I received specific suggestions including: the Windsor and Hantsport water treatment plants, 100 King St. and 76 Morison Dr., and the Hants County Courthouse (240 King St.). Both 100 King St. and 76 Morison Dr (the WHRM administrative buildings) are pending an office location review by direction of Council. Through discussions with other staff, I gathered that expenses such as furnace oil at the Courthouse are reimbursed by the Province – so Municipal facilities would be better targets for emissions reductions and financial savings.

The feedback largely agreed with what Will and I found during building conditions surveys – that the Windsor Community Centre is in dire need of upgrades and would be a good centerpiece of an application to the FCM. Additionally, some staff mentioned that using the opportunity to investigate other buildings would be beneficial, as many are inefficient. By revamping community focused facilities to reduce corporate emissions, the Municipality will create educational focal points where people of the Region congregate. This will encourage residents and visitors to consider environmental initiatives, which would also reduce community emissions and energy poverty in the Region and more widely.

NEXT STEPS

- 1) Motion and recommendation from the MCCAP Committee to Committee of the Whole for May 9, 2023.
- 2) If the motion is approved by Council, quotes for feasibility studies will be requested to support an application to the FCM for funding.
- 3) Pre-application to the FCM for funding to complete feasibility studies.

FINANCIAL IMPLICATIONS

If Council approves the motion from the MCCAP Committee, quotes for feasibility studies will be obtained. Based on the FCM setting the maximum allowable cost at \$200,000, the minimum Municipal contribution of 20% would be \$40,000. This would allow WHRM to receive up to 80% of eligible costs from the FCM: \$160,000.

The WHRM Operating Reserve is currently projecting a March 31, 2024, balance of \$2.8 million and has the capacity to fund the \$40,000 municipal contribution for this grant application.

ALTERNATIVES

The MCCAP Committee may recommend that Committee of the Whole:

- recommend that Council approve in principle funding 20% as the Municipal contribution of an application to the FCM Community Building Retrofit Initiative to support a feasibility study as drafted or as specifically revised by direction of the MCCAP Committee; or
- provide alternative direction such as requesting further information on a specific topic.

ATTACHMENTS

There are no attachments to this report.

REVIEW

Report Prepared by: _____
John Ogilvie, Climate Action Coordinator

Report Reviewed by: _____
Diana Gibson, Acting Director of Financial Services

Report Approved by: _____
Sara Poirier, Director of Planning and Development



WEST HANTS REGIONAL MUNICIPALITY REPORT

Information <input type="checkbox"/>	Recommendation <input checked="" type="checkbox"/>	Decision Request <input type="checkbox"/>	Councilor Activity <input type="checkbox"/>
--------------------------------------	--	---	---

To: Municipal Climate Change Action Plan Committee (MCCAP)

Submitted by: _____
 Kristyn Remme, Waste Services/Public Works Safety Coordinator

Date: April 12, 2023

Subject: International Compost Awareness Week

LEGISLATIVE AUTHORITY

West Hants Regional Municipality Greenhouse Gas Emission Local Action Plan – Action Items 5.8 and 7.3

RECOMMENDATION

...that the MCCAP Committee recommends that Council declare the first full week in May as International Compost Awareness Week in a manner substantively the same as in Attachment A of the report titled “International Compost Week” to the MCCAP Committee dated April 12, 2023.

BACKGROUND

Property <input type="checkbox"/>	Public Opinion <input type="checkbox"/>	Environment <input checked="" type="checkbox"/>	Social <input type="checkbox"/>	Economic <input type="checkbox"/>	Councilor Activity <input type="checkbox"/>
-----------------------------------	--	---	---------------------------------	-----------------------------------	--

Action item 5.8 of the Greenhouse Gas Emission Local Action Plan is to explore opportunities for West Hants Regional Municipality (WHRM) to integrate as part of the circular economy. Action item 7.3 is to create food and waste reduction education programs in partnership with the community and schools. Composting is an essential part of the circular economy and as such, any opportunity to learn about and improve composting in the Region is beneficial to reduce emissions and waste.

DISCUSSION

International Compost Awareness Week (ICAW) is the largest and most comprehensive education initiative in the compost industry. Globally, it is celebrated each year during the first full week of May, where the goal is to build public awareness around the benefits of composting and compost use for effective resource management, soil health, plant growth, and climate change mitigation.

Throughout the week of ICAW, community, school, government, and business events are held to encourage and celebrate all types of composting – from backyard to large-scale. For municipalities, the initiative is the perfect way to engage businesses, non-profits, teachers, community leaders, and residents in activities that will encourage and celebrate composting.

A brief history of organics recycling in West Hants:

On June 1st, 1997, compostable organic material was banned from entering landfills in Nova Scotia. While residents of the former Town of Windsor participated in a curbside organics program early on, residents of the former Municipality of the District of West Hants were responsible for composting food waste in backyard composters. In April 2018, the curbside composting program was introduced for residents of West Hants.

Current-day, WHRM offers curbside organics collection to residents and businesses along all public roads. These materials are transported to Northridge Farms, a commercial producer and retailer of compost and compost tea.

Residents are able (and encouraged!) to utilize backyard composters if they desire, while the green cart can be used for the organic material that is unsuitable for backyard composters, such as bones, dairy or meat.

Key points on organics recycling and compost use that highlight why *International Compost Awareness Week* is such an important awareness-building program:

- The use of landfill space and incineration can be reduced by at least one-third when organics are recycled.
- When organic material is buried in a landfill, the oxygen-depleted environment creates methane, a greenhouse gas that is 80 times more harmful than carbon dioxide for 20 years after it is released. This can be significantly reduced through the recycling of organics.
- Compost offers a significant answer to climate change mitigation through a process called soil sequestration. Healthy, biodiverse soil absorbs and stores carbon from the atmosphere, serving as a carbon bank.
- Long-term soil health and productivity depends on the biological diversity of soils; plants use organic matter to convert materials into plant-available nutrients. This natural process keeps the soil well-aerated and further reduces the need for pesticide use to combat soil-borne and other plant diseases.

- Compost plays a significant role in both water conservation and quality. Compost binds pollutants to organic material and prevents them from entering waterways. Soil erosion is mitigated, and water-holding capacity is improved through compost's enhancement of soil structure, binding soil particles together.

NEXT STEPS

Social media posts via the Municipal Facebook page and website to publicize International Compost Week and inspire community engagement.

FINANCIAL IMPLICATIONS

The endorsement of International Compost Week will not have any direct impacts on Municipal finances.

ALTERNATIVES

The MCCAP Committee may recommend that Council:

- declare the first full week in May as International Compost Awareness Week as drafted or as specifically revised by the direction of the MCAP Committee; or
- provide alternative direction such as requesting further information on a specific topic.

ATTACHMENTS

Attachment A Letter to Council from the MCCAP Committee

REVIEW

Report Prepared by: _____
Kristyn Remme, Waste Services/Public Works Safety Coordinator

Report Reviewed by: _____
John Ogilvie, Climate Action Coordinator

Report Approved by: _____
Sara Poirier, Director of Planning and Development

Attachment A



April 12, 2023

RE: Endorsement of International Compost Week

Dear Mr. Mayor and Members of Council,

The Municipal Climate Change Action Plan (MCCAP) Committee requests that Council endorse International Compost Awareness Week with the declaration stated below:

Whereas the recycling of organic residuals such as food scraps, yard trimmings and soiled paper and the subsequent returning of compost to our soils are keys to tackling climate change; and

Whereas these are activities that all Canadians can do, whether at home, work or play; and

Whereas the process of composting eliminates the generation of landfill methane, a greenhouse gas which, according to the United Nations Environment Programme, is 80 times more harmful than carbon dioxide for 20 years after it is released; and

Whereas the application of compost increases organic matter in soils, which improves agricultural productivity while lowering carbon levels in the atmosphere; and

Whereas composting and compost use provides a range of additional benefits, including:

- reducing waste disposal by at least one third;
- improving the health of our soils – which in turn reduces the need for pesticides, mitigates flooding, improves the resilience of soil to extreme weather events such as droughts, enhances the nutritional quality of our foods, and generally improves food security;
- supporting the preservation of biodiversity;
- minimizing soil erosion, a process that depletes topsoil and results in nutrient and chemical pollution of our waterways; and

Whereas International Compost Awareness Week provides an annual opportunity for all of us to promote and celebrate one of the most important and effective tools immediately available to tackle climate change, food security and soil degradation; and

Whereas by proclaiming International Compost Awareness Week, we recognize the critical role that composting plays in creating a sustainable future for our communities;

Now therefore, the MCCAP Committee petitions West Hants Regional Municipality Council to endorse and declare the first full week in May as International Compost Awareness Week in West Hants, for 2023 and every year following.

Sincerely,

Councilor Rupert Jannasch
Chair, Municipal Climate Change Action Plan Committee



WEST HANTS REGIONAL MUNICIPALITY REPORT

Information <input checked="" type="checkbox"/>	Recommendation <input type="checkbox"/>	Decision Request <input type="checkbox"/>	Councilor Activity <input type="checkbox"/>
---	---	---	---

To: Municipal Climate Change Action Plan Committee (MCCAP)

Submitted by: _____
John Ogilvie, Climate Action Coordinator

Date: April 12, 2023

Subject: Planning and Development Fleet Conversion

LEGISLATIVE AUTHORITY

West Hants Regional Municipality Greenhouse Gas Emission Local Action Plan, Action 3.3.

RECOMMENDATION

As this is an information report, there is no recommendation or decision request.

BACKGROUND

Property <input type="checkbox"/>	Public Opinion <input type="checkbox"/>	Environment <input checked="" type="checkbox"/>	Social <input type="checkbox"/>	Economic <input type="checkbox"/>	Councilor Activity <input type="checkbox"/>
-----------------------------------	--	---	---------------------------------	-----------------------------------	--

Action 3.3 of the Greenhouse Gas (GHG) Emission Local Action Plan is to create a fleet management plan to introduce electric vehicles to the Municipal fleet over time. The Municipal fleet is the third largest source of emissions in the corporate inventory. Overall, the Municipal fleet produced approximately 192 tonnes of GHG emissions in 2018/19; the Planning and Development Department fleet makes up 6 tonnes of that, representing 3% of Municipal fleet emissions.

To inform a plan, the Clean Foundation performed a feasibility study of converting the Planning and Development fleet to electric vehicles. Data collection devices were installed on the 4 existing vehicles that collected data for 12 weeks from July 27th to October 19th, 2022. The devices recorded the number of trips and their length, idling times, days of the week in use, and location and vehicle movements. Additionally, a user survey was conducted to understand the

requirements and perceptions of staff and the impacts that fleet conversion may have on Municipal operations.

DISCUSSION

The fleet conversion assessment conducted by the Clean Foundation provides a detailed understanding of fleet usage for the Planning and Development Department (Attachment A and B). This is integral to planning an approach to convert the fleet to electric/non-emitting vehicles, which is a long-term process. The most cost-effective approach is to replace vehicles as they reach their end of useful life for the Municipality, otherwise the capital cost of electric vehicles can be prohibitive. Once a vehicle is replaced with an electric one, the ongoing operational costs are much lower and emissions are reduced significantly. The study was performed on the Planning & Development Department fleet as a subset of the overall Municipal fleet; however, it is reasonable to estimate similar impacts from converting comparable vehicles in other Departments. This study can provide the foundation for informing the conversion of the passenger-type vehicle fleet owned by the Municipality, which would have a measurable impact on corporate emissions.

I duplicated Figure 1 below from the report by the Clean Foundation, which shows a detailed breakdown of replacing the Planning and Development Department 2018 Jeep Compass. It was chosen for a detailed case study because it is used the most of any vehicle in the fleet. The Clean Foundation compared a gas-powered 2021 Jeep Compass with an electric 2021 Kia Niro, based on a 7-year ownership period. The Kia Niro has an estimated total upfront purchase price of \$43,745 including taxes and rebates. The total estimated upfront cost of the Jeep Compass is \$30,353.

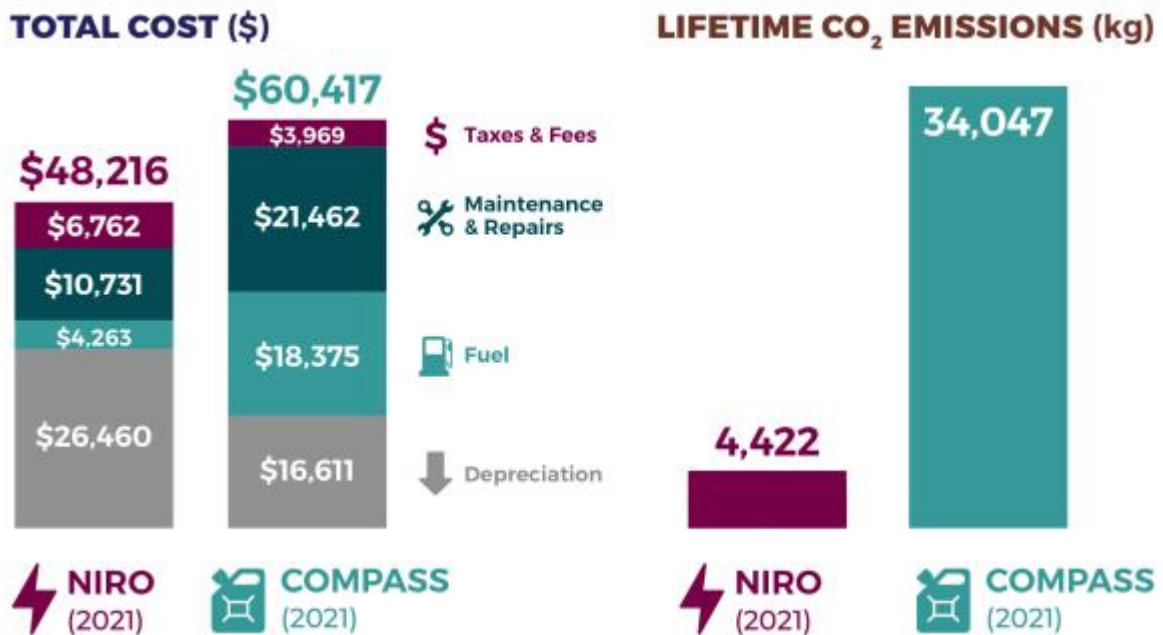


Figure 1: Case Study of Jeep Compass

As shown, an electric Kia Niro produces 87% fewer emissions and the ownership costs are 20% less than those of the gas-powered Jeep Compass – during a 7-year ownership period. The financial savings are a direct benefit for the Municipality, representing approximately \$1,700 saved annually over the 7-year ownership period.

I also duplicated Figure 2 below from the report by the Clean Foundation, which displays replacing the other units in the Planning and Development Department fleet. It shows emissions reductions and the financial implications of replacing other vehicles in the Planning and Development fleet.

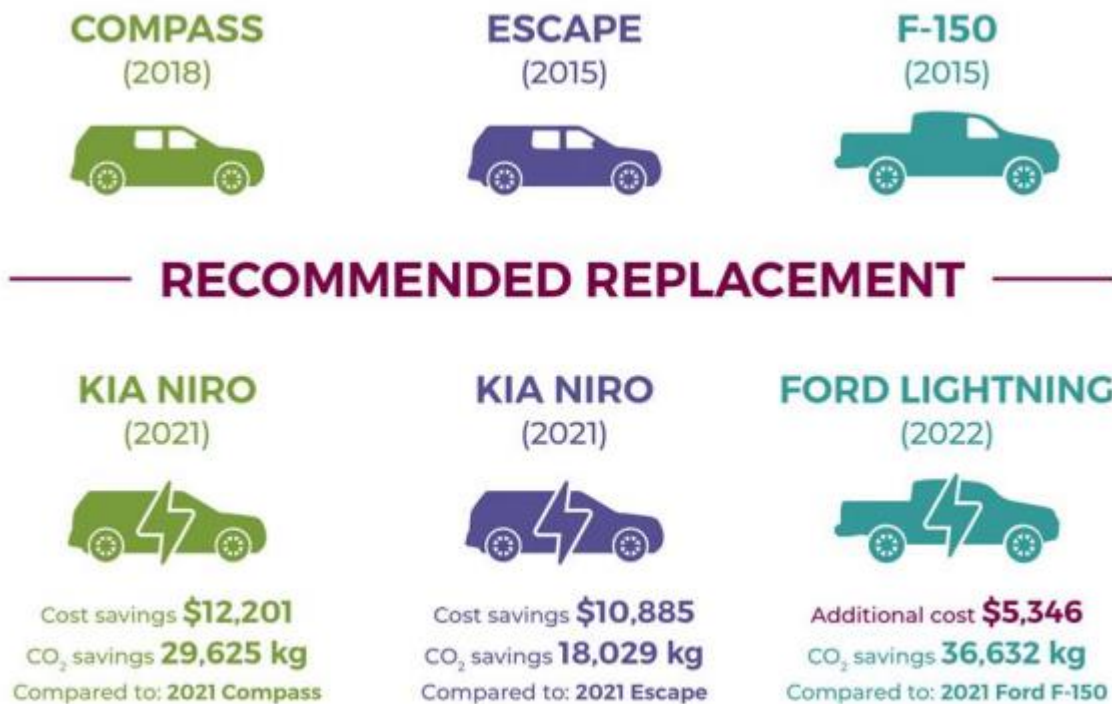


Figure 2: Planning and Development Department Fleet Replacement Results

The replacement of all vehicles in the Planning and Development Department fleet shows similar results as the detailed case study, except for the F-150 pickup truck. The emissions reduction associated with an electric truck are significant; however, it results in an additional cost over the 7-year lifespan. Over time this additional cost may decrease, as more companies produce electric trucks and the technology improves.

The considerable emissions reduction associated with the fleet conversion will reduce particulate matter and pollution, improving local air quality. Besides the clear environmental benefits of reducing emissions to decrease the Municipal climate change impact, these factors are linked to improved human health. Better health outcomes and cleaner communities create a desirable place to live, and taking this step will show Municipal leadership in climate action – in a cost-effective manner. Further details and suggestions from the Clean Foundation are

included in the summary and technical reports, attached to this report for the Committee to review.

NEXT STEPS

1. Circulate findings from the Clean Foundation study to all Planning and Development Department staff to incorporate into criteria for replacing / purchasing vehicles for the Planning and Development Department.
2. Circulate this report and Clean Foundation study to all Departments to consider when replacing / purchasing vehicles for their fleets.
3. Converting fleet to electric vehicles over time as Municipal vehicles require replacement.

FINANCIAL IMPLICATIONS

The completion of the fleet conversion study itself has no financial implications on the Municipal budget. As vehicles within the Planning and Development Department fleet and overall Municipal fleet reach the end of their useful life, this report will inform the selection of replacement vehicles that are more environmentally friendly. Replacing vehicles in the fleet as they wear out will lessen the impact on Municipal finances. Additionally, as outlined in this report and the study from the Clean Foundation, electric vehicles have a positive financial impact over the long term.

ALTERNATIVES

The Committee may request further information on this topic.

ATTACHMENTS

- | | |
|--------------|---|
| Attachment A | Clean Foundation – West Hants Regional Municipality Fleet Conversion Assessment: Summary Report |
| Attachment B | Clean Foundation – West Hants Regional Municipality Fleet Conversion Assessment: Technical Report |

REVIEW

Report Prepared by: _____
John Ogilvie, Climate Action Coordinator

Report Approved by: _____
Sara Poirier, Director of Planning and Development



Attachment A

Fleet Conversion Assessment

WEST HANTS REGIONAL MUNICIPALITY



Contents

- Table of Acronyms 2
- Introduction 3
- About Clean Foundation 3
- Fleet Benchmark 4
- Total Cost of Ownership & Emissions Case Study 5
- Recommendations 8
- Acknowledgements 10

Table of Acronyms

Term	Acronym
Electric Vehicle	EV
Internal Combustion Engine Vehicle	ICEV
Manufacturer Suggested Retail Price	MSRP
Total Cost of Ownership	TCO
Incentive for Zero Emissions Vehicle Program	iZEV
Carbon Dioxide	CO ₂

Introduction

Municipalities in Nova Scotia want to reduce their greenhouse gas emissions to support the provincial goal of achieving net zero emissions by 2050. Fleet electrification can significantly reduce transportation associated GHG emissions as well as other harmful pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, particulate matter, and formaldehyde.

To support municipalities looking to reduce fleet related GHG emissions, Clean Foundation completed a study in collaboration with the Municipality of West Hants. West Hants' light duty fleet contains the following five vehicles:

- 2021 Jeep Compass
- 2018 Jeep Compass
- 2015 Ford Escape
- 2015 Ford F-150

The study took place over 12 weeks from July 27th to October 19th, 2022. Each of the fleet vehicles had a Geotab OBD-II device installed. These devices collect data each time the vehicle is used. Data collected includes vehicle movements and location, number and length of trips, idling times, and days of week in use.

In addition to data collected from the vehicles, we collected data from fleet users in an anonymous survey to take account of their needs in its decision making. Any discussion of fleet changes should involve the fleet users at a fundamental level as their insights will prove invaluable when discussing potential for right-sizing and/or transitioning to EVs. Part of a successful fleet transition is user buy-in, which begins by ensuring that users understand the rationale for the transition to EVs and feel supported throughout the roll-out.

Using the Geotab data we produced a fleet benchmark: a summary of typical fleet vehicle use. We then used the data from the benchmark to create case studies to explore the financial and climate impacts of transitioning to EVs and suggest potential EV options to replace the ICEVs in West Hants' fleet.

About Clean Foundation

Clean Foundation is a Nova Scotia-based independent, non-governmental environmental charity that began in 1988. One of Clean Foundation's mandates is helping communities decrease their GHG emissions, and our expertise in the clean transportation field makes us well suited to support communities looking to understand the costs and benefits of electrifying their fleets.

Fleet Benchmark

Below is the summary of the data collected during the Taking the Wheel study. There are several ways of measuring how vehicles are used.

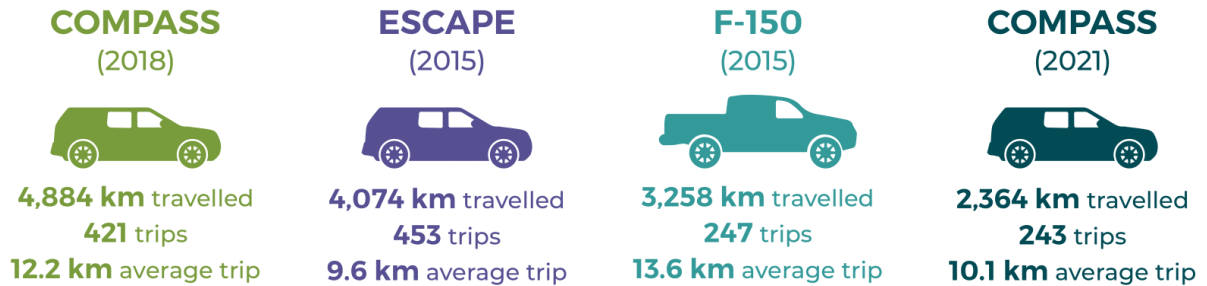


Figure 2: Summary of fleet usage during study period

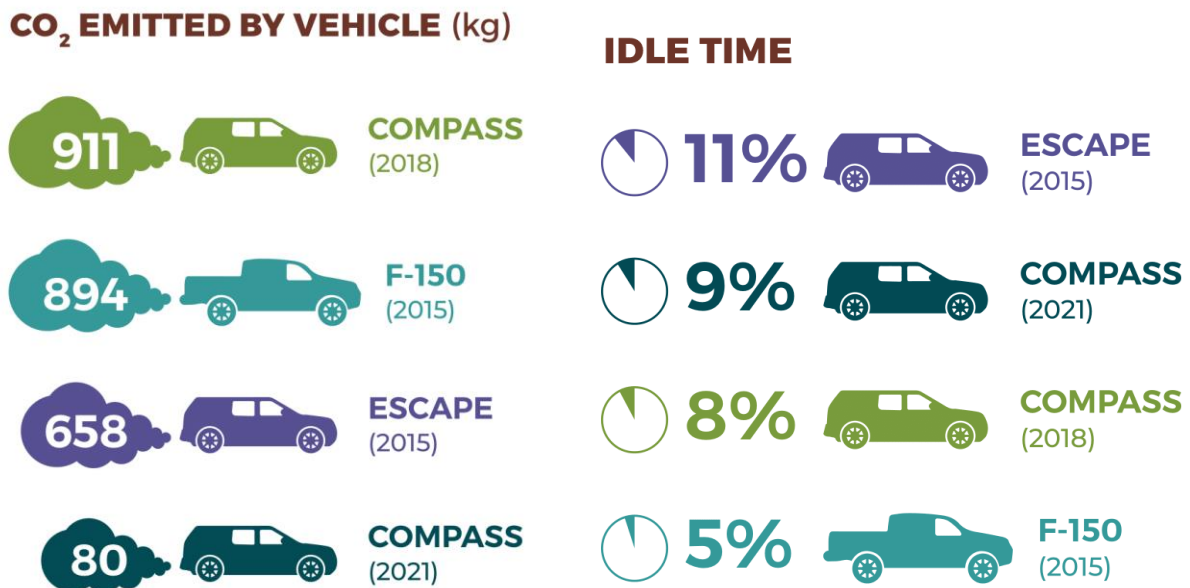


Figure 3: Carbon emitted during study period & Idling time as a percentage of total "Engine on" time.

The most important information collected is how far each vehicle travelled during the collection period because this is the most direct measurement of how much each vehicle is used and has the most direct impact on fuel consumption. Trip total also gives a measurement of how much each vehicle is used; however, this information lacks the context of how far each of those trips last. Combining trip totals

with distance travelled allows the average trip distance to be determined. Figure 2 shows that fleet vehicles travelled similar distances over the period. The 2018 Compass and the 2015 Escape each went on more total trips, resulting in greater total distance.

The total amount of emissions during the study period was also tracked. This is most directly impacted by the distance travelled by the vehicle but is also influenced by the fuel economy of the vehicle, as well as how much time each vehicle spent idling. . West Hants' fleet idled remarkably little in comparison to other municipal fleets, where vehicles often idle for 20-30% of the total engine on time. EV's do not idle in the traditional sense that ICEV's do, meaning that they avoid all emissions that would be created while idling in an ICEV. In many cases, this is an area that municipal fleets can improve on their emission outputs through driver training, however West Hants' fleet users are doing very well in this area.

The 2021 Compass emitted such a small amount of CO₂ that it is likely due to error on the part of the OBD-II device, or the vehicle was not properly measuring how much gasoline was in the tank. Regardless, it would most likely be the lowest emitter in the fleet due to driving the lowest number of trips and kilometers. In total, the fleet emitted just over 2,500 kg of CO₂ into the air during the 12-week period, which is comparable to the weight of one and a half Jeep Compasses, which weigh approximately 1,600 kg.

Fleet User Surveys

Decisions regarding municipal fleets impact a variety of stakeholder groups in different ways. Municipal constituents should always be the priority stakeholder group for municipalities and the driving force behind decisions. However, In the short-term, municipal workers who drive fleet vehicles will experience a more direct impact in their day-to-day lives.

Municipal fleet users rely on their work vehicles regularly to complete tasks that are vital to the community. If their workplace decides to replace an ICEV with an EV, the worker and their tasks may be impacted. As the most directly impacted group, it is important that municipal fleet users have a way to express how changes could impact them. As part of the Taking the Wheel study, a survey was conducted among municipal fleet users, to attempt to capture the needs of fleet users within the scope of the project.

The survey aimed to capture information falling into two categories. The first section of the survey aimed to capture information relating to how vehicles are currently being used to accomplish work tasks. More importantly, this section aims to capture information that cannot be measured numerically.

The second category of the survey covers respondent's current attitudes and concerns towards EVs and their potential integration into the fleet.

Total Cost of Ownership & Emissions Case Study

This case study makes a comparison of the lifetime costs and emissions of a new EV and a new ICEV. The vehicles selected for the comparison were selected based on which fleet vehicles saw the heaviest use during the data collection period. The latest available model of the most used vehicle in the fleet was chosen as the ICEV, while an EV of a similar class was chosen for comparison. If the most heavily used

vehicle in the fleet currently has no reasonably comparable EV, the next most used fleet vehicle was chosen.

The case study uses a fleet procurement analysis tool, which was originally created by the US Department of Energy and is available for public use. For the purposes of this study, only sales tax, maintenance, fuel, and depreciation were included in the results. The price of fuel was set at a conservative \$1.40 CAD.

The most used and highest CO₂ emitting vehicle in the West Hants fleet was the 2018 Compass. For that reason, it was chosen to be used in TCO comparison case study. This vehicle drove 4,884 km during the period, which projects to just over 21,000 km over the full year. Because it is recommended to plan EV ownership length around the 8 year or 160,000 km warranty on EV batteries, a 7-year time of ownership was used for the Compass for TCO and emissions estimations.

	2021 Kia Niro	2021 Jeep Compass
MSRP	\$44,995	\$26,394
Tax-in MSRP	\$51,745	\$30,353
Rebates	\$8,000	\$0
Total Upfront Cost	\$43,745	\$30,353

Table 1: Upfront Costs Comparison

Depreciation and taxes are both higher on the EV than the ICEV due to the higher upfront cost of the vehicle. However, the EV more than makes up these costs in maintenance and fuel over the lifetime of the vehicle. When factoring in the value of vehicle at the end of ownership, the TCO of the EV is lower than its total upfront costs. The longer an EV is owned, the longer its low maintenance and fuel cost savings have time to make up for the higher upfront costs. Meanwhile, ICEVs see increasing maintenance costs the longer they are owned, which prevents them from benefitting as much as EVs from long term ownership.

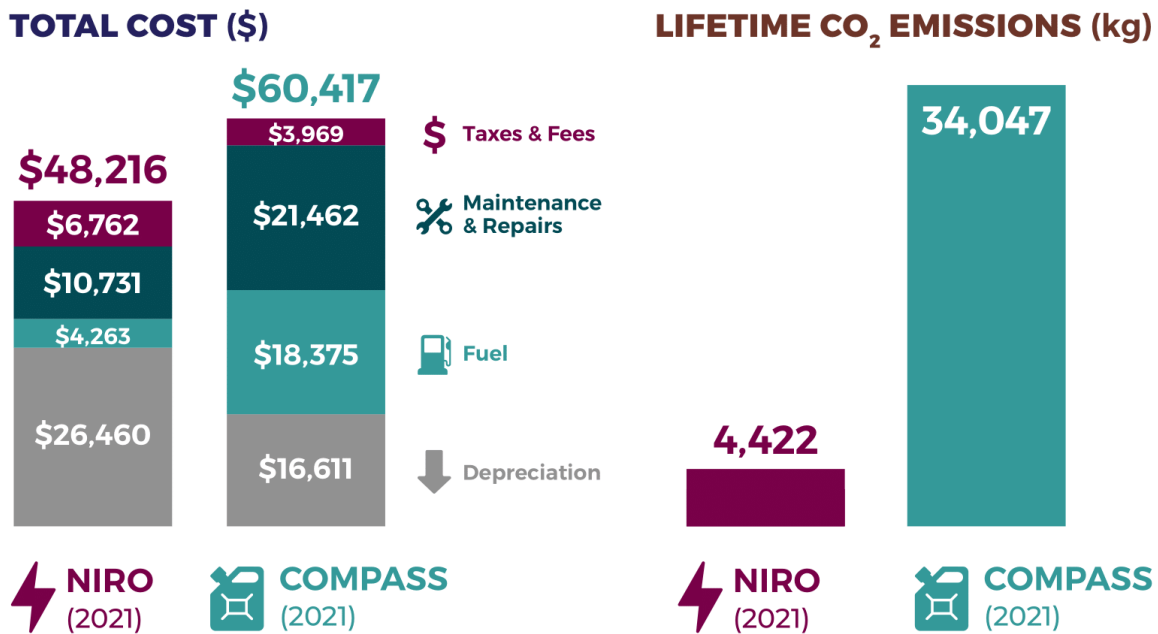


Figure 4: Lifetime Cost and Emissions comparison between an EV and ICEV

The estimates of fuel consumption in this case study were determined using the estimated fuel economies for each vehicle, as determined by the United States government¹. These fuel economies were compared to fuel economy data collected during the study.

Well-to-wheel emissions are an all-encompassing measurement of emissions required for fuel production, distribution, and use. While EVs create no tailpipe emissions, the electricity they consume still comes from the grid, which come from various sources. In 2019 Nova Scotia used fossil fuels for 76% of its energy, with 52% coming from coal.

Nova Scotia is moving towards clean energy sources, so emissions related to electricity production will only decrease as time passes. Fossil fuels require transportation from where they are extracted to where they will eventually be used, whether they will be burned to fuel the grid or within an ICEV to propel a vehicle. Altogether, the well-to-wheel emissions of the ICEV will amount to over ten times the amount of the EV. Pollutants attributed to vehicles are not limited to only CO₂. Nitrous oxides, sulfur oxides, and other particulates can be harmful to both humans and our environment.

¹ US Department of Energy and Renewable Energy. www.fueleconomy.gov

Recommendations

Recommendation #1: Minimizing Impact on Fleet Users

We recommend that municipalities put forth an effort to understand how fleet users will be impacted by transitioning a portion of the fleet to EVs. Municipal fleet vehicles are work vehicles and it is up to the municipality to determine if an EV could complete the tasks that are currently being performed without placing burden on the user of the vehicle.

Understandably, fleet users have concerns about how these changes will impact their ability to complete their work tasks, and those concerns fall into a few categories. Electric vehicles are still new to most people, so the first category of concerns are concerns that come with unfamiliarity of new technology. Many concerns of this nature can be addressed by connecting with those who have more experience with the technology and who are keen to learn. The provincial EV education and engagement program, Next Ride, helps address these types of concerns daily, but these conversations also happen organically in our communities as an increasing amount of people are driving EVs. Concerns that fall into this category include questions about charging, battery technology, environmental impacts, and winter driving. Answering as many questions and concerns about these topics prior to introducing EVs into the fleet is advisable for making the transition as smooth as possible.

Many more of the concerns shared by fleet users relate to how the vehicle will be used. Factors such as the size of the vehicle, towing/weight capacity, ground clearance, and use of all-wheel drive can all be important to completing job tasks

Many of the concerns of fleet users are surrounding batteries and the possibility of long wait times during a job while an EV recharges. These are valid concerns but depend highly on the usage patterns of the vehicles. The data collected during this study shows that most fleet vehicles and personnel would rarely need to be recharging a vehicle during the work day, so long as the vehicle is fully charged to start their day. No vehicle in the fleet ever drove over 200 km in a day, which is well under the maximum range of most EVs on the market even on cold days. The 2018 Jeep Compass, which drove the furthest each day on average, drove under 100 km on more than 66% of days. Most EV sedans and SUVs have a range of around 400km.

Recommendation #2: Suitable for replacement

Minimizing the impact on fleet users will be accomplished by determining which vehicles are most suitable to replace. Determining this can be accomplished by considering all qualitative requirements of the vehicle (such as towing and ground clearance) as well as its quantitative use patterns.

In the short term, qualitative needs will take precedence over quantitative, because staff being able to complete their job takes precedence over cost and emissions savings. The level of disruption to operations is only determined by the currently available makes and models of EVs on the market. At this current point in time, EVs likely could not accomplish every task that West Hants' current fleet of vehicles is being used to do as well as some ICEVs. However, the EV market is rapidly evolving, and in a few years the restrictiveness in decision making created by qualitative needs is likely to diminish greatly.

The three vehicles that are candidates for transition are the 2018 Jeep Compass, 2015 Ford Escape, and 2015 F-150. For each vehicle, a comparison between a potential replacement EV and a replacement ICEV. Costs and emissions were then calculated for the EV and ICEV.

The comparisons were made by comparing the latest available model of each vehicle with a new model of a similar class of EV. The comparisons show that replacing either the Escape or a Compass with an EV would result in the largest monetary savings and would reduce CO₂ emissions significantly. Replacing the F-150 with a Ford Lightning would cost more over its lifetime than replacing it with an ICEV, however the emission reduction would be more significant than in than converting any other vehicle in the fleet.

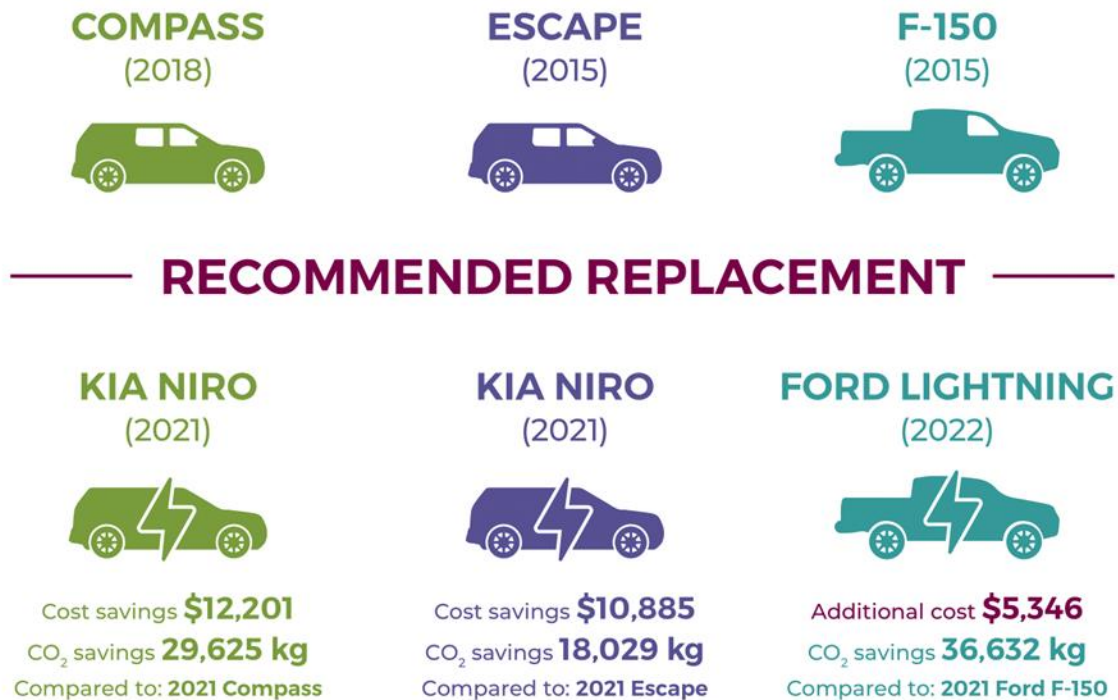


Figure 5: Lifetime cost and emissions savings for each potential vehicle replacement

Recommendation #3: Plan ownership duration around battery warranties

Electric vehicles have higher upfront costs and lower long-term costs compared to ICEVs. Keeping EVs in use for longer periods of time decreases their annual cost of ownership. When comparing TCO of new vehicles, the advantage of EVs grows as the period of ownership increases. We recommend that municipalities plan to replace their EVs every eight years or every 160,000 km, which is the same as the warranty on EV batteries. By replacing fleet EVs at the end of the battery warranty, fleets can take advantage of the lower TCO for as long as possible without any risk of needing to pay to replace a battery.

Acknowledgements

Clean Foundation would like to thank the Nova Scotia Department of Natural Resources and Renewables for their generous funding of this study, and to the Municipality of West Hants for its enthusiastic participation.

We are also grateful for the advice and guidance of our colleagues at Halifax Regional Municipality, Nova Scotia Power Inc., and Northern BI.



Attachment B

Fleet Conversion Assessment

WEST HANTS REGIONAL MUNICIPALITY



Contents

- Table of Acronyms..... 3
- Executive Summary 4
- Introduction 5
- About Clean Foundation 6
- Study Methods 6
- Fleet Benchmark 7
- Fleet User Surveys 10
- Financial Considerations 10
- Electricity Versus Gasoline Prices..... 12
- Regenerative Braking..... 13
- Total Cost of Ownership & Emissions Case Study 14
- Additional Considerations..... 17
- Charging..... 17
- Recommendations 21
- Acknowledgements 23
- Appendix: Fleet User Survey 24

Table of Acronyms

Term	Acronym
Electric Vehicle	EV
Battery Electric Vehicle	BEV
Plug-in Hybrid Electric Vehicle	PHEV
Internal Combustion Engine Vehicle	ICEV
Manufacturer Suggested Retail Price	MSRP
Total Cost of Ownership	TCO
Incentive for Zero Emissions Vehicle Program	iZEV
Carbon Dioxide	CO ₂

Executive Summary

Municipalities in Nova Scotia are seeking to reduce their greenhouse gas emissions to support the provincial goal of achieving net zero emissions by 2050. Electrifying municipal light-duty vehicle fleets will help them reach this goal. To meet the growing demand for reducing fleet related emissions, Clean Foundation completed a pilot study in collaboration with the Municipality of West Hants. West Hants' light duty fleet contains four vehicles. The study took place over 12 weeks from July 27th to October 19th, 2022. Each of the fleet vehicles had a Geotab OBD-II device installed. These devices collect data on vehicle movements and location, the number and length of trips taken, idling times, and days of week in use.

This study recommends approaching fleet electrification in a way that is as least disruptive to current operations as possible. This means that the recommendations provided are attempting to outline which vehicle replacements could be reasonable first choices in the fleet electrification process. The vehicles that make the best candidates are those that are used consistently to travel significant daily distances, yet not enough distance that range becomes an issue. This will lead to the EV saving significantly in fuel and emissions, without causing disruptions to users. Whenever new technologies are introduced into the workplace, there are likely to be challenges that employees have not experienced in the past. By choosing best vehicle for replacement possible, we aim to give employees the opportunity to adjust to these changes. It also gives fleet users the opportunity to provide informed feedback on future decisions involving EVs.

In addition to data collected from the vehicles, we surveyed fleet users. Survey results were collected and compiled from each municipality and town that participated in the Taking the Wheel study. The surveys focused mainly on what users think about electric vehicles (EVs) and how they think they might be impacted by the transition fleet vehicles to electric. This took into consideration the types of tasks that fleet users routinely use their vehicles to complete, as well as how much they use their vehicle in an average workday. When compared to data collected using OBD-II devices, the survey results showed that users perceived a higher rate of vehicle usage than was seen over the study period. This is connected to the most common concern that users had, which was that the range limitations of EVs would impact their ability to complete tasks. Any discussion of fleet changes should involve the fleet users at a fundamental level as their insights will prove invaluable in determining which vehicles to replace and on what timelines. Ensuring that users understand and support the rationale for the transition and feel

A Fleet benchmark was created using the OBD-II data to assess analyse how the fleet vehicles were used during the data collection period. This benchmark helps show which vehicles were used most often and which vehicles drove the furthest distance, as well as how often they idled and how much carbon they emitted into the atmosphere. The fleet benchmark data was then used to create an estimate of how each vehicle would be used over the course of a full year. These estimates were taken into consideration when determining which vehicles would be most suitable to be replaced the in the short term.

Using data projections from the fleet benchmark, we created lifetime cost and emissions comparisons between each vehicle that was determined to be reasonable to replace and a similar class EV. The result from each comparison is listed in the recommendations section, and one comparison was selected as a case study. West Hants' 2018 Jeep Compass was compared to a Kia Niro. This vehicle is projected to travel over 21,000 km per year, and the lifetime TCO for the Niro would be more than \$18,000 cheaper

than a replacing it with a new Compass. Over its lifetime, the Niro would avoid almost 30,000 kg of CO₂ equivalents in emissions. For comparison, a Jeep Compass weighs approximately 1,600 kg.

Introduction

Municipalities in Nova Scotia want to reduce their greenhouse gas emissions to support the provincial goal of achieving net zero emissions by 2050. Fleet electrification can significantly reduce transportation associated GHG emissions as well as other harmful pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, particulate matter, and formaldehyde.

In the electric vehicle (EV) market, there are two vehicle sub-types: battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). BEVs are fully electric, while PHEVs have a full gas engine as well as an electric motor. Because PHEVs have both gas and electric propulsion systems their batteries are much smaller than in BEVs. PHEVs therefore have a smaller electric range as a trade-off for the ability to switch between gas and electric drive modes. In this report, we use EVs to refer to both types of vehicles, and BEV or PHEV to refer to each sub-type.

In discussions with municipal staff, we determined that there is a fleet analysis service gap for small fleets. Currently there are no providers that offer this service at a cost that is amenable to Nova Scotia's small municipalities. To support municipalities looking to reduce fleet related GHG emissions, Clean Foundation completed a study in collaboration with the Municipality of West Hants. West Hants' light duty fleet contains the following four vehicles:

- 2021 Jeep Compass
- 2018 Jeep Compass
- 2015 Ford Escape
- 2015 Ford F-150

The study took place over 12 weeks from July 27th to October 19th, 2022. Each of the fleet vehicles had a Geotab OBD-II device installed. These devices collect data each time the vehicle is used. Data collected includes vehicle movements and location, number and length of trips, idling times, and days of week in use.

In addition to data collected from the vehicles, we collected data from fleet users in an anonymous survey to take account of their needs in its decision making. Any discussion of fleet changes should involve the fleet users at a fundamental level as their insights will prove invaluable when discussing potential for right-sizing and/or transitioning to EVs. Part of a successful fleet transition is user buy-in, which begins by ensuring that users understand the rationale for the transition to EVs and feel supported throughout the roll-out.

Using the Geotab data we produced a fleet benchmark: a summary of typical fleet vehicle use. We then used the data from the benchmark to create case studies to explore the financial and climate impacts of transitioning to EVs and suggest potential EV options to replace the ICEVs in West Hants' fleet.

About Clean Foundation

Clean Foundation is a Nova Scotia-based independent, non-governmental environmental charity that began in 1988. Our passion is providing the knowledge, tools, and inspiration needed to encourage the actions that lead to positive environmental change. Clean Foundation promotes green solutions for today – and supports the environmental leaders of tomorrow.

With funding from the Nova Scotia Department of Natural Resources and Renewables, Clean Foundation delivers the Next Ride program, which offers free EV education and test drive services for members of the public, as well as fleet users, fleet managers and municipal decision makers. One of Clean Foundation's mandates is helping communities decrease their GHG emissions, and our expertise in the clean transportation field makes us well suited to support communities looking to understand the costs and benefits of electrifying their fleets.

Study Methods

The purpose of Taking the Wheel is to use data to provide insights to municipalities so they can make well informed decisions regarding their fleet vehicles. Collecting data is a way of describing with numbers what is happening around us. By detailing what has happened in the past, we can attempt to predict what will happen in the future.

Fleet decisions are long term in nature, as the turnover rate of most municipal fleets is between six to eight years. Taking the Wheel's largest constraint is the time limit on the data collection period, which occurred over 12-week period. This data would then be extrapolated to estimate the future fleet usage patterns over their lifetime of six to eight years. This means that the projected data values are susceptible to short term variables. The study took place in four municipalities, starting as early as August and ending as late as December. Seasonal variables are unable to be accounted for because of the time limitation.

This study utilizes onboard diagnostic devices (OBD-II) to gather real world data from municipal fleet vehicles across Nova Scotia. An OBD gathers and relays information using GPS technology. The information an OBD collects can be analyzed and used to gain a better understanding of how a vehicle is currently being used. An OBD will automatically record when the vehicle engine is turned on and when it turns off, as well as the start and end odometer reading. A manual entry logbook records start and end locations, while an OBD also records the route between those two points.

While acting as an advanced logbook, an OBD is also relaying information collected from sensors inside the vehicle. Using these sensors, the OBD can record how much fuel a particular trip used, how fast the vehicle was going at a specific time, the engine rpms, acceleration, and more. This information can be processed to determine other useful information such as the amount of carbon dioxide produced in an individual trip. Information from individual trips can be compiled into larger samples of data. As more data is collected, patterns begin to emerge, which give rise to valuable insights.



Figure 1: OBD-II device (right) and harness (left) used in the Taking the Wheel study.

Fleet Benchmark

Data Collected

Below is the summary of the data collected during the Taking the Wheel study. There are several ways of measuring how vehicles are used.

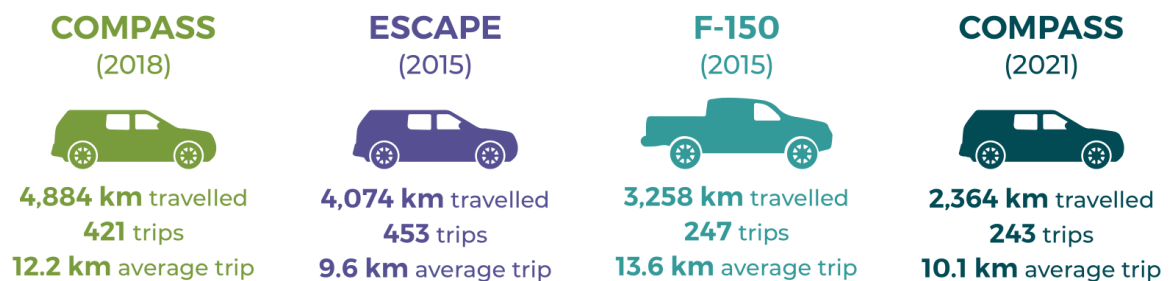


Figure 2: Summary of fleet usage during study period

The most important information collected is how far each vehicle travelled during the period. This is the most direct measurement of how much each vehicle is used and has the most impact on fuel consumption. Trip total also gives a measurement of how much each vehicle is used; however, this information lacks the context of how far each of those trips last. Combining trip totals with distance travelled allows the average trip distance to be determined. Figure 2 shows that fleet vehicles travelled similar distances over the period. The 2018 Compass and the 2015 Escape each went on more total

trips, resulting in greater total distance.

CO₂ EMITTED BY VEHICLE (kg)

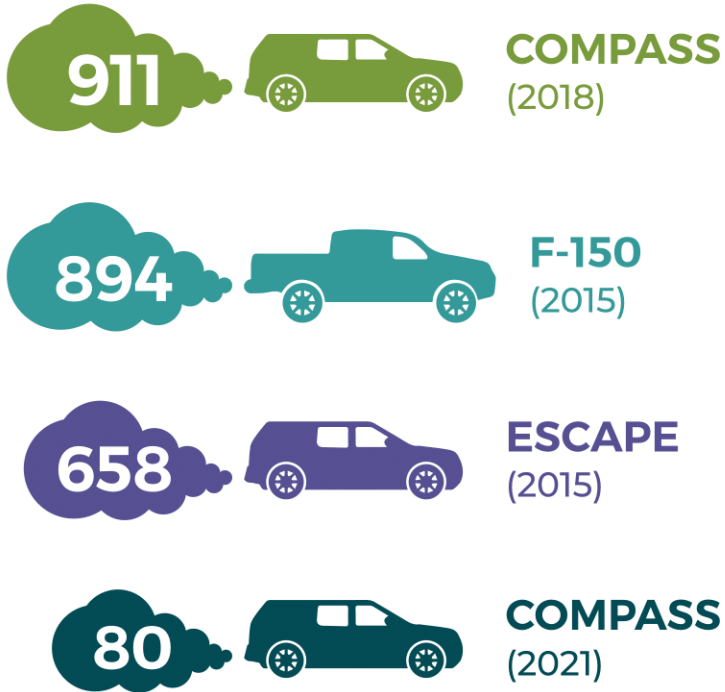


Figure 3: Carbon emitted during study period

IDLE TIME

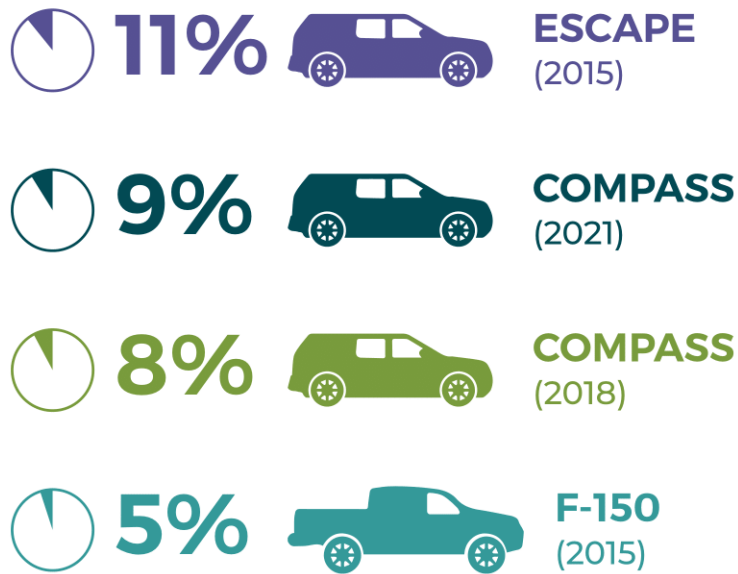


Figure 4: Idling time as a percentage of total “Engine on” time.

The total amount of emissions during the study period was also tracked. This is most directly impacted by the distance travelled by the vehicle but is also influenced by the fuel economy of the vehicle, as well as how much time each vehicle spent idling. West Hants’ fleet idled remarkably little in comparison to other municipal fleets, where vehicles often idle for 20-30% of the total engine on time. EV’s do not idle in the traditional sense that ICEV’s do, meaning that they avoid all emissions that would be created while idling in an ICEV. In many cases, this is an area that municipal fleets can improve on their emission outputs through driver training, however West Hants’ fleet users are doing very well in this area.

The 2021 Compass emitted such a small amount of CO₂ that it is likely due to error on the part of the OBD-II device, or the vehicle was not properly measuring how much gasoline was in the tank. Regardless, it would most likely be the lowest emitter in the fleet due to driving the lowest number of trips and kilometers. In total, the fleet emitted just over 2,500 kg of CO₂ into the air during the 12-week period, which is comparable to the weight of one and a half Jeep Compasses, which weigh approximately 1,600 kg.

Fleet User Surveys

Stakeholders

Decisions regarding municipal fleets impact a variety of stakeholder groups in different ways. Municipal constituents should always be the priority stakeholder group for municipalities and the driving force behind decisions. However, other stakeholders may be impacted more directly. In the short-term, municipal workers who drive fleet vehicles will experience a more direct impact in their day-to-day lives.

Municipal fleet users rely on their work vehicles regularly to complete tasks that are vital to the community. If their workplace decides to replace an ICEV with an EV, the worker and their tasks may be impacted. As the most directly impacted group, it is important that municipal fleet users have a way to express how changes could impact them. As part of the Taking the Wheel study, a survey was conducted among municipal fleet users, to attempt to capture the needs of fleet users within the scope of the project.

The survey aimed to capture information falling into two categories. The first section of the survey aimed to capture information relating to how vehicles are currently being used to accomplish work tasks. Much of this information is also being captured using OBD's, such as how far a user drives in the average day, or the duration of their driving. The results of the survey can be compared against the numerical findings to determine whether fleet users are understanding of their own driving habits and if it reflects the data sample.

The second category of the survey covers respondent's current attitudes and concerns towards EVs and their potential integration into the fleet. These concerns are qualitative in nature and were the focus of the survey. The survey aims to let fleet users describe information about their vehicles current use cases, and how EV usage may or may not impact their current usages. It also gives respondents an opportunity to say which topics surrounding EVs that they would benefit learning more about.

Financial Considerations

Capital Cost

Electric vehicles currently have a higher average upfront cost compared to ICEVs. This high upfront cost stems mainly from the costs of raw materials needed to manufacture each type of vehicle. As of May 2022, the average EV cost \$8255 USD in raw materials while the average ICEV cost \$3662 USD. Both figures have doubled since the beginning of the pandemic, when raw materials for EVs and ICEVs cost \$3381 USD and \$1779 USD respectively.¹ The difference between the cost of raw materials can be attributed largely to battery materials such as lithium, nickel, and cobalt.

¹ 2022 AlixPartners Global Automotive Outlook | AlixPartners. (n.d.). [www.alixpartners.com](https://www.alixpartners.com/media-center/press-releases/2022-alixpartners-global-automotive-outlook/).
<https://www.alixpartners.com/media-center/press-releases/2022-alixpartners-global-automotive-outlook/>

These costs contribute directly towards EVs having higher manufacturer suggested retail prices compared to ICEVs. To encourage consumers to purchase an EV over an ICEV, the Canadian government implemented the Incentive for Zero Emission Vehicles program (iZEV), which offers a \$5000 rebate to Canadian residents and organizations on eligible EVs. In addition to the federal program, Nova Scotia's rebate program 'Electrify' offers up to an additional \$3000 on eligible vehicles, for a total rebate of \$8000.



Maintenance and Repairs

Electric vehicles are less costly to maintain than ICEVs. This is because EVs have roughly 90% fewer moving parts that can wear and break down, and half as many total parts.² The powertrain of an EV requires no engine or transmission, instead having an electric motor powering the driveshaft directly. Engines alone contain approximately 200 parts that need to be maintained. Internal Combustion Engine vehicles use more fluids, such as engine oil, than EVs, which must be changed regularly and incur further service costs. Brake pads on EVs also last longer due to the use of regenerative braking. Routine maintenance and scheduling are administrative burdens, which can be lessened with the switch to EVs.

Batteries

While EVs avoid most of the maintenance costs associated with ICEVs, they have costs of their own. Batteries are a major concern, as they contribute significantly to the initial MSRP of EVs being higher than ICEVs.³

Typically, EVs are covered under warranty for either eight years or 160,000km. For this reason, it is recommended that fleet managers replace their EVs every eight years. Electric vehicle batteries also slowly degrade, leading to a lower maximum charge capacity of roughly 1-2% annually. Batteries are also very heavy and can typically account for roughly a third of the weight of an EV. This leads to tires wearing out faster than they typically would on an ICEV. This is a safety trade-off though, as the weight

² Harto, C. (2020). Electric Vehicles Ownership Costs: Today's electric Vehicles Offer Big Savings for Consumers [Review of Electric Vehicles Ownership Costs: Today's electric Vehicles Offer Big Savings for Consumers]. In <https://www.consumerreports.org>. Consumer Report

³ Battery replacement can cost up to \$20000 USD due to the high price of battery materials

of the battery being on the bottom of the vehicle gives EVs a lower center of gravity compared to ICEVs, increasing overall traction, and making EVs more resistant to rollovers.

Electricity Versus Gasoline Prices

Why is charging an EV so much cheaper than fueling an ICEV?

The majority TCO savings from owning an EV come from cost difference between refueling. Largely, this difference is due to electricity is a source of immediate usable energy, while gasoline and other fossil fuels are only a form of energy storage.

Engines operate at around 30% efficiency. This means that for every litre of gasoline that goes into a tank, only 30% of the energy contained in it will make it to the rest of the drivetrain. By the time that gasoline is converted into useful energy, the wheels of an ICEV car only get to use between 16-25% of the energy that was originally contained in the tank. Comparatively, EVs only require an inverter to change electricity from the grid into usable electricity for the vehicle. This process results in a roughly 10% loss to get energy directly to the drivetrain. EVs can use more than 70% of the electricity contained in the battery, without factoring in the energy that is recovered by regenerative braking.

How much cheaper is it?

Conversions are needed to make a direct cost comparison between the two because the cost of each is measured differently. When purchasing electricity, customers are charged per each kilowatt hour (kWh) that is transferred from the grid to their vehicle. Gasoline is charged by the litre (L), which is a unit of volume. The energy density of gasoline is needed to make a comparison. Energy density is the amount of energy contained in a litre, and gasoline has an energy density of 8.9 kWh/L. This means that buying 8.9 kWh of electricity is the equivalent of buying a litre of gasoline.

A litre of gasoline as of January 17th, 2023, cost \$1.46 CAD (including tax), fluctuating up and down each week. The standard cost of electricity in Nova Scotia is \$16.22 (before tax) per kWh. By multiplying the cost of electricity by the energy density of gasoline, you find that “a litre of gas worth” of electricity will cost \$1.44, which is surprisingly close to the actual price of gas. However, this is before the efficiency of each vehicle type is taken into consideration.

Multiplying the cost per kWh by the drivetrain efficiencies and including taxes, a full litre of gas worth of energy to the wheels of an EV costs roughly \$1.83 vs \$7.30 for the same amount of energy to the wheels of an ICEV, which means that energy for a ICEV is four times as expensive. Gasoline costs are also constantly in flux, while electricity prices are fixed. Fixed prices are much easier to budget around and make financial forecasts much more accurate.

By the time the energy reaches the wheels of an ICEV, only 16-25% of the energy purchased at the gas tank remains. Electric vehicles can be between 85-90% efficient when including energy recaptured using regenerative braking.

Regenerative Braking

Regenerative brakes are a mechanism used in EVs to recover energy when braking. They use an electric motor, which acts as an electric generator when the vehicle is slowing down.

The advantages of fossil fuels such as coal, gasoline, and natural gas is that they can store a lot of energy into a small volume or weight. Gasoline is roughly 100 times as dense as current lithium-ion battery technology. If the fuel weighs too much, the vehicle becomes inefficient, as it would need to burn more fuel to account for weight that the fuel itself adds. The energy density of batteries was the single largest barrier to introducing EVs into the automotive market. EVs have existed just as long as ICEVs but could not match their range. Improved battery technology is at a point where batteries are can give range that is competitive with an ICEV, at the cost of a battery pack that is half the weight of the vehicle. Some of this weight is offset by avoiding the need for an engine.

Combustion is also a non-reversible process, meaning that once energy is used it can never be recovered. Batteries are the opposite, as energy can flow both to and from the battery at the same time. This allows for technology like regenerative brakes to recover some of the energy that is lost when a vehicle is slowing down or stopping by turning reversing the rotation of the motor when the vehicle is slowing down, essentially turning it into a generator.

How much energy can Regenerative Brakes save?

Regenerative brakes only save energy when compared to traditional brakes, which turn kinetic energy into heat and noise that is lost energy. However, coasting is still more efficient than using regenerative brakes.

However, taking full advantage of coasting to maximize range is not commonly practiced, and there will always be circumstances when braking is required.

Regenerative brakes work best when driving in stop and go traffic, where the vehicle will never have enough room to bring the vehicle to a stop through coasting. Regenerative brakes are also more efficient at recapturing energy at lower speeds. This is because the energy required to move a vehicle increases exponentially as speed increases.

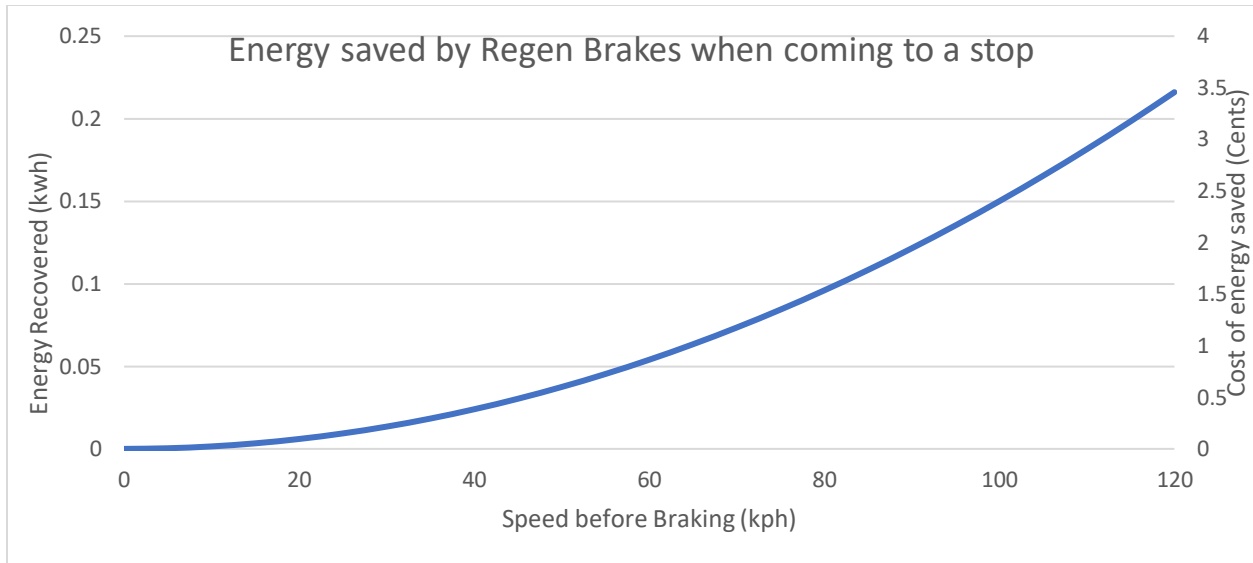


Figure 5: Cost of energy recovered using 70% effective regenerative brakes

This graph shows the energy that a 2000kg vehicle would save by coming to a complete stop from any starting speed, up to 120kph, using the current price of electricity in Nova Scotia.

Total Cost of Ownership & Emissions Case Study

This case study makes a comparison of the lifetime costs and emissions of a new EV and a new ICEV. The vehicles selected for the comparison were selected based on which fleet vehicles saw the heaviest use during the data collection period. The latest available model of the most used vehicle in the fleet was chosen as the ICEV, while an EV of a similar class was chosen for comparison. If the most heavily used vehicle in the fleet currently has no reasonably comparable EV, the next most used fleet vehicle was chosen.

The case study uses a fleet procurement analysis tool, which was originally created by the US Department of Energy and is available for public use. For the purposes of this study, only sales tax, maintenance, fuel, and depreciation were included in the results. The price of fuel was set at a conservative \$1.40 CAD. 2021 Models were used for comparison because these were the latest available in the model.

Case Study Vehicle Selection

The most used and highest CO₂ emitting vehicle in the West Hants fleet was the 2018 Compass. For that reason, it was chosen to be used in TCO comparison case study. This vehicle drove 4,884 km during the period, which projects to just over 21,000 km over the full year. Because it is recommended to plan EV ownership length around the 8 year or 160,000 km warranty on EV batteries, a 7-year time of ownership was used for the Compass for TCO and emissions estimations.

Lifetime Costs

	2021 Kia Niro	2021 Jeep Compass
MSRP	\$44,995	\$26,394
Tax-in MSRP	\$51,745	\$30,353
Rebates	\$8,000	\$0
Total Upfront Cost	\$43,745	\$30,353

Table 1: Upfront Costs Comparison

Depreciation and taxes are both higher on the EV than the ICEV due to the higher upfront cost of the vehicle. However, the EV more than makes up these costs in maintenance and fuel over the lifetime of the vehicle. When factoring in the value of vehicle at the end of ownership, the TCO of the EV is lower than its total upfront costs. The longer an EV is owned, the longer its low maintenance and fuel cost savings have time to make up for the higher upfront costs. Meanwhile, ICEVs see increasing maintenance costs the longer they are owned, which prevents them from benefitting as much as EVs from long term ownership.

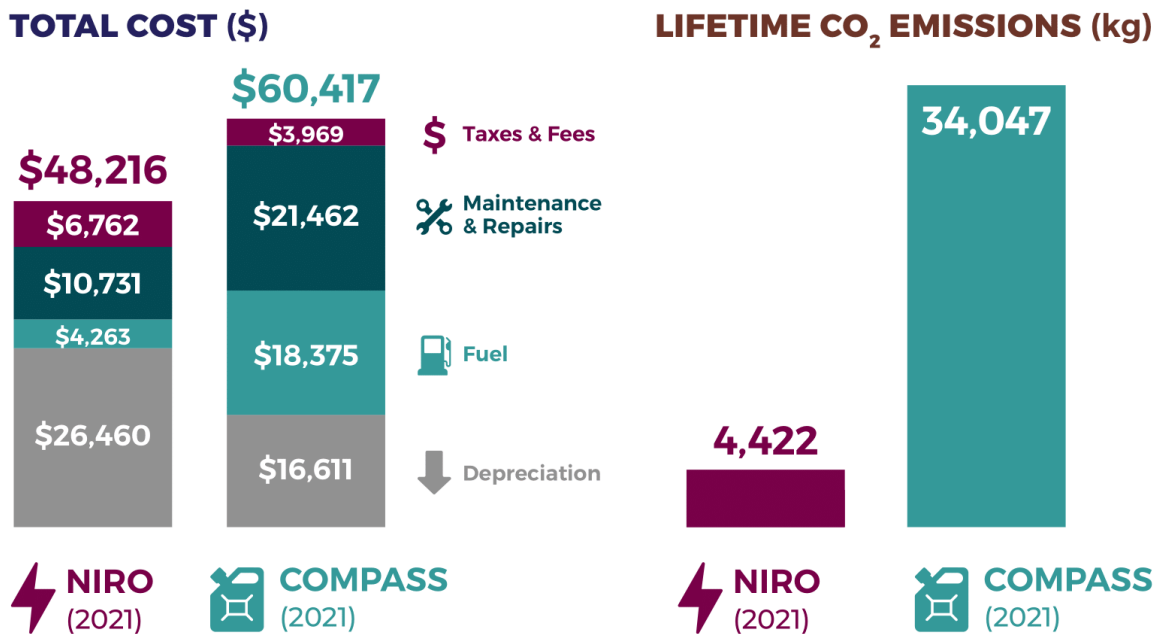


Figure 6: Lifetime Cost and Emissions comparison between an EV and ICEV

Lifetime Emissions

Well-to-wheel emissions are an all-encompassing measurement of emissions required for fuel production, distribution, and use. While EVs create no tailpipe emissions, the electricity they consume still comes from the grid, which use varying sources of energy depending on the region. In 2019 Nova Scotia used fossil fuels for 76% of its energy, with 52% coming from coal.

This is where most emissions related to EVs stems from. While Nova Scotia has a relatively dirty grid, the province is moving towards clean energy sources, so emissions related to electricity production will only decrease as time passes. Fossil fuels require transportation from where they are extracted to where they will eventually be used, whether they will be burned to fuel the grid or within an ICEV to propel a vehicle. Altogether, the well-to-wheel emissions of the ICEV will amount to over seven times the amount of the EV.

Emission Type	2021 Kia Niro	2021 Jeep Compass
NO _x	8.51 kg	23.16 kg
SO _x	6.76 kg	8.04 kg
PM10	0.44 kg	1.72 kg
PM2.5	0.27 kg	1.25 kg

Table 2: Non-CO₂ lifetime emissions comparison

Pollutants attributed to vehicles are not limited to only CO₂. Other pollutants include nitrous oxides (NO_x), sulfur oxides (SO_x), and other particulates. These pollutants impact air quality and can be harmful to both humans and our environment. Particulates PM10 and PM2.5 are less than 10 microns and 2.5 microns in diameter respectively. These can be considered a human carcinogen, because they are so small in diameter that they are difficult for our respiratory system to filter before they reach our lungs. This comparison shows that transitioning to EVs will have a large positive benefit on the air quality in West Hants.

Charger Installation Costs

The cost to install chargers is a cost that must be considered when first adding an EV into a fleet. There are several types of chargers with varying levels of cost. EV chargers are typically classified from level 1 to 3. Level 1 chargers can plug into a wall outlet, providing 7-9km of range each hour. Many EV owners have a level 2 charger installed in their home, which charge around 30-60km per hour (depending on the vehicle and charger), more than enough to charge overnight. Level 3 chargers are what is known as fast chargers, Direct Current Fast Chargers (DCFCs), or superchargers. They can charge up to 25km *per minute* on an empty battery. The installation costs for level 3 chargers could be prohibitive, making a level 2 the most practical for any application besides long-range trips.

Level 2 charger installations vary widely in cost, from around \$750 all-in at the low end, up to \$10,000 for very complex installations. Clean Foundation has found that the average installation cost is between \$2500-\$3000 per plug.

Installation costs vary additionally based on whether the charger is indoors or outdoors and based on how much wiring is needed to connect the charger to the load service panel. An indoor installation costs around \$1000 CAD in labour, while an outdoor installation costs around \$2000 CAD. The difference in price is due to the costs of trenching, concrete, and longer wiring. Funding is available through the ZEVIP program, which can provide up to 50% of costs up to \$5000 CAD per charging connector included in the project. The ZEVIP program requires a minimum of 20 charger installations per project, however there

are third-party funding streams such as Clean Foundation's EV Boost program which provide the same funding for smaller installation projects.⁴

Additional Considerations

EV Availability

Wait times for EVs typically are anywhere from three months up to as long as three years. Dealerships also require an often refundable deposit (\$500-\$1000), so the best course of action for anyone wanting an EV within the next three years is to consider putting the deposit down immediately.

Global supply of EVs has not been able to meet demand, which has increased rapidly over the past several years. Many factors have impacted the supply shortage, such as the increasing price of raw materials needed for batteries, a semiconductor shortage, and global supply chain issues. On the global scale, production of raw materials for batteries such as lithium, cobalt, and nickel will need to increase to meet the drastic increase in demand, which is required to reduce wait times.

On the provincial scale, ZEV mandates are having a profound impact on where ZEVs are being sold. Currently, Canada has a country wide mandatory goal of having every new light duty vehicle and passenger truck sold in Canada being a ZEV by 2035. British Columbia and Quebec have both passed their own ZEV mandates, allowing them to set mandatory target percentages for ZEVs sold prior to the Canada-wide target.

These policies have a direct impact in the vast majority of EVs being sold in Canada to be sold in either BC, Quebec, or Ontario. In 2021, 93.4% of ZEVs were sold in these provinces alone.⁵ This is a large reason why EVs are in such short supply locally in Nova Scotia.

Charging

Range anxiety

Range anxiety is the second largest barrier to EV adoption after sticker price and therefore will be the number one barrier for acceptance among fleet users. Range anxiety is a driver's fear that their vehicle will not have enough range to reach the next place it will refuel.

Infrastructure is another factor that drives range anxiety. Internal combustion engines have dominated the transportation market for most of the past century. The infrastructure needed to support the widespread use of ICEVs has had over a century to establish itself, and the infrastructure needed to support EV adoption has been improving slowly over the last decade.

⁴ ZEVIP info is accurate as of February 2023, requirements and available funding may change.

⁵ Government of Canada, S. C. (2018, December 4). Automotive statistics. www.statcan.gc.ca. <https://www.statcan.gc.ca/en/topics-start/automotive>

Gas stations can be found at almost every exit along highway corridors, or near every major artery into or out of a city. The concentration of gas stations is so dense that ICEV drivers rarely experience range anxiety, as they are most likely minutes away from their nearest station. Electric vehicle charging stations are much more sparsely concentrated, which removes the luxury of not needing to think about when they will need to stop to recharge.

Over the past decade, significant progress has been made to overcome the factors that contribute to range anxiety. Public EV charging infrastructure and the maximum range capabilities of EV batteries have both improved significantly. These are helping reduce range anxiety in opposite ways. Increasing maximum range means that vehicles will be able to reach charging stations that are further away, while improving infrastructure ensures that charging stations are closer together. These both increase the total amount of charging stations within range. The energy density of Lithium-ion battery packs is increasing each year⁶, while Canada's fast charging network is also expanding each year.

While the public charging network is expanding each year, most EV users primarily charge at home or at work. Public charging infrastructure is only necessary for users who travel further than the maximum range of their vehicle in a day, or for users who do not return to a location with a charging station in a day. By locating charging stations at trip end points rather than centralized locations, most EV users avoid relying on public infrastructure. For these users, public infrastructure only becomes relevant when using their vehicle for occasional long-range trips.

Charging stations are spread further apart than gas stations and are currently less reliable. Charging stations face other obstacles as well, such as going offline, limited charging space, accessibility, and longer wait times compared to filling a car with gasoline (depending on the type of vehicle and charging station).

For these reasons, the best practice for long-range use cases is to always keep a backup charging location in mind. The backup location needs to be within the vehicles remaining range, prioritizing that EV drivers plan to stop early rather than taking a risk and stretching the vehicles range to the furthest possible charging station. There are tools and apps available to EV users for route planning, such as A Better Route Planner.

[Plugshare map](#)

Fleet EV drivers should also be aware of locations of other EV charging stations in the area. Plugshare exists for this purpose and shows all publicly available charging stations. When installing charging stations to support fleet transition to EV usage, municipalities should consider whether the chargers should be solely for private use, or if they are meant to be available for the public as well. Municipalities should consider how they want their chargers to be used, and whether they should be listed on a service such as Plugshare.

⁶ Muralidharan, N. et al, (2022). Next-Generation Cobalt-Free Cathodes – A Prospective Solution to the Battery Industry's Cobalt Problem. *Advanced Energy Materials*, 12(9), 2103050. <https://doi.org/10.1002/aenm.202103050>

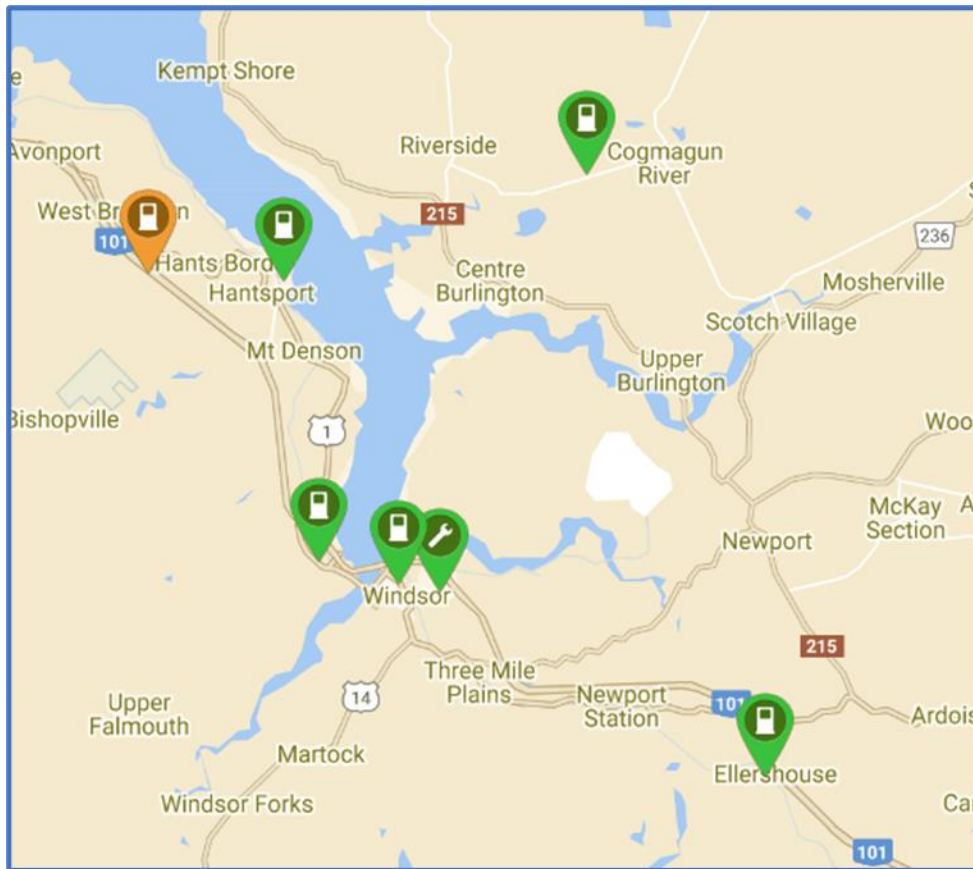


Figure 8: Plugshare map of West Hants showing location of all public Level 2 public charging stations

Fleet Vehicle use case

Using EVs as fleet vehicles fall under a different use case than a personal vehicle. The most important difference is where the vehicle spends its time and charges during non-work hours. Most work vehicles are always left at a work parking lot overnight, so work parking lots ideal places to install level 2 chargers.

Some employees bring their work vehicle home overnight, which may create complications. If the vehicle charges overnight at an employee’s private residence, a level 2 charger may need to be installed at that property if the vehicle is going to be fully charged overnight. This depends on how much the vehicle is being driven each day, as a level 1 charger can provide around 100 km of range every 12 hours, which may be more than enough for the workday. Level 2 charger installations can come at a significant price. If an employer is willing to pay for the installation cost, then the price of recharging the vehicle becomes a separate issue.

Many municipalities also operate their fleet out of several locations. Separate departments or branches can be spread out in different locations. For the greatest convenience, chargers could be installed at each location where a fleet vehicle stays overnight.

Chargers at the workplace will be a change that applies to everyone. Chargers typically have a dedicated parking spot and having ICEVs park in those spots could become disruptive to fleet operations. EV users

also need to remember to plug in at the end of the day. These are relatively small changes that should become second nature over time, but may need special attention during the transition to EVs.

Recommendations

Recommendation #1: Minimizing Impact on Fleet Users

We recommend that municipalities put forth an effort to understand how fleet users will be impacted by transitioning a portion of the fleet to EVs. Municipal fleet vehicles are work vehicles and it is up to the municipality to determine if an EV could complete the tasks that are currently being performed without affecting the fleet user's workday significantly.

Understandably, fleet users have concerns about how these changes will impact their ability to complete their work tasks, and those concerns fall into a few categories. Electric vehicles are still new to most people, so the first category of concerns are concerns that come with unfamiliarity of new technology. Many concerns of this nature can be addressed by connecting with those who have more experience with the technology or are keen to learn. The provincial EV education and engagement program, Next Ride, helps address these types of concerns daily, but these conversations also happen organically in our communities as an increasing amount of people are driving EVs. Concerns that fall into this category include questions about charging, battery technology, environmental impacts, and winter driving. Answering as many questions and concerns about these topics prior to introducing EVs into the fleet is advisable for making the transition as smooth as possible.

Many more of the concerns shared by fleet users relate to how the vehicle will be used. Factors such as the size of the vehicle, towing/weight capacity, ground clearance, and use of all-wheel drive can all be important to completing job tasks. There are several vehicles on the EV market that can address most of these needs. There are many EV models available that have both all-wheel drive as well as comfortable ground clearance for navigating rough terrain. However, EVs are not as efficient as ICEVs at towing heavy loads or towing over long distances. Towing or hauling heavy loads will significantly reduce the range EVs. It is recommended that municipalities explore how often each vehicle is required to tow heavy loads or over long distances, as those vehicles will likely be the most difficult to replace with an EV.

Many of the concerns of fleet users are surrounding batteries and the possibility of long wait times during a job while an EV recharges. These are valid concerns but depend highly on the usage patterns of the vehicles. The data collected during this study shows that most fleet vehicles and personnel would rarely need to be recharging a vehicle during the workday, so long as the vehicle is fully charged to start their day. No vehicle in the fleet ever drove over 200 km in a day, which is well under the maximum range of most EVs on the market even on cold days. The 2018 Jeep Compass, which drove the furthest each day on average, drove under 100 km on more than 66% of days. Most EV sedans and SUVs have a range of around 400km.

Recommendation #2: Suitable for replacement

Minimizing the impact on fleet users will be accomplished by determining which vehicles are most suitable to replace. Determining this can be accomplished by considering all qualitative requirements of the vehicle (such as towing and ground clearance) as well as its quantitative use patterns.

The qualitative needs of a vehicle give a strong indication of how difficult and disruptive it may be to replace. Separately, the quantitative data tracked throughout the study is most useful for comparing and predicting the costs and emissions that will be saved by transitioning. In the short term, qualitative needs will take precedence over quantitative, because staff being able to complete their job takes precedence over cost and emissions savings. The level of disruption to operations is only determined by the currently available makes and models of EVs on the market. At this current point in time, EVs likely could not accomplish every task that West Hants' current fleet of vehicles is being used to do as well as some ICEVs. However, the EV market is rapidly evolving, and in a few years the restrictiveness in decision making created by qualitative needs is likely to diminish greatly.

We recommend taking a slow and measured approach to EV fleet adoption, starting with at most one or two vehicles and monitoring how this impacts operations. This method gives fleet users time to adjust to changes that come with EV adoption, while allowing the municipality time to decide how to move forward with fleet transition in the future.

Out of the four vehicles in West Hants' fleet, only the 2021 Jeep Compass stands out as an unreasonable candidate to be replaced with an EV in the short term. This vehicle is the newest vehicle in the fleet, and there is an older vehicle of the same model in the fleet. This vehicle also drove the least distance over the data collection period. For each other vehicle, a comparison between a potential replacement EV and a replacement ICEV. Costs and emissions were then calculated for the EV and ICEV.

The comparisons were made by comparing the latest available model of each vehicle with a new model of a similar class of EV. For the replacements of the 2018 Jeep Compass and 2015 Ford Escape, a 2021 Kia Niro was selected as the EV for the comparison, although there are several other models of electric SUVs available. However, there is currently only one model of electric truck that is commercially available for purchase, that being the Ford Lightning. The 2015 Ford F-150 was compared to the Lightning for this reason. The comparisons show that replacing either the Escape or a Compass with an EV would result in the largest monetary savings and would reduce CO₂ emissions significantly. Replacing the F-150 with a Ford Lightning would cost more over its lifetime than replacing it with an ICEV, however the emission reduction would be more significant than in than converting any other vehicle in the fleet.

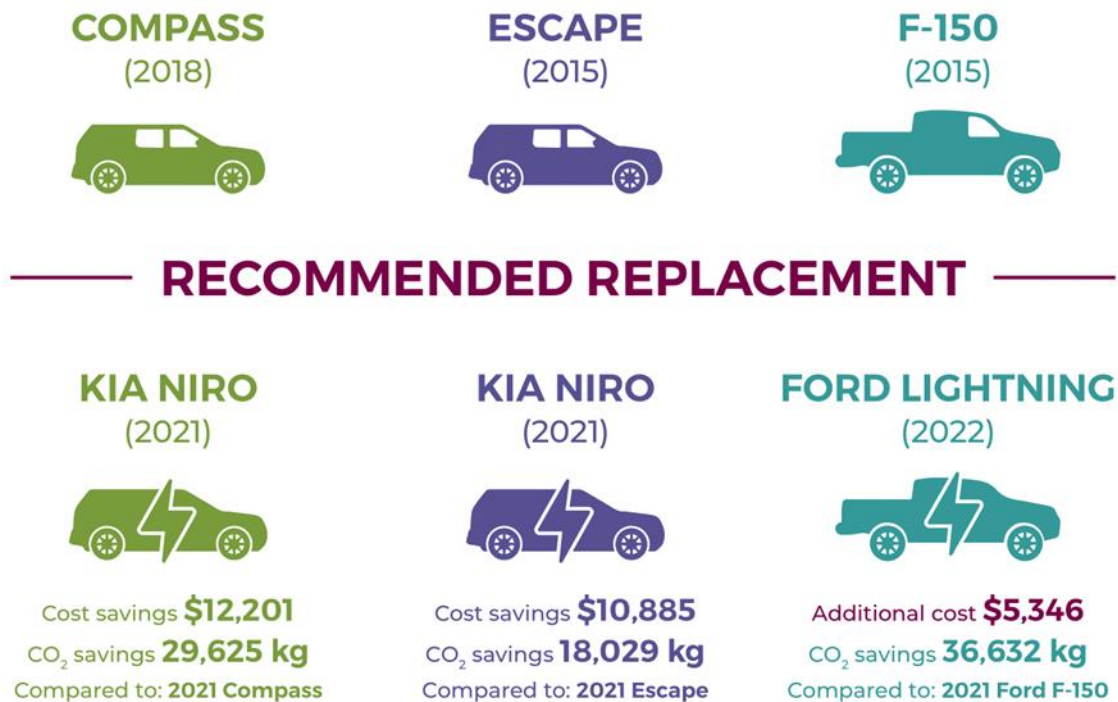


Figure 8: Lifetime cost and emissions savings for each potential vehicle replacement

Recommendation #3: Plan ownership duration around battery warranties

Electric vehicles have higher upfront costs and lower long-term costs compared to ICEVs. Keeping EVs in use for longer periods of time decreases their annual cost of ownership. When comparing TCO of new vehicles, the advantage of EVs grows as the period of ownership increases. We recommend that municipalities plan to replace their EVs every eight years or every 160,000 km, which is the same as the warranty on EV batteries. By replacing fleet EVs at the end of the battery warranty, fleets can take advantage of the lower TCO for as long as possible without any risk of needing to pay to replace a battery.

Acknowledgements

Clean Foundation would like to thank the Nova Scotia Department of Natural Resources and Renewables for their generous funding of this study, and to the Municipality of West Hants for its enthusiastic participation.

We are also grateful for the advice and guidance of our colleagues at Halifax Regional Municipality, Nova Scotia Power Inc., and Northern BI.

Appendix: Fleet User Survey

1. What is the name of your municipality?

[More Details](#)

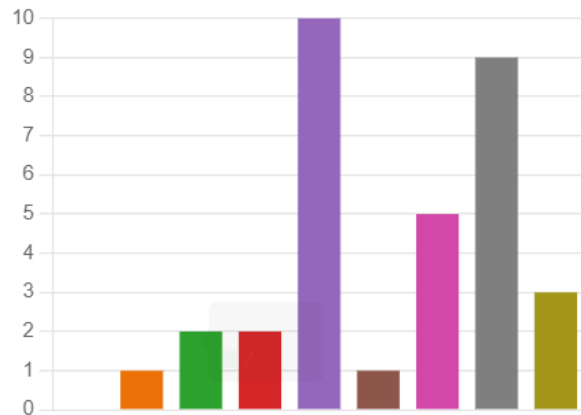
● Amherst	0
● Mahone Bay	7
● New Glasgow	5
● West Hants	8



2. Which of the following types of light-duty vehicles do you drive for work? Select all that apply.

[More Details](#)

● Small to mid-size car	0
● Full-size car	1
● Minivan	2
● Full-size van	2
● Small to mid-size SUV	10
● Large-size SUV	1
● Small to mid-size pickup truck	5
● Large pickup truck	9
● Other	3



5. Roughly how many minutes do you typically spend driving on days which you drive a light-duty fleet vehicle for work?

[More Details](#)

 Insights

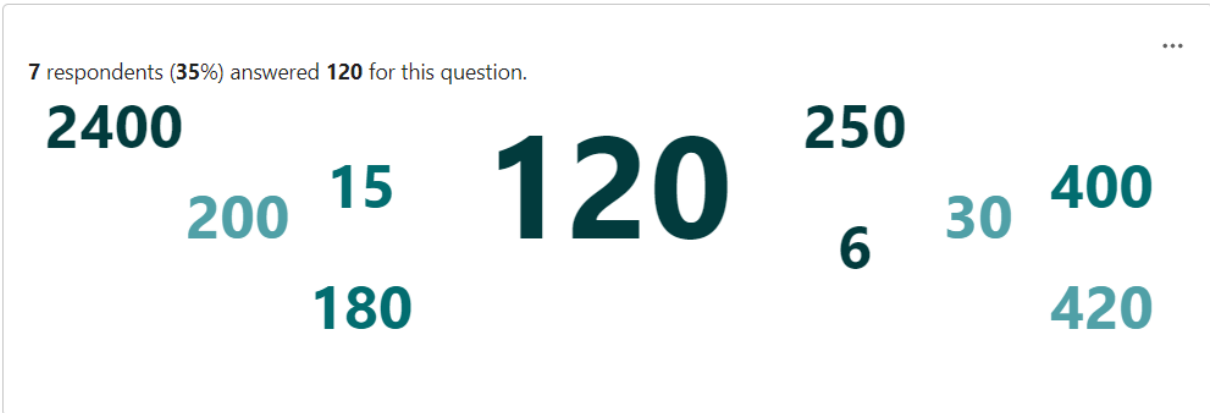
20
Responses

Latest Responses

"120"

"60"

"420"



6. How many kilometers do you drive in a typical day when using a light-duty fleet vehicle?

[More Details](#)

 Insights

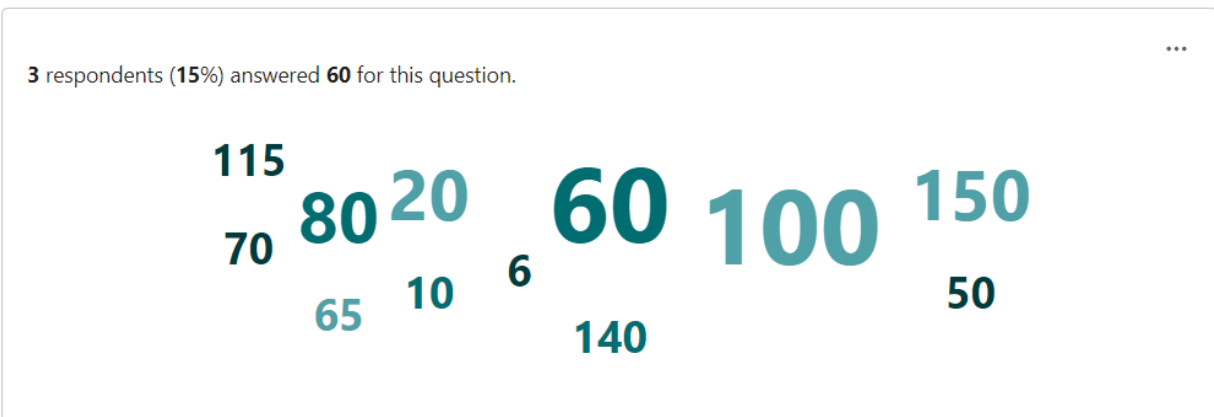
20
Responses

Latest Responses

"120"

"20"

"70"



7. Which types of roads do you travel on for work? Select all that apply.

[More Details](#)

<input type="checkbox"/> Pavement	16
<input type="checkbox"/> Asphalt	15
<input type="checkbox"/> Gravel	13
<input type="checkbox"/> Dirt	13
<input type="checkbox"/> Other	1



8. Do you ever take your work vehicle home with you at the end of the work day?

[More Details](#)

<input type="checkbox"/> Yes	2
<input type="checkbox"/> No	18



9. How often do you take your work vehicle home with you overnight?

[More Details](#)

<input type="checkbox"/> Daily	0
<input type="checkbox"/> Weekly	2
<input type="checkbox"/> Monthly	0
<input type="checkbox"/> Occasionally, less than monthly	0
<input type="checkbox"/> Seasonally Dependent	0

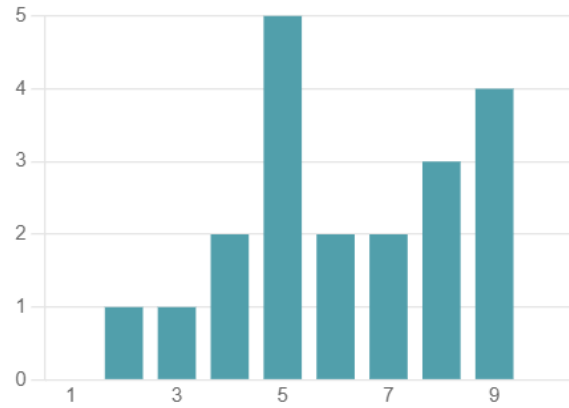


11. How do you feel about electric vehicles? 1 being very negative, 10 being very positive.

[More Details](#)

 Insights

6.20
Average Rating



12. Below are some common attitudes towards electric vehicles. Select any that you agree with.

[More Details](#)

- They have too many issues with ... 6
- I think they're great for commut... 6
- I think they are interesting and v... 12
- I'd like to learn more about wha... 5
- They're good but still have issue... 5
- They are great. The more I learn... 3

