ELECTRIC VEHICLE SUITABILITY ASSESSMENT

Capital Regional District

DECEMBER 2018

Making a difference...together

fleetcarma

STRATEGICALLY ADOPT PLUG-IN ELECTRIC VEHICLES SO THAT THEY WORK BEST FOR YOU.

Table of Contents

INTRODUCTION

FleetCarma's efficiency assessments inform organizational decision-making by using data from your current vehicles to evaluate the potential pathways to a cleaner and more cost-effective vehicle fleet.

The primary purpose of this fleet assessment report is to demonstrate the potential strategies that can be employed to achieve efficiency savings through the use of plug-in electric vehicles and enhanced management of existing vehicle assets. Efficiency savings include the financial benefits gained through Total Cost of Ownership (TCO) reductions as well as the corresponding reductions in fuel usage and greenhouse gas (GHG) emissions.

This process started with collecting second-by-second vehicle diagnostics data from your existing vehicles to formulate your fleet baseline, and in turn, drive FleetCarma's EV analysis. This approach ensures you are comparing vehicle options in your own real-world drive cycles.

The powertrain analysis developed by FleetCarma provides an independent third party methodology for your organization to evaluate your options. This predictive analytics system also simplifies the complexity of adopting plug-in vehicles that offer a range of performance and suitability capabilities across any fleet's portfolio of applications. The algorithms used deliver a reliable determination of the amount of

fuel and electricity that would be used by your plug-in vehicles and the anticipated savings potential of the more efficient vehicles you are considering. The data provided in this summary report serves as a review of the results from the study and a guide for making decisions regarding the electrification of your vehicle fleet. We start this report with highlights from the fleet baseline data that serve as a benchmark on how your vehicle fleet is currently performing. We follow with a summary of results from the powertrain model outputs and translate those into actionable recommendations. Our primary objective is to evaluate the extent to which plug-in electric vehicles would be suitable for your organization. This includes an examination of when and how they may charge, the anticipated reductions in operating costs and emissions, and the electric driving range capabilities as they relate to each of your duty cycles. In the final section of the report, we examine other types of efficiency opportunities to take advantage of, even in areas where plug-in electric vehicles may not work for you. For example, you will find specific saving opportunities as they relate to idle reduction, eco-driving, and fleet right-sizing. We welcome any and all questions and appreciate being partners with you in this process.

This process begins with data collected from your current vehicles to drive FleetCarma's EV powertrain algorithms in your real-world drive cycles.

FLEET BENCHMARK

Data logging your current duty cycles with FleetCarma devices provides two benefits. (1) The granularity of the data collected enables us to drive EV powertrain models with statistical confidence and (2) the data from your current vehicles provides a comparative benchmark to evaluate a series of potential EV adoption scenarios. Below are some baseline metrics collected from your vehicles.

All Fleet

39
duty cycles
(were monitored)

11 light duty trucks, 17 SUVs, 5 passenger vans, 3 full-sized vans and 3 sedans monitored.

45
kilometres
(average daily utilization)

This translates to an average calendar year utilization of 7,115 kilometres per vehicle.

13
L/100 km
(average fleet fuel economy)

Baseline vehicle fuel economy ranged from 4-27 L/100 km.

1.5
hours / day
(average engine-on hours)

Engine-on hours can help you evaluate the potential maintenance benefits of vehicles that run on electricity.

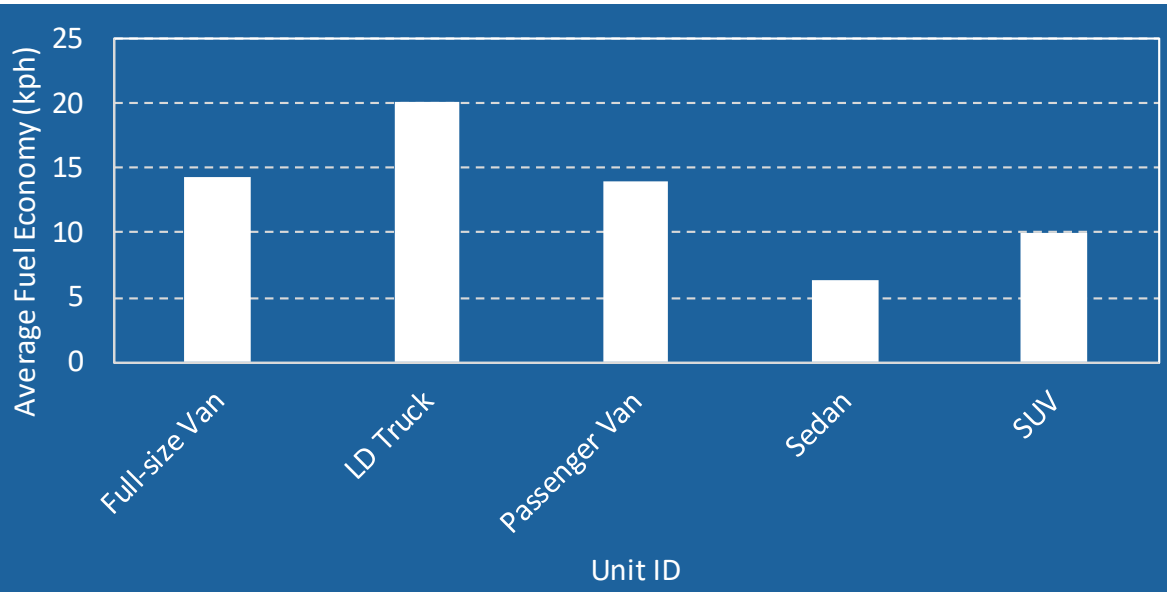
29
kph
(average duty cycle speed)

Average speeds are a high level indicator of the type of driving that your drivers do (highway or city).

27
%
(average time idling)

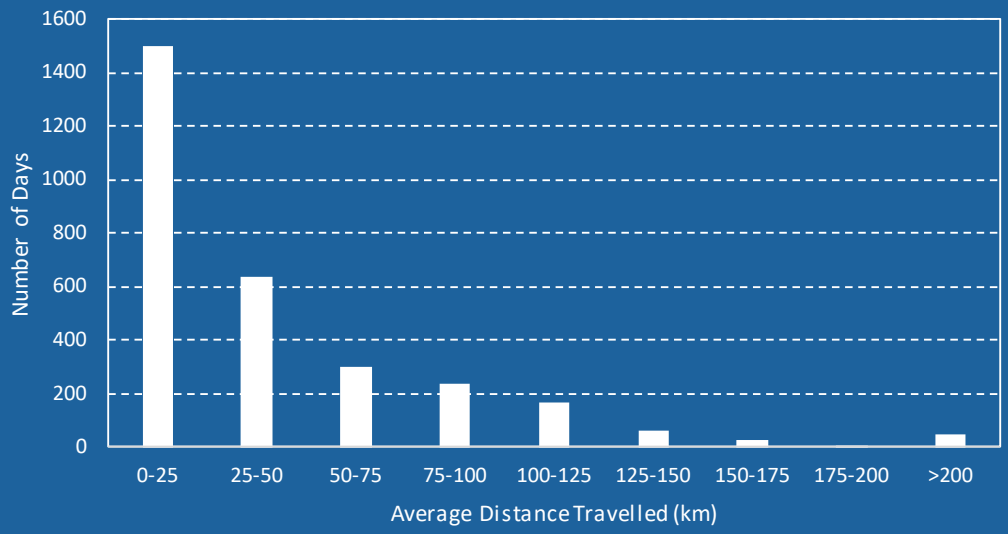
The amount of idling will impact fuel spend, tailpipe emissions, and even maintenance requirements.

Fuel Economy by Vehicle Type



Your Daily Utilization Histogram

Distance Travelled per Day Driven



Your average fuel economy is shown in the graph above with the current mix of vehicle types in your fleet. We provide the full fuel economy picture for every vehicle and every trip in the FleetCarma web portal as well. Clearly, since the fuel economy of your baseline vehicles varies from one duty cycle to the next, the potential fuel cost savings from plug-in vehicles should be highest on a per kilometer basis with the duty cycles that have the lowest fuel economy. However, daily utilization will have a substantial impact on the overall electric vehicle miles travelled (eVMT). In your daily utilization histogram above, we can see that of the days on which your vehicles were driven, 72% drove less than 50 kilometres, and 90% drove less than 100 kilometres. When considering EVs in ideal operating conditions, these thresholds are useful to evaluate the suitability of a hybrid or fully electric vehicle for your fleet.

FLEETCARMA RECOMMENDED EV DEPLOYMENT

This section shows your FleetCarma recommended EV deployment. Given this deployment, our simulation models show that in order to maximize ROI, the purchase price of your EVs should be no larger than the target.

The table below shows the recommended EV deployment purchase price, based upon the MSRP. By purchasing all recommended vehicles at this price and spreading savings across the fleet, you can expect to achieve the returns indicated on page 12. This analysis assumes that all of the recommended vehicles are purchased and deployed as indicated below. Please see page 9 to match the duty cycle with the recommended electric vehicle.

EV Model	Number of Vehicles	Bid Price	Duty Cycles
Mitsubishi Outlander PHEV	13	$43,000	See Page 9

BEST FIT DUTY CYCLES FOR EVs

In the table below, all of the baseline vehicles are listed in order of highest to lowest TCO Savings over the service life.

Department	Make & Model	Recommended EV	TCO Savings
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$35,339.06
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$32,645.42
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$18,335.52
Parks & Environmental Services	2018 Toyota RAV4	Mitsubishi Outlander PHEV	$16,164.51
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$11,685.18
Planning & Protective Services	2017 Chevrolet Equinox	Mitsubishi Outlander PHEV	$8,857.45
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$5,343.46
Integrated Water Services	2011 Ford Ranger	Mitsubishi Outlander PHEV	$4,723.49
Integrated Water Services	2017 Toyota RAV4 Hybrid	Mitsubishi Outlander PHEV	$3,835.21
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	$3,214.73
Integrated Water Services	2007 Ford Ranger	Mitsubishi Outlander PHEV	$3,131.00
Parks & Environmental Services	2010 Ford Ranger	Mitsubishi Outlander PHEV	$2,480.89
Integrated Water Services	2009 GMC Canyon	Mitsubishi Outlander PHEV	$1,690.23

The vehicles above were chosen based upon information provided by the Captial Regional District (CRD). By downsizing duty cycles that do not need the passenger or cargo capacity provided by a LD truck, van or SUV, there is an additional opportunity to reduce CO_2 emissions, and fuel expenditure.

BEST FIT DUTY CYCLES FOR EVs

13 Mitsubishi Outlander PHEV

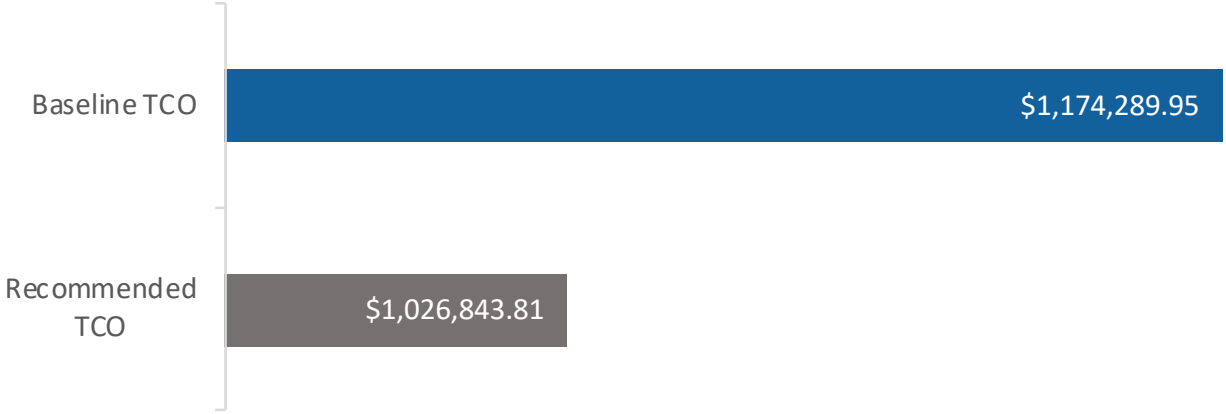
$43,000 Bid Price

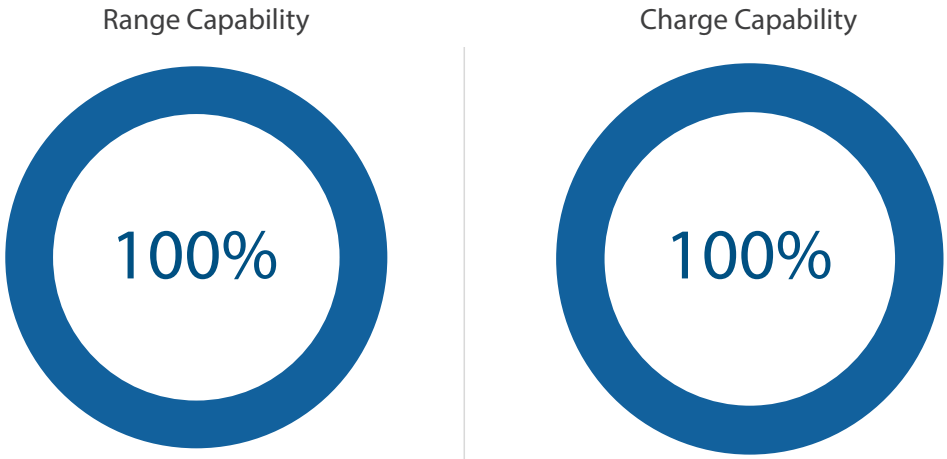
SUMMARY RESULTS

Providing quantified, independent third party, financial, and environmental results of plug-in electric vehicles in your duty cycles is what we do best.

Imagine logging all the speeds and all the energy demands from your vehicles for every second of every trip that your fleet drivers make. Now, imagine being able to use all that data to determine how alternative, more efficient technology would perform for any given trip, day, week, or year. These are the results that we are able to capture here. Using these data and our powertrain modelling tools we accurately compare the total cost of ownership of your baseline vehicles to the vehicles you are considering. Total costs include the vehicle acquisition costs and operating costs. In all cases presented, we assess EV suitability with one chance to charge per day, at the time that the vehicle finishes its final trip. For plug-in hybrids, the powertrain models determine the electric distance travelled and the corresponding overall fuel economy to drive the TCO calculations. In addition to the total cost perspective, these results help provide the framework to discuss further EV benefits such as GHG reductions, green marketing opportunities, and grid services that could enhance the total EV value equation.

When comparing your baseline vehicles to the optimal EV deployment scenario, it is clear that there is the potential for significant cost savings across the fleet.





Using the results of the recommended deployment shown on page 9, we can determine the potential savings that can be achieved from the most optimal EV deployment. We anticipate this potential to be about $147,446.16 in Total Cost of Ownership savings over the individual vehicle service lives. To do this analysis, we chose electric vehicles which we thought would be the most suitable to carry out each individual duty cycle in this fleet study and save your fleet the most on cost. We also take into account the capabilities of any potential EV deployments by running powertrain models of each EV on the data that we obtained from your baseline vehicles to determine whether the EV would be able to do the job of the baseline. We never recommend an EV which is not range capable. In your fleet, we found that the best-fit vehicles were 100% charge capable. This is the percentage of overnight times on average the vehicles will be able to fully charge.

If 13 of the baseline vehicles are replaced with the FleetCarma Recommended plug-in vehicles, the fleet will see the following total savings over the service lives of the baseline vehicles.

Total Fleet Savings (13%)

$147,446

If 13 vehicles are replaced with the best fit vehicle, the fleet could save $147,446 in total savings over the service life. This represents 13% of the fleet budget.

Annual Emission Reductions (43%)

↓49 tons

If 13 vehicles are replaced with the best fit vehicle, the fleet could realize an emission reduction of 49.2 tons per year over the service life, representing a 43% reduction in CO_2 emissions.

Annual Fuel Reduction (43%)

↓16,067 L

If 13 vehicles are replaced with the best fit vehicle, the fleet could reduce gasoline and diesel consumption by a total of 16,067 L annually over the service life, representing a 43% reduction in fuel.

MORE THOUGHTS ON FLEET EFFICIENCY

We understand that not every duty cycle in the fleet will be suitable for a plug-in electric vehicle right away. In the meantime, we present in this section of the report other opportunities for your fleet to capture further efficiency savings which relate to idling, eco-driving, and fleet right-sizing.

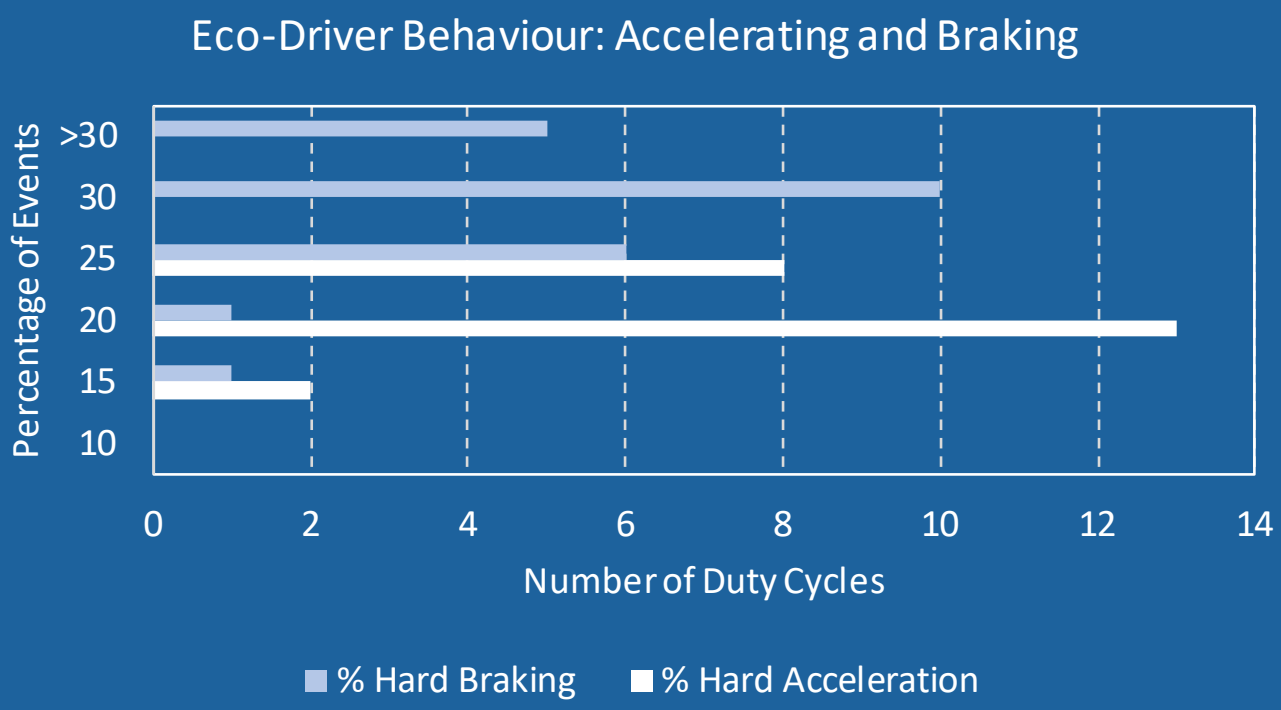
IDLING

Based on the data collected from your vehicles, 27% of engine-on time is spent idling. Using a telematics system to manage idle-reduction programs could save 187 L of gasoline per month, resulting in a savings of $7 per vehicle.

27%	187 L	$7
engine-on time spent idling	total monthly fuel used for idling	average potential savings each month per vehicle

DRIVER SAFETY

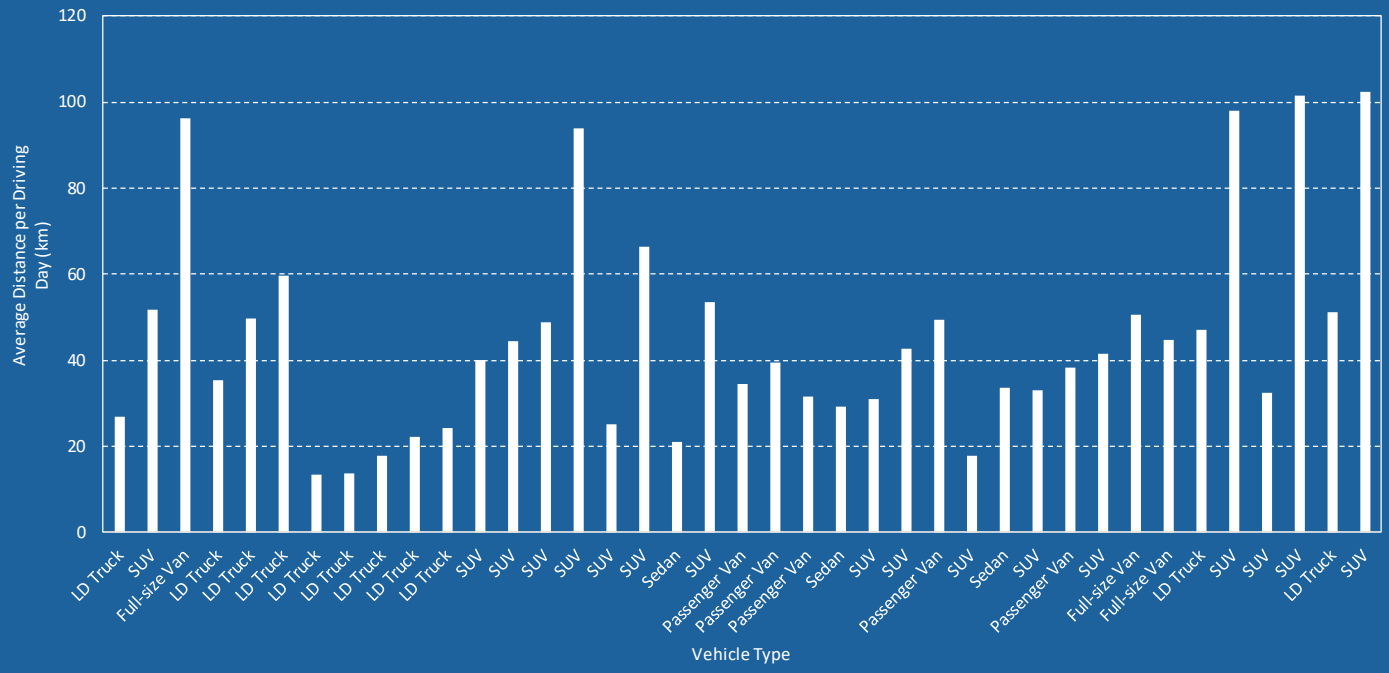
The graph below shows a histogram of the acceleration and braking scores for each driver. In this case, the lower the score the better they are performing. For your fleet, 95% of drivers are below the hard braking threshold of 20% and 100% of drivers are below the hard acceleration threshold of 20%.

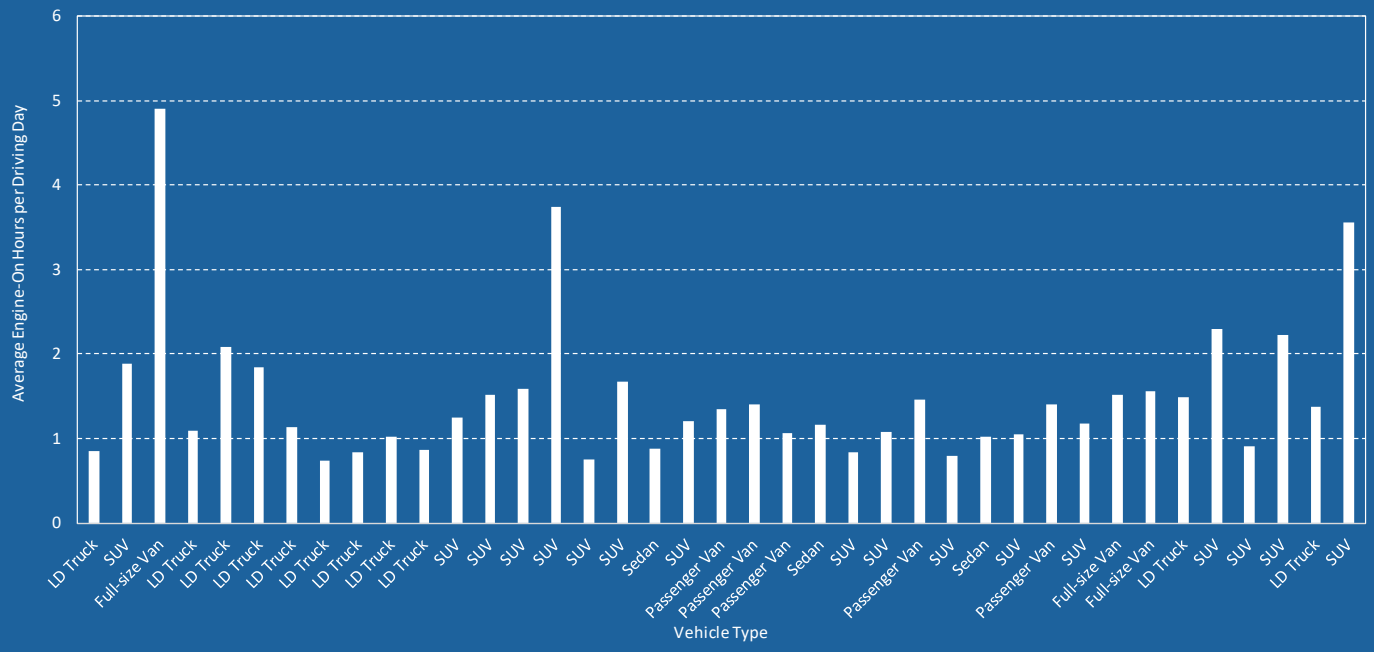


These Eco-Driver Behaviour scores may indicate opportunities within your fleet to review safe driving practices. Smooth braking and smooth acceleration can help reduce maintenance costs over the life of the vehicle. For an electric vehicle, smooth braking allows for more energy to be captured via the regenerative braking process.

UTILIZATION

Based on your daily utilization, we found that few of your vehicles are being used heavily, and a few were under utilized. The threshold for an under utilized vehicle is less than 25 kilometres per day, and less than 1 hour of engine on-time. Vehicles that meet this criteria could be replaced by a mileage reimbursement vehicle or a pool vehicle.





VEHICLE CHARGING INFRASTRUCTURE

To find out what to expect in terms of the charging needs of your new EVs, we looked at the amount of time your current vehicles spend parked overnight - their "dwell time".

Based on the recommended EV deployment on page 8, we estimated the amount of time each vehicle would need to charge at a Level 1 station versus a Level 2 station to determine the potential charging needs of your EV fleet. These requirements from the EV can then be combined with the nightly dwell times[2] for each of your current vehicles to determine the number and types of charging stations your fleet may require with this deployment. There are multiple strategies that can be employed when purchasing charging infrastructure to make sure you meet the needs of your fleet drivers, budget, and organization. We offer four of these potential strategies below so that your organization can determine what will work best in your particular case. The options we consider here include Level 1 (wall outlet), Level 2 (charging station) Single Port, and Level 2 Dual Port. Dual port stations are generally more expensive, but do not require someone to move the plug from one vehicle to another when the first vehicle has completed charging.

Current Dwell Time[1]	Number of Vehicles
Short	4
Medium	1
Long	8

Infrastructure Scenario	Total Cost[3]	Charging Power Level	Number of Stations	
1 - Dedicated	$15,000	1	8	
		2	5	
2 - Plug Sharing	$15,000	1	8	
		2	5	
3 - Power Sharing	$15,000	1	8	
		2	5 Single Port	0 Dual Port
4 - Complete	$39,000	1	0	
		2	13	

1 Short, medium, and long dwell times for the suggested PHEVs are < 4 hrs, 4-8 hrs, and > 8 hrs, respectively. Short, medium, and long dwell times for the suggested BEVs are < 12 hrs, 12-16 hrs, and > 16 hrs, respectively.

2 Please see the Appendix for more information on the nightly dwell times for each vehicle and strategies to optimize charging.

3 We assumed Level 1 stations cost $0 and Level 2 stations cost $3,000 for single port and $4,500 for dual port.

WHERE TO BEGIN

As you start purchasing plug-in vehicles for your fleet, you want to begin with the vehicles that will have the lowest total cost of ownership when compared to the vehicles you are currently operating with.

Looking at the comparative data in the reports, we can identify two key areas to begin to consider plug-in vehicle adoption.

1. Implementing PHEVs will ensure the vehicles are range capable and able to support the level of utilization observed in this fleet. To facilitate the implementation of an electric fleet, charging stations must be available and drivers must be encouraged to plug in the vehicles to maintain a high EV fraction. This will allow you to realize the maximum level of savings.
2. There is a large opportunity to transition light duty trucks and/or SUVs to PHEV SUVs. At this time, there are not many SUV EVs available. However, additional significant fuel and emission savings can be realized if the conventional light duty trucks and SUVs can be replaced replaced with suitable PHEVs.

STUDY DETAILS

The results and recommendations in this report have been analyzed using the following information while accounting for vehicle resale value, range capability, and charge capability:

Service Life and Energy Costs		Emissions Factors	
Service life per vehicle	7 years	Tailpipe (Gas)	2,325g $C0_2$/L
Current cost of fuel	$1.45/L (Gasoline)	Upstream (Gas)	740g $C0_2$/L
Current cost of electricity	$0.12/kWh	Upstream (Electricity)	259g $C0_2$/kWh

ELECTRIC FLEET MANAGEMENT GOALS

Once you have begun to deploy electric vehicles in your fleet, the following goals will help you to realize the savings potentials described in this report. FleetCarma Telematics Technology can be used to track performance on the KPIs listed below.

Along with opportunities for savings on costs, fuel, and emissions, electric vehicles also offer new opportunities to better manage the vehicles you own. Active management of fleet vehicles to ensure that EVs get used first can drive up your EV ROI and ensure that your fleet is never paying for high-cost, high-emissions fuel when it is not necessary.

Adding EVs to your fleet also opens up opportunities to show sustainability leadership as an organization through implementing new and more efficient technologies. Electric vehicles are just one part of a holistic sustainability plan which aims to reduce the overall greenhouse gas emissions of the organization as well as promoting and educating others about sustainability best-practices.

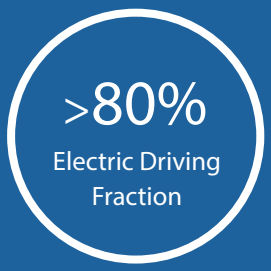
Employing systems to manage charging and day-to-day usage can help fleet drivers feel comfortable driving the new electric vehicles that have been added to the fleet, avoiding hesitation and range anxiety. With the remaining gasoline vehicles that you have in the fleet, there are also opportunities to improve fuel efficiency and driver safety mentioned earlier in this report. This section allows us to attach goals to these metrics like Hard Acceleration and Braking.

QUALITATIVE GOALS

1. Demonstrate EV leadership through outreach and technology demonstration.

2. Practice environmental stewardship through reductions in carbon intensity (CO_{2eq}) per mile

QUANTITATIVE GOALS



The electric driving fraction refers to the percentage of trips driven using electricity rather than gasoline. This applies to Plug-in Hybrid Electric Vehicles. A higher electric driving fraction results in a lower TCO.

Plug-in compliance refers to the percentage of nights that drivers plug in their vehicles after the last trip of the day so that it can have time to charge overnight. It ensures that Starting SOC is as high as possible.

SOC stands for State of Charge and refers to the degree to which the high-voltage battery of a plug-in vehicle has been charged or depleted. Starting SOC refers to the SOC at the beginning of the first trip of the day. A more fully charged battery allows for a higher electric driving fraction, and limits range anxiety.

Hard Acceleration Events is another metric used by FleetCarma clients to measure driving efficiency and driver safety. This is calculated as a percentage of total acceleration events.

Braking style does impact plug-in vehicle efficiency since smooth braking helps the vehicle regenerate energy while driving and also improves driver safety. This is calculated as a percentage of total braking events.

NEXT STEPS

The core objective of an EV suitability assessment is to help you determine your best strategy for EV adoption, to formulate customized EV utilization goals, and to have the information your need to move forward with confidence.

Understanding your fleet utilization to the level presented here should give you all that you need to make informed decisions about your fleet composition. If fleet efficiency is a priority for your organization then we have got your back. As vehicle technology evolves, the complexity of managing these vehicles changes. This is why at FleetCarma we have worked hard to provide our customers with a vehicle monitoring and fleet management system flexible enough to work on all vehicle types. As you continue to strive to deploy a diverse set of vehicles, we would be happy to help you along the way. For more information see some of the features we offer through our telematics system on the next page or contact us again any time.

EV Utilization Metrics

Track all the your EV KPIs with FleetCarma EV monitoring system. No need to pay for sub-metering - with this system you can track all your driving and charging data in one common system.

Charge Management

Want to improve the TCO of your electric vehicles? Consider using them as energy assets for your local grid. With real-time EV monitoring, we can automate your managed charging strategy.

Vehicle Location Tracking

FleetCarma's vehicle monitoring technology can help you keep track of real-time vehicle location with live mapping tools. Also track historic locations of trips and charge events for your vehicles.

Odometer Readings & DTCs

Can you benefit from a more automated preventive maintenance program? With FleetCarma's system you can instantly know your vehicles' odometers and when diagnostic trouble codes are present.

Full Fleet Support

Monitor plug-in vehicles, conventional vehicles, and heavy-duty vehicles with one common system. FleetCarma's system is the most flexible fleet monitoring technology on the market today.

EV ROI Scorecard

FleetCarma's customer support team will work with you along the way to a positive EV experience. We'll provide periodic EV ROI Scorecards for you and your team to ensure goals are met.

APPENDIX 1

This appendix was included to show the individual dwell times of the vehicles.

Department	Make & Model	Recommended EV	Dwell Time
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Short
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Short
Integrated Water Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Long
Parks & Environmental Services	2018 Toyota RAV4	Mitsubishi Outlander PHEV	Long
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Long
Planning & Protective Services	2017 Chevrolet Equinox	Mitsubishi Outlander PHEV	Long
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Long
Integrated Water Services	2011 Ford Ranger	Mitsubishi Outlander PHEV	Short
Integrated Water Services	2017 Toyota RAV4 Hybrid	Mitsubishi Outlander PHEV	Short
Executive Services	2017 Ford F-150	Mitsubishi Outlander PHEV	Long
Integrated Water Services	2007 Ford Ranger	Mitsubishi Outlander PHEV	Medium
Parks & Environmental Services	2010 Ford Ranger	Mitsubishi Outlander PHEV	Long
Integrated Water Services	2009 GMC Canyon	Mitsubishi Outlander PHEV	Long

2-60 Northland Road,
Waterloo Ontario, N2V2B8
1-800-975-2434

www.fleetcarma.com