Driver Training for a Low-carbon and Fuel-efficient City Fleet

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August 2025

Disclaimer

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organizations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability and climate action across the region.

This project was conducted under the mentorship of the City of Coquitlam staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of the City of Coquitlam or the University of British Columbia.

Acknowledgements

The author acknowledges that the work for this project took place on the unceded ancestral lands of the Syilx (Okanagan) Peoples, and impacts the kʷikʷəƛ̓əm traditional and ancestral lands, including those parts that were historically shared with the q̓iċəy̓ (kat-zee), and other Coast Salish Peoples.

The author would like to thank Dr. Jenalee Kluttz of the City of Coquitlam, the Mentor of this project for her invaluable guidance and motivation provided throughout the program, as well as Karen Taylor of the University of British Columbia Sustainability Hub for her facilitation of the project and constant support. The author would also like to sincerely acknowledge the participants of the focus groups and interviews for their valuable time and insights.

Cover Photo provided by the City of Coquitlam

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Executive Summary

The City of Coquitlam's Environmental Sustainability Plan established a target of achieving a 45% reduction in greenhouse gas emissions by 2030 when compared to 2007 levels and reaching carbon neutrality by 2050. Approximately 50% of corporate emissions of the City of Coquitlam originates from its vehicle fleet; therefore, the Environmental Sustainability Plan outlines multiple action items to mitigate transportation-related emissions. Action 19 focuses on developing a civic driver training program to encourage sustainable driving habits among staff members and curb emissions. This report presents a comprehensive evaluation of prospective pathways for developing and implementing a training program on sustainable driving habits.

An extensive literature review was performed to evaluate previously executed sustainable driver training programs worldwide. This review aimed to identify the strengths and weaknesses of these programs to inform the design and delivery of the civic driver training. Also, a series of focus groups and interviews were conducted with several staff members of the City of Coquitlam representing different departments. The interviews revealed a lack of awareness about the existing shared battery-electric vehicle program and mixed levels of knowledge on sustainable driving habits among staff members. In addition, planning and executing a series of 'crew talk' sessions was identified as the optimal method of knowledge dissemination considering the nature of work of staff members.

Based on the findings of the literature review, focus groups, and interviews, a new chapter for the City of Coquitlam Driver's Manual was drafted, which will provide users with guidance on driving sustainably to lower fuel usage and costs. Furthermore, a series of four crew-talk sessions extensively covering sustainable driving techniques was conceptualized. In addition, an introductory session to educate staff members about the Environmental Sustainability Plan, emission reduction targets of the City of Coquitlam, and sustainable driving, was developed. Moreover, strategic recommendations on the execution of the program as well as increasing awareness on sustainable driving have also been proposed in this report. These findings will help improve the energy efficiency of the vehicle fleet and support staff engagement in the City's decarbonization efforts.

1 Introduction

Accelerated climate change due to anthropogenic greenhouse gas (GHG) emissions can result in numerous negative impacts across the globe such as increasing global temperatures, rising sea levels, increased frequencies of extreme weather events, and damage to biodiversity and ecosystems. Hence, it is important for federal, provincial, and local governments to demonstrate leadership and enact policies to ensure the environmental sustainability of their communities. The City of Coquitlam (hereafter referred to as “The City”) published its inaugural Environmental Sustainability Plan (ESP) in January, 2022 with the aim of planning and supporting efforts which strengthen the environmental sustainability of the local community [1]. As per the ESP, The City aims to lower their GHG emissions by 45% by 2030 when compared to 2007 emission levels and attain carbon neutrality by 2050. The City’s vehicle fleet accounted for 36% of Coquitlam’s corporate GHG emissions in 2020, highlighting the need for urgent action aimed at reducing emissions from this key source of GHG emissions. As part of the ESP’s fleet emission mitigation strategy, The City has proposed developing a civic driver training program to promote sustainable driving habits among staff [1]. In addition, The City has adopted a ‘green fleet strategic plan’ to gradually transform its light-duty vehicle fleet into a low- and zero-emission fleet, and the proposed civic driver training program can be used to endorse the usage of low- and zero-emission vehicles among staff members.

This project was conducted to understand the most practical and feasible methodologies of developing and delivering a training program on sustainable driving practices aimed at staff members of municipalities who regularly use fleet vehicles. During the development of institutional training programs, it is vital to critically review previous training programs executed within similar organizations to identify the best practices and prepare for potential shortcomings. Moreover, it is also important to actively engage with staff members to identify the best potential approaches to develop and deliver such programs. This report outlines a comprehensive approach integrating literature review and stakeholder engagement to inform the development of training resources on sustainable driving practices.

2 Project Objectives

The main objectives of this project were to recommend updates for the City of Coquitlam's Driver Manual to include sustainable driving practices and develop an online and/or in-person civic driver training and education program for the City staff members. These two objectives were segregated into four sub-objectives, as described below.

1. Conduct a comprehensive literature review on existing driver training and education initiatives across the globe, with a focus on electric vehicle operation and fuel-efficient driving strategies. The primary purpose of this literature review was to identify established best practices, potential barriers for implementation and mitigation strategies.
2. Engage in focus groups and interviews with staff members of The City who routinely operate or oversee fleet vehicles to collect insights on current driving behaviors and prospective areas for improvement. The information gathered from the interviews would be used to shape the delivery of the online and/or in-person training resources.
3. Use the findings from the literature review and staff interviews to recommend updates to the City of Coquitlam Driver's Manual to integrate sustainable driving practices applicable to both electric vehicles and internal combustion engine vehicles.
4. Design a structured online and/or in-person civic driver training and education program to be used for continuous staff education, based on the identified best practices and stakeholder input.

3 Literature Review

Transportation is the second-largest source of greenhouse gas (GHG) emissions among various economic sectors in Canada [2]. Several key targets have been established by governments around the world to mitigate transport-related GHG emissions, such as the target of making all new light-duty vehicle sales zero-emission by 2035 set by both the Government of Canada and the European Union, as well as the United States Environmental Protection Agency's goal of making two-thirds of the new passenger car sales zero-emission by 2032 [3]–[5]. The development and deployment of zero-emission vehicles such as battery-electric vehicles (BEVs), hydrogen fuel cell vehicles, and hybrid vehicles, development of cleaner fuels such as renewable diesel, biodiesel, and hydrogen, and expansion of public transportation are some of the major focal points of policymakers and decision-makers in this regard [6], [7]. Additionally, the adaptation of fuel-efficient driving techniques and practices – often referred to as eco-driving – is another promising approach of reducing GHG emissions, aimed at enhancing the fuel economy of vehicles through encouraging drivers to change their driving habits. However, eco-driving is often overlooked despite it's potential of reducing GHG emissions, and this is due to technological advancements such as zero-emission vehicles, start-stop technology, and adaptive cruise control receiving much more focus when compared to the impact of driver behavior on the vehicular fuel consumption [8]. Nevertheless, fuel-efficient driving techniques and practices offer significant environmental, economic, safety, and social benefits as presented in Figure 1. Eco-driving has the potential of reducing fuel consumption and costs between 10-20% [9], [10]. The environmental benefits of eco-driving include lower GHG, particulate, and NO_x emissions, and the social and safety-related advantages are improved in-vehicle comfort and lowered road rage and accidents [11]. Thus, it is important to encourage drivers to adopt eco-driving techniques in their day-to-day lives.

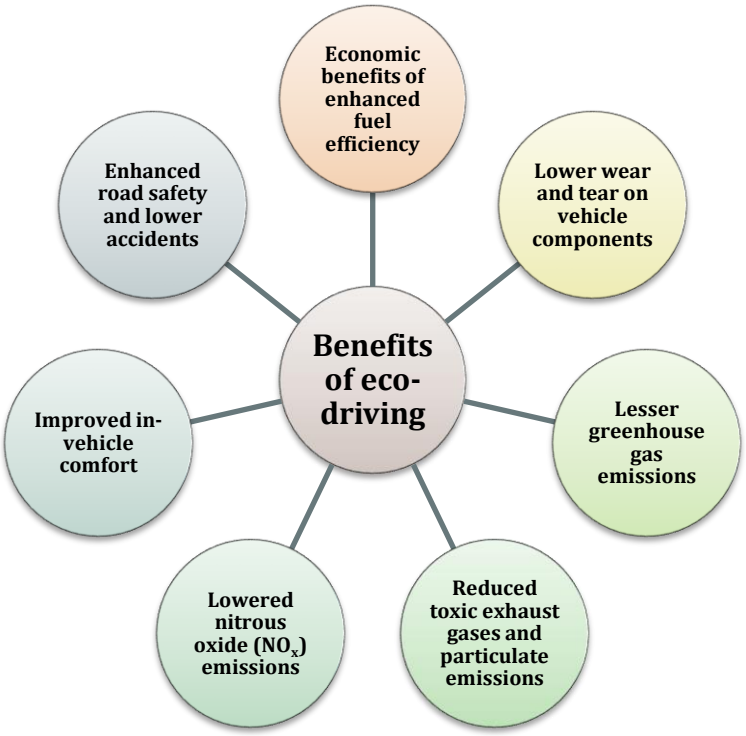

Figure 1 – Benefits of eco-driving

Proper education in eco-driving is a crucial element of embedding environmentally and economically sustainable driving habits among city drivers, as proven in several scientific studies on education programs. The effectiveness of two eco-driver training programs carried out in multiple cities in Queensland, Australia and Madrid, Spain was evaluated through fuel consumption data before and after the training, and 4.6% and 6.3% respective reductions in fuel consumption were observed [12], [13]. Another study based on China revealed that even though professional drivers may be less able or willing to change their long-term driving habits in comparison to non-professional drivers, eco-driver training can be effective in reducing idling and improving acceleration-deceleration patterns [14]. The study further states that education should be supplemented with in-vehicle coaching for eco-driver training to yield maximum benefits. Furthermore, these studies demonstrate that well-structured eco-driver training programs and resources are a vital aspect of materializing the prospective environmental, economic, and safety benefits. Moreover, continuous progress monitoring, motivation, and ongoing education are also vital in sustaining eco-driving in the longer term.

The aim of this brief literature review was to explore eco-driving programs established by municipalities to educate their drivers on sustainable driving habits. The methods of program delivery, continuous data collection and monitoring mechanisms, and the attained progress of the

programs would be compared. The knowledge gathered through this review would be useful in designing future eco-driving courses for municipalities, assisting in tailoring the content and delivery formats while ensuring maximum economic and environmental benefits.

3.1 Eco-driving Techniques

Fuel-saving driving techniques should not be limited to only when the vehicle is being driven; this concept should be extended to pre- and post-trip phases as well which includes route optimization, inspection, and proper maintenance of vehicles [15]. The ECOWILL project which aimed at educating licensed and learner drivers in Europe on eco-driving has characterized fuel-efficient driving techniques into two categories as the golden and silver rules of eco-driving [8], [16], [17]. The golden rules include five of the most important eco-driving techniques, and silver rules include eight other eco-driving tips, as delineated below.

3.1.1 The Golden Rules of Eco-driving

The five golden rules of eco-driving as defined in the ECOWILL project have been presented in Figure 2, and each of them has been discussed in detail in this section.

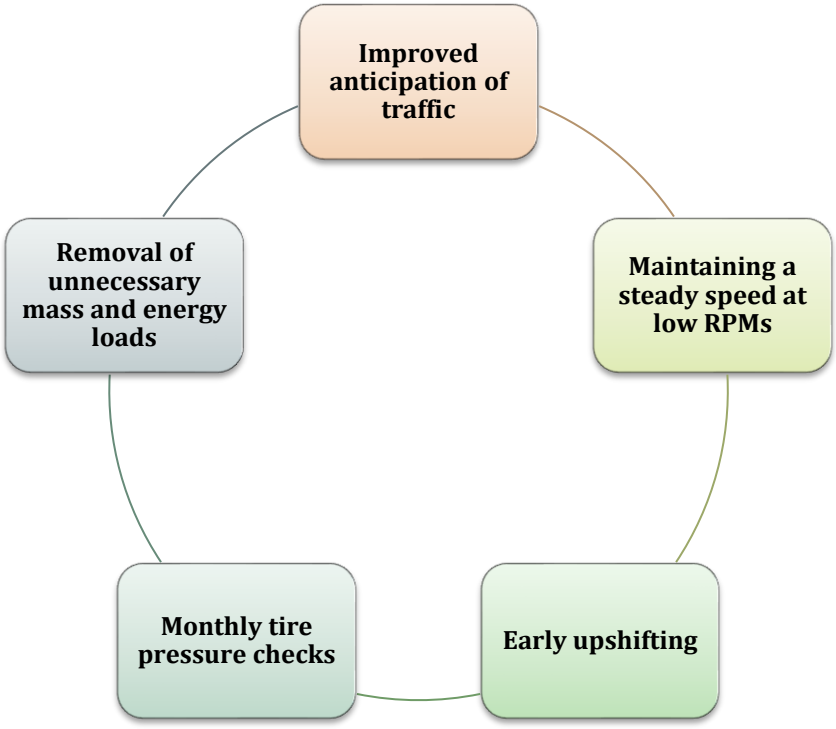

Figure 2 – The five golden rules of eco-driving as defined in the ECOWILL project

- Improved anticipation of traffic

Hard braking results in wasted forward momentum and kinetic energy, especially in vehicles with no regenerative braking [18], [19]. This rule recommends looking ahead as far as possible while driving and attempting to predict the movements of other vehicles, pedestrians, and cyclists, with the goal of minimizing hard braking when slowing down is required. It is also encouraged to maintain a greater distance from the vehicles in front to avoid hard braking. Compliance with this technique will ensure a steady speed is maintained, minimize fuel consumption, and enhance road safety.

With enhanced anticipation and a greater distance to the vehicles ahead, it is also possible to further improve fuel efficiency by coasting to decelerate instead of braking. It is desirable to take the foot off the accelerator pedal as soon as a slowdown is noticed in the traffic ahead. Most modern vehicles will cut off the fuel supply to the engine as soon as the accelerator pedal is released, and the vehicle will slow down from aerodynamic drag, rolling resistance, and friction. This is additionally advantageous due to the reduced wear on braking system components.

- Maintaining a steady speed at a low RPM

Large fluctuations of speed through rapid acceleration and hard braking can result in unnecessarily increased fuel consumption. It has been proven that speed fluctuations between 75-85 kmph every 18 seconds may increase fuel consumption up to 20% [18]. Especially in city-driving, the potential of saving time via high accelerations and speeds – as well as consequent hard braking – is quite low since city-driving is heavily affected by external factors such as traffic lights, other road users, and lower speed limits [16]. Therefore, it is recommended to always maintain a steady speed at low RPM values. In this regard, adhering to posted speed limits is another fuel-saving driving technique since most light-duty vehicles attain maximum fuel efficiency between the speeds 50 and 80 kmph and the fuel consumption rises at speeds exceeding this range [18]. Additionally, cruise control is a highly useful technology for highway driving since this ensures a constant speed and avoids unnecessary acceleration. Moreover, it is suggested to accelerate smoothly up to 20 kmph from standstill in five seconds, conserving fuel [18].

- Early upshifting

This is an eco-driving rule which is mainly associated with manual transmission vehicles. Early upshifting is recommended to maximize fuel economy since driving at medium or high RPM values increases fuel consumption substantially when compared to driving at low RPM values. It is advised to shift upwards between 2,000 and 2,500 RPM as this will optimize fuel economy [20].

- Monthly inspections of tire pressure

Tire pressure is a vital factor contributing to the fuel economy since underinflated tires can drastically reduce fuel economy. Tires underinflated by 8 psi can raise fuel consumption by approximately 4%, as well as reduce the lifespan of tires considerably [18], [21]. Therefore, it is strongly suggested to check tire pressures at least once a month to ensure that they are inflated to the pressure specified by the vehicle manufacturer.

- Removing unnecessary loads from the vehicle

This rule refers to both mass loads as well as energy loads. Vehicles with lower net weights will reduce the amount of energy required to move it forward; thus, it is recommended to remove unnecessary items from vehicles to conserve fuel. A 1% increase in fuel consumption can be expected when the weight of the vehicle increases by 25 kg [18]. In addition to heavy items, this applies to vehicle accessories which can incur higher aerodynamic drag resistance as well, such as roof racks and roof boxes. Hence, it is acceptable to remove such loads from vehicles when not required.

Air conditioning is an energy load which can heavily contribute to increased fuel consumption. Therefore, it is highly recommended to minimize the use of air conditioning as much as possible. When driving in the city, opening the windows of the vehicle can reduce the need for air conditioning. However, highway driving with windows down can incur drag resistance, subsequently increasing fuel consumption; thus, windows should be shut when driving at higher speeds. Furthermore, ensuring the recirculation mode is turned on while using air conditioning can reduce energy consumption.

3.1.2 The Silver Rules of Eco-driving

Additional rules of eco-driving defined as ‘silver rules’ in the ECOWILL project have been displayed in Figure 3, and each of them has been discussed in detail in this section.

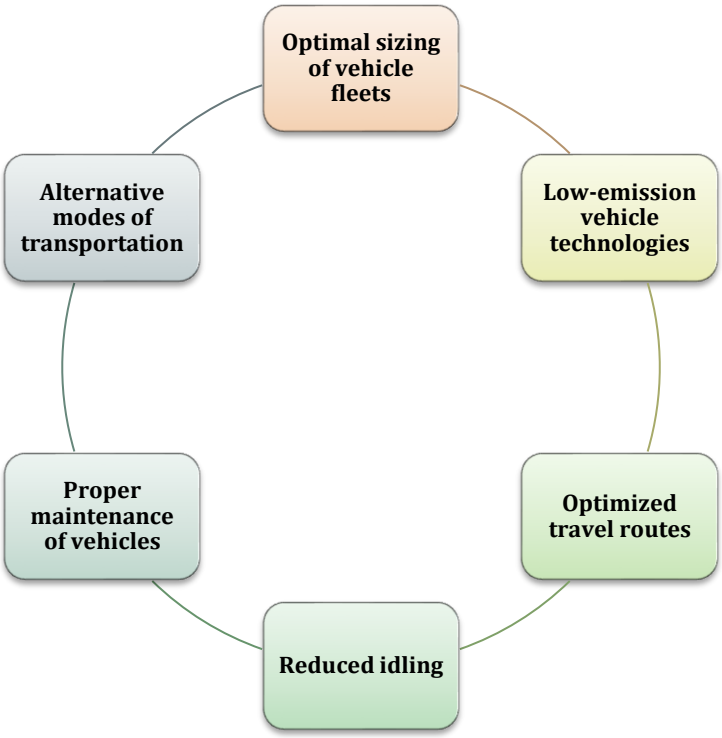

Figure 3 – The silver rules of eco-driving as defined in the ECOWILL project

- Optimal vehicle sizing and low-emission technologies

The prospect of mitigating emissions from transportation stems from the vehicle acquisition process itself [8]. It is desirable to opt for smaller vehicles which align with the optimal weight and engine size for their intended purpose during the decision-making process. Furthermore, low-emission vehicles such as hybrid vehicles, plug-in hybrid vehicles, or zero-emission BEVs can reduce fuel usage even further. Selecting vehicles with a fuel consumption display and cruise control is also advisable, even though these technologies have become commonplace in recent years.

- Optimizing travel routes

Driving multiple short trips is a factor which can contribute to higher fuel usage since it may eliminate the opportunity for the engine to reach its optimal operating temperature. Fuel consumption is higher in colder engines when compared to those at their design temperature. Hence, it is advised to combine journeys to achieve multiple tasks in one trip as opposed to separate trips for each task. It is also desirable to map out an optimized route using online maps such as Google Maps or websites such as DriveBC which provide real-time information on traffic flows and road conditions. This will ensure areas with high volumes of traffic and other obstacles

such as construction and accidents will be avoided. Selecting a time of the day with reduced levels of traffic will also ensure reduced travel times and subsequent fuel consumption.

- Avoid idling

Idling the engine is a considerable factor behind the fuel wastage. In fact, a study on 60 Canadian fleets between 2005 and 2008 revealed that fleet vehicles were idling during 30-50% of their operational time [22]. Therefore, it is recommended to always turn the engine off when a stop is needed; however, this does not apply to stopping in traffic due to safety reasons. Various sources recommend multiple time limits as the maximum desirable time to leave the engine idling. For instance, the ECOWILL project recommends turning off the engine if a stop exceeding 20 seconds is required [8], [17], whereas the same time limit is stated in Natural Resources Canada (NRCan) as 60 seconds [18]. Different municipalities in Canada – including the City of Coquitlam – have already adapted bylaws making excessive idling of non-zero-emission vehicles illegal and subject to penalties. The Cities of Vancouver and Coquitlam do not permit idling exceeding 3 minutes [23], [24], whereas this can be as restrictive as one minute in some other municipalities [25]–[27], barring limited exceptions. Subsequently, it is also recommended to avoid starting the engine until the driver and all passengers are ready to drive, as well as to not idle for a long time after starting the engine to warm it up since engines tend to warm up faster when the vehicle is being driven.

- Proper vehicle maintenance

Keeping up with the vehicle maintenance according to the maintenance schedule provided by the manufacturer can improve longevity of the vehicle and its performance. In addition to the fuel-related benefits, proper maintenance will reduce the wear and tear of the vehicle and increase its lifespan as well.

- Alternative modes of transportation

Driving less is one of the most effective ways of reducing fuel consumption in the longer term. Encouraging walking, biking, or using public transit whenever reasonably possible will be immensely beneficial with respect to environmental and economic benefits of reduced vehicle usage. It is also desirable to establish carpooling or car-sharing systems within the organization to reduce the number of vehicles being driven.

The maximum fuel-saving prospects for each of the eco-driving techniques have been summarized in

Table 1. Increased anticipation, optimized route planning, and avoidance of speeding are the techniques with the highest prospective fuel savings.

Table 1 – Maximum fuel-savings attainable through various eco-driving techniques (based on ref. [11])

Eco-driving practice	Prospective maximum fuel savings
Increased anticipation of traffic	33%
Route optimization	30%
Adherence to speed limits	23%
Removal of unnecessary mass and energy loads	10%
Avoidance of unnecessary idling	4%
Maintenance of correct tire pressure	3%

3.1.3 Additional Eco-driving Techniques for Electric Vehicles

Even though BEVs have emerged as a promising alternative to GHG-intensive fossil fuel vehicles, the apprehension that the battery might get completely depleted before the completion of a trip – also referred to as range anxiety – is a noticeable concern among BEV drivers [28]. Reducing range anxiety among existing and prospective BEV users is essential for their widespread adoption and achieving climate targets. Hence, it is important to extract the maximum possible driving range out of a BEV to curb range anxiety and improve energy efficiency.

Many of the driving techniques described above – such as maintaining a steady speed, increased anticipation of traffic, avoiding hard accelerations, using air conditioning sparingly, and maintaining the correct tire pressure – are applicable for BEV range maximization as well. Additionally, there are some other range maximization practices specific to BEVs, which have been discussed below.

- Preconditioning the cabin

Preconditioning the cabin refers to getting the cabin temperature adjusted according to the users' desire, while the BEV is plugged into the charger, as opposed to during the trip. This can be more conveniently achieved using a smartphone app in the case of modern BEVs [29]. This will utilize grid electricity for initial cabin temperature control instead of battery power, maximizing the battery energy available for the trip.

- Using regenerative braking and one-pedal driving within city limits

Regenerative braking is an energy recovery technology which allows to capture and utilize part of the kinetic energy of the BEV during braking to charge the battery. Studies have demonstrated that regenerative braking can allow up to 25-40% of the braking energy to be recuperated [30]. Regenerative braking can be maximized through a driving mode unique to electric vehicles which is known as “one-pedal driving.” This mode allows the driver to control the speed of the vehicle through the level of pressure on the accelerator pedal, and it is even possible to bring a BEV to a complete stop by completely releasing the accelerator pedal [31]. Regular regenerative braking and one-pedal driving both are advantageous for increasing driving range via energy recovery as well as reduced wear on the brakes [32]. Therefore, it is advisable to use regenerative braking and one-pedal driving during city driving with considerable stop-and-go traffic to capture otherwise-wasted energy.

- Adhering to battery-friendly charging habits

Lithium-ion batteries are among the most common types of batteries used in BEVs and it is highly recommended to avoid charging lithium-ion batteries to 100% often and regularly maintain it in the range of 20-80%. This is because charging lithium-ion batteries exceeding 80% and discharging them deeply beyond 20% can place unnecessary strain on the electrodes [33]. Routinely maintaining the battery level in the 20-80% range will alleviate this strain, extending the lifespan of the batteries and reducing the need for expensive battery replacements. In modern BEVs and charging stations, this can be specified via a pre-charging setting where the charging will terminate once the level reaches 80% [33]. Nevertheless, practical situations such as planning for long journeys may result in occasionally unavoidable full charging. Therefore, users should ensure that the battery is not subjected to unusually high or low levels prolongedly. Furthermore, battery chargers can be divided into 3 categories – level 1, level 2, and level 3 – based on the charging speed. Level 3 direct current fast chargers are the most convenient in this regard due to their short charging times; however, extended use of level 3 chargers may compromise the battery lifespan due to the continued exposure to strenuous conditions. Therefore, it is also advised to use fast charging sparingly to reduce the stress on the battery and use Level 2 chargers which offer a balance between battery lifespan and convenience [34].

3.2 Case Studies on Municipality-based Eco-driving Initiatives

Several publicly available case studies related to eco-driving were gathered through a thorough online search, and they have been discussed in detail in this section.

3.2.1 The ECOWILL Project

The main goals of the European ECOWILL Project were to conduct short-duration training for already-licensed drivers and preparation of eco-driving lessons to be included in training for learner drivers. The short-term training provided through this project included one-on-one practical training sessions on fuel-efficient driving habits for light-duty vehicles and it was delivered through 12 'master trainers' and 700 driving instructors. Participants had to drive on a pre-determined route twice with fuel consumption measured: once with their typical driving habits and the next while receiving advice on eco-driving techniques with a particular focus on the first three golden rules described in section 3.1.1. Also, eco-driving concepts were promoted at automotive-related events and conferences. Additionally, an online 'Eco-Driver Assessment' was established for drivers to self-evaluate their individual driving style and habits. Out of the marketing messages used in this campaign, the economic benefits of enhanced fuel efficiencies were the most popular, followed by the safety-related advantages eco-driving, lower stress levels, and the promotion of eco-driving as a modern way of driving. Interestingly, the environmental benefits were not portrayed as the main marketing message and they were only included among the additional benefits.

The ECOWILL project yielded numerous positive results in terms of fuel cost savings and trainee experience. The reduction of fuel consumption during the one-on-one practical training was between 9-18% in the second driving stint in comparison with the first, with a weighted mean of 14%. A long-term fuel consumption reduction of 7.5% was expected at the end of the project, with the long-term retention of fuel-efficient driving techniques. The feedback received from drivers trained under this project were immensely positive; the percentages of drivers who felt the program was useful, who expected to be saving fuel in the future, and who would recommend the program to other drivers all exceeded 90%. In addition, it was learnt that eco-driving needs to be promoted among drivers on an ongoing basis rather than focusing on individual learning initiatives for results to be continuously achieved in the longer-term. Even though this project did not exclusively focus on city vehicle fleets, the actions undertaken during this project and the lessons learnt could be immensely valuable for planning and executing future eco-driving training

initiatives. All the above information regarding the ECOWILL project was obtained from the final project report [8].

3.2.2 Fleet Eco-driving Program Launched in New South Wales, Australia

A pilot eco-driving program was launched targeting fleet drivers across two city councils in the state of New South Wales, Australia: the Gosford City Council and the Wyong Shire Council. Each council fleet consisted of more than 330 light-duty vehicles. After a thorough review of previous Australian and global eco-driving programs and a pre-training survey to identify knowledge gaps and prospective barriers, several key messages were formulated as follows.

a) Safety, environmental, and economic benefits
b) Methods of improving driving habits
c) Impacts of speeding, unnecessary idling, and unnecessary mass and energy loads on fuel usage
d) Correct tire pressure
e) Optimizing fleet vehicle usage

Through the pre-training survey, the lack of financial motivation since eco-driving vehicles belonging to city fleets will not result in personal financial benefits for the drivers, and the fringe benefit tax mileage requirements were identified to be potential barriers to eco-driving. The information was disseminated primarily via internal newsletters, distribution of flyers during a mandatory safety session, directing trainees to existing online resources, biweekly emails, and visual signage such as computer screensavers, stickers, keyrings, and signs.

The success of the program was measured through a post-program survey as well as the fuel consumption data of the fleet vehicles. The qualitative post-program survey identified a marginal increase in the utilization of eco-driving habits; however, the changes in fuel usage were not solely attributable to the program outcomes due to the multitude of variables which may impact fuel consumption. Successful elements of this project include focusing on safety as a primary motivator to adopt eco-driving techniques, periodic email reminders, visual reminders such as keyrings, screensavers, and signs, as well as the role of pre- and post-program surveys in identifying the existing knowledge levels and potential barriers to eco-driving and recognizing changes in knowledge and behaviors. Contrastingly, focusing on the entire city fleet from the beginning was deemed unsuccessful due to the limited time frame of the project. Commencing eco-driving training programs with a small pilot group to encounter fewer barriers, delivering

personally relatable eco-driving messages, establishing a commitment to the program through a verbal or written pledge, using multiple methods to convey important information, and continuous evaluation and adjustments are among the major recommendations of this eco-driving program. Some of the visual reminders used in this project can be found in Appendix A. All the information related to this program was obtained from the online resource titled “Economic Driving Program ‘How to’ Manual: A guide for developing your own eco-driving program” [11].

3.2.3 Regional District of Central Kootenay Eco-driving Handbook

A joint venture known as the ‘Carbon Neutral Kootenays’ was launched in 2008 as a collaboration between three regional districts in British Columbia, Canada – Central Kootenay, East Kootenay, and Kootenay Boundary – and the Columbia Basin Trust to achieve the climate goals of the British Columbia Climate Action Charter [35]. One of the actions of this venture was to publish a handbook on reducing emissions from municipal vehicle fleets in October 2012. This handbook is mainly divided into two sections as described below: communication and action.

- Communication: Some of the potential communication strategies for information on eco-driving to be disseminated include pre-shift tailgate meetings, two-way communication methods, lunch-and-learn sessions, visual reminders such as signs and stickers, and internal newsletters and email updates to facilitate government-wide engagement.
- Action items: The main actions recommended by the Carbon Neutral Kootenays regarding sustainable driving in municipal fleets are as follows.
    - Fuel consumption tracking on a vehicle-by-vehicle basis
    - Identifying and minimizing idling using global positioning systems (GPS), electronic control modules, and other tracking measures. This also includes introducing anti-idling technologies such as block heaters/engine pre-heaters, auxiliary power units, and direct fired heaters.
    - Providing continuous training, motivation, and recognition for participants
    - Impacting driver behavior through practical examples such as cyclists riding naturally to preserve their energy; most eco-driving techniques such as coasting to decelerate, optimized route planning, and minimizing loads involve natural momentum and energy conservation.
    - Reviewing and ‘right-sizing’ the vehicle fleet
    - Establishing vehicle maintenance logs to include tire pressure checks, proper fluid levels, wheel alignments, and engine tune-ups

- Reviewing and optimizing travel to circumvent rush hour traffic and minimizing the number of trips while maximizing the useful loads per trip
- Identification and timely replacement of inefficient vehicles considering life cycle environmental impacts and costs
- Use of GPS or other vehicle monitoring mechanisms to track fuel usage, idling time, and travel distances
- Information sessions: Two workshops were conducted focusing on the economic and environmental benefits of eco-driving and developing a Fleet Management Action Plan. In addition, over 30 staff members were provided with in-vehicle eco-driving training.

This handbook recommends integrating sustainable driver training into the new member onboarding process and the broader fleet policy to maximize participation of members. The use of telematics to display real-time fuel efficiency in vehicles is also suggested to instigate behavioral changes. In addition, the handbook includes guidelines on preparing checklists for right-sizing vehicles and daily circle-checks as well, based on the work done by The Town of Oakville, Ontario, Canada. All the information above was obtained using its publicly available online version [36].

3.2.4 Effects of Eco-driver Training on the City of Calgary and Blue Mountain Ski Resort

Two similar pilot projects were carried out in the City of Calgary and the Blue Mountain Ski Resort, Ontario, Canada to determine the impacts of eco-driving training on driver. Both projects were executed in three phases: a pre-training data logging phase to identify prospective areas of improvement in driver behavior, the delivery of customized eco-driver training, and a post-training data logging phase to evaluate the effectiveness of training.

During the pre- and post-training data logging phases, the fleet vehicles were equipped with CarChip® in-vehicle monitoring technology to gather data on the number of trips, drive time, drive distance, average trip distance, average speed, average top speed, hard acceleration and deceleration counts, and idling time. Drivers were not notified of the types of data collected as a measure to limit the influence of these systems on driving habits. Considerable idling was identified among the studied City of Calgary vehicles due to vehicles being used as mobile offices; a reduction of 4-10% in the daily idling time was observed after the training. However, changes in acceleration and deceleration behavior were deemed statistically insignificant.

The results observed in the Blue Mountain Ski Resort fleet are considerably more prominent in comparison to those of the City of Calgary project. An 8% reduction in fuel costs was observed during the latter ski season, along with reductions of 14%, 55%, 44%, and 2% in average daily speed, the number of hard decelerations per 100 km, the number of hard accelerations per 100 km driven, and the daily idling time, respectively. However, the maximum potential benefits attainable from the training could have been diluted since only 60% of the staff members were able to receive the training; the other 40% represent seasonal staff members. This underscores the importance of disseminating the knowledge on eco-driving to as many staff members as possible to maximize prospective benefits. In this regard, separate trainings were conducted for the ski resort department managers with the aim of long-term retention and dissemination of the training for future ski seasons and seasonal staff members.

The results of both these projects demonstrate that positive changes in driver behavior can be instigated via eco-driver training, as well as the usage of vehicle monitoring technology or telematics systems to maximize benefits. All the information related to this project was obtained from the academic journals *Transportation Research Part D: Transport and Environment* [22] and *Journal of Sustainable Tourism* [37].

3.2.5 The Eco-driving Initiative of the Transport, Health, Environment Pan-European Program

The Transport, Health, Environment Pan-European Program (THEPEP) initiated an eco-driving program at the *klimaaktiv mobil* conference held in Vienna, Austria to promote eco-driving among its member nations. Under this initiative, pilot eco-driver training projects and workshops were carried out in the THEPEP member nations by Austrian master trainers, most noticeably in Kazakhstan and Russia.

- Almaty, Kazakhstan – A pilot eco-driving workshop was for commuter cars and buses. Seventeen driving instructors from driving schools and 13 public bus drivers from the city fleet took part in the program, and practical sessions demonstrated average fuel reductions of 6-22%.
- Kaliningrad, Russia – A pilot eco-driving workshop was conducted for bus drivers. Ten driving instructors from driving schools and two bus drivers from a local mini-bus fleet took part in the program.

The recognition of the benefits of specifically training for stopping and recommencing journeys from bus stops and the importance of real-time fuel consumption display and monitoring devices were the major learning outcomes of these workshops. All information on this initiative were obtained from the report titled “Guidelines for National Eco-driving Initiatives” [38].

3.3 Lessons Learnt and Recommendations

Through studying the above training initiatives and programs on eco-driving closely, a number of lessons can be drawn for future planning of eco-driving training initiatives for city-fleet drivers, as discussed in this section.

3.3.1 Essential Characteristics and Components of Eco-driver Training Programs

Figure 4 summarizes characteristics of successful eco-driver training initiatives, as defined in reports compiled by the International Council on Clean Transportation [15] and the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology [38]. Customization or contextualization of eco-driving programs based on factors such as the vehicle composition of the fleet, their intended purpose of use, typical road and weather conditions, and local regulations results in better conveyance of key messages. However, eco-driving across numerous vehicle types often consists of common techniques; therefore, brand-new programs do not always need to be developed. The content development should consider existing levels of knowledge of the audience, and the ideal finalized training content will consist of three main elements: fundamentals of fuel efficiency, driving techniques, and vehicle inspection and maintenance. Relatedly, the proper formulation of key messages to be delivered through the training program is another important aspect. Messages should be crafted based on the existing knowledge levels within the organization and their relevance to staff members [11]; yet, it is important to include all the safety-related, social, and environmental advantages of eco-driving in addition to economic benefits [38]. The delivery of eco-driving programs will also improve from the provision of flexible delivery methods due to potential scheduling conflicts. Some of the most common delivery methods include organized in-person sessions, in-vehicle practical training, online sessions and training materials, and driving simulators in some cases. In-person sessions and in-vehicle practical training offer the advantages of being highly effective due to improved interactions with trainers, at the expense of needing to scheduling complexities. Comparatively, online sessions facilitate flexibility and the ability to revisit training materials.

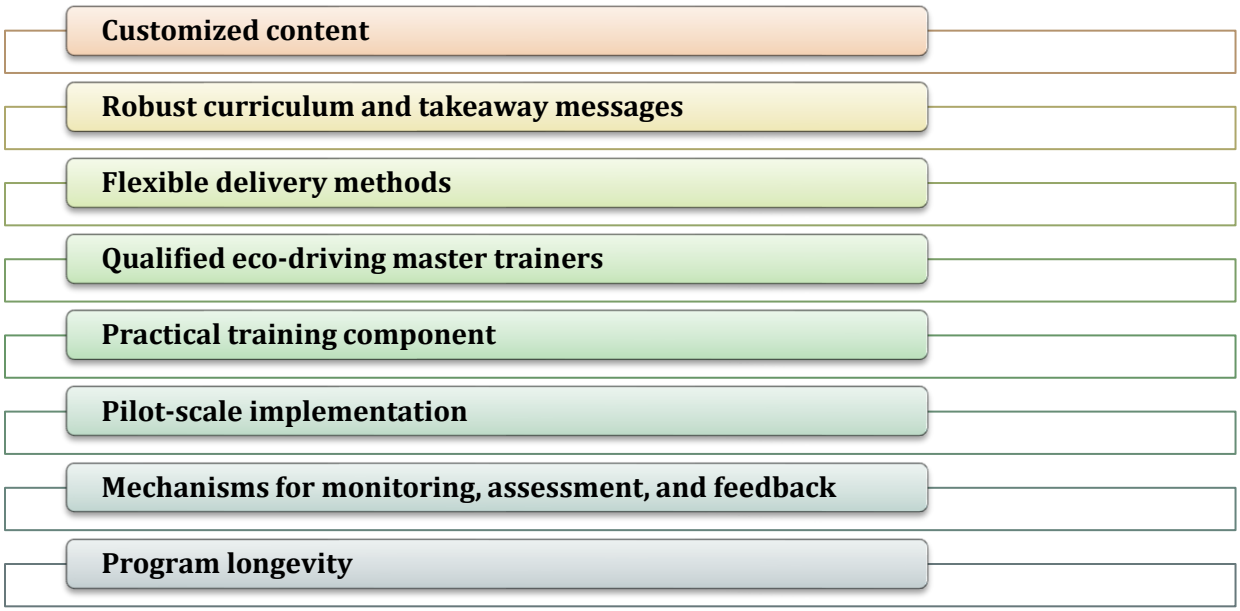

Figure 4 – Essential characteristics of a successful eco-driver training program

The role of instructors is a vital element for the long-term success of eco-driver training. In this regard, the establishment of 'master trainers' has been an effective strategy adapted in the European ECOWILL project [8], which can be deployed in other organizations as well. They should be provided with initial training and then used to facilitate the dissemination of knowledge within organizations via in-person or online modes, answering questions brought forward by trainees as well. The ability to understand the interests of trainees and the ability to effectively convince participants of the benefits of eco-driving are some of the essential qualities of an effective trainer. Master trainers can also be used to assist the facilitation of practical driver-training sessions as well. The Austrian guidelines state that a practical training component is essential to fully materialize the prospective benefits of eco-driving in the long term, as opposed to simply attempting to adhere to eco-driving techniques on their own [38]. Practical training will ensure the observation of the actual driving habits of participants including long-engrained fuel-inefficient practices, and the provision of personalized advice to overcome such practices. A common way of integrating practical training is to have trainees drive twice along a pre-determined route with medium traffic: once before the theoretical training and once after. In this approach, the actual driving style of participants should be observed during the first session. Next, theoretical knowledge of eco-driving should be provided, and those practices will be put into practice during the second session with the guidance of the trainer. It will also be beneficial to compare fuel consumption data of the two sessions to observe the effects of eco-driving practices firsthand.

Commencing the program for a smaller-scale pilot group as opposed to engaging the entire organization from the start is another recommended approach of initiating eco-driving programs. This will provide opportunities to test out the training approaches for their effectiveness and refine the delivery as needed when compared to larger-scale implementation which can be resource intensive. The project carried out in the Gosford City Council and Wyong Shire Council encountered difficulties in managing the implementation of the program across the entire fleets of both councils during the allotted timeframe [11]. The number of barriers encountered at once is likely to be reduced during small-scale commencement as well. In addition, mechanisms for evaluating the effectiveness of the training, providing feedback to trainees, and monitoring the progress on an ongoing basis should be established. The effectiveness can be assessed and continuously monitored using fleet fuel consumption data, or other key performance indicators (KPI) such as idling time and number of hard accelerations and braking. Mechanisms of communicating the performance to staff members and providing suggestions for further improvement should also be determined. Moreover, eco-driver training programs should be successful in the long term for the realization of maximum benefits; hence, training should be planned considering longevity. Periodic refresher training is an effective method of reinforcing the key takeaways and ensuring the longevity of benefits as opposed to one-time training. Methods such as periodic gentle reminder emails and newsletters and signage such as screensavers, stickers, and keyrings are also proven methods of reinforcement [11].

An example of a methodical planning framework for eco-driver training program delivery has been presented in Figure 5. This framework is largely based on the project carried out in the Gosford City Council and the Wyong Shire Council [11], and has been extensively discussed in section 3.2.2. The approach followed in the mentioned project can be modified to include the designation of master trainers and facilitating the delivery of training through them, as well as an acknowledgement of participation in the training in the form of a certificate, as suggested in other project reports [8], [15], [38].

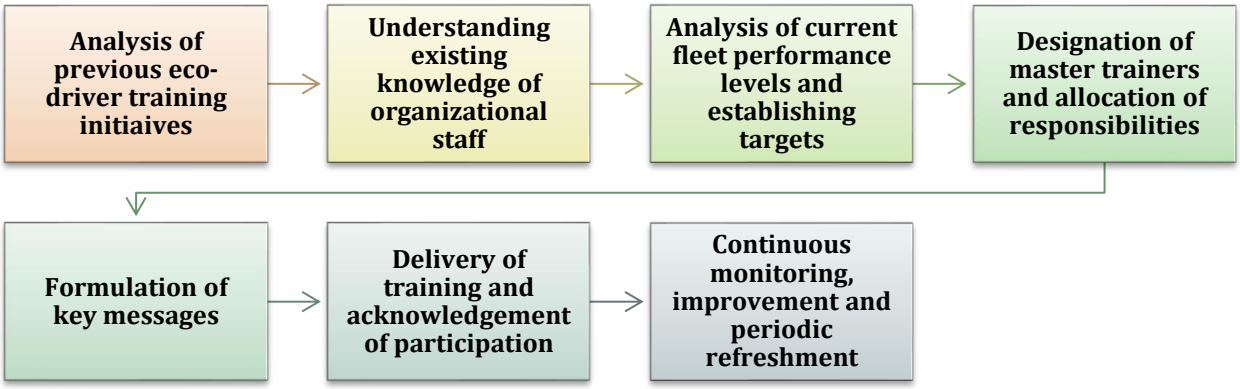

Figure 5 – A potential framework for an eco-driver training program

3.3.2 Advantages of Telematics Systems

Telematics systems are increasingly used among municipal fleets and eco-driver training initiatives due to their numerous advantages: the capability of providing real-time or non-real-time information on driver performance, the wide range of information which can be captured such as hard braking and accelerating and idling time, route optimization potential, and data-driven driver improvement potential. Some of the examples for projects which have used telematics systems are listed below.

- The City of Calgary eco-driving project and the Blue Mountain Ski Resport eco-driving project [22], [37]: These two projects utilized CarChip® data-loggers [39] to obtain non-real-time data on the daily average times and distances driven, number of hard accelerations and decelerations per 100 km driven, idling times, and average and maximum speeds.
- The implementation of telematics in Utah, United States: In 2017, the State of Utah Division of Fleet Operations employed telematics in their vehicle fleet to achieve cost reduction, increased fleet utilization and productivity [40]. The resultant annual fuel cost savings and first-party collision cost reduction were 8% and 21%, respectively. However, these savings combined with the maintenance savings produced net savings of only $25 per vehicle per year, when offset against the cost of the telematics system.
- Telematics used by the New York City: An executive order has been signed in 2019 by the New York City Mayor mandating the use of telematics in all fleet agencies of the City [7]. An initiative to reduce the vehicle fleet by a minimum of 855 vehicles was announced in April 2022, which was implemented after analysis of telematics data [41]. Moreover, telematics data has also revealed better-than-anticipated performance of hybrid fleet vehicles of the City when compared to internal combustion engine vehicles [42].

- The use of telematics during Argentinian truck eco-driving training: The Federación de Entidades Empresarias del Autotransporte de Cargas (FADEEAC) of Argentina has implemented telematics to evaluate freight truck driver performance and provide training as needed to improve fuel-efficient driving habits [15].

3.3.3 Overcoming Potential Obstacles and Long-term Sustenance of Eco-driving Habits

In connection with deployment of eco-driver training programs within organizations, numerous potential barriers which may hinder the fruition of environmental and economic benefits have been identified through numerous pilot projects, as illustrated in Figure 6. The Austrian guidelines for eco-driver training states that the inadequate knowledge and numerous mistaken beliefs on eco-driving are among the most potent barriers to eco-driver training ventures [38]. A common misconception on eco-driving is that it refers to a less appealing driving style with reduced speeds which may misalign with long-engrained driving habits of many drivers, especially those who underwent their initial driver training and licensing process in the distant past. This can be particularly visible among truck and bus drivers who may be skeptical of eco-driving trainers and educators since they may naturally hold themselves in high regard due to being drivers by profession. A certain resistance to change has been observed among this group of drivers. To overcome this barrier, eco-driving coaches need to grasp the interests and goals of the trainees and tailor the delivery of the eco-driving message to address them. For instance, prospective economic benefits may be the most appealing factor for drivers of private vehicles who are not reimbursed their fuel costs, whereas safety may be the most attractive factor for fleet drivers since fuel costs are not borne by them [11], [38]. Appropriate tailoring of the training delivery will be an effective way of promoting eco-driving among both these groups.

In addition, another common mistake is the notion that eco-driving can be easily adopted without adequate practical training. Simply reading through guidelines posted on a webpage or internal web portal and attempting them on one's own may be inadequate to fully materialize prospective fuel savings in the long term. Thus, the importance of practical sessions in eco-driving training – both in-vehicle and classroom-style – should also be emphasized.

Moreover, it has been discovered in many of the pilot training projects conducted that the long-term average reduction in fuel consumption is much lower than that in the immediate aftermath of the training. The ECOWILL project reports an expected 7.5% long-term fuel consumption reduction versus a 9-18% immediate reduction [8], whereas other studies have demonstrated long-term fuel usage reductions of 2-5% compared to immediate reductions of up to 25% [43].

Long-term sustainability of these eco-driving practices among fleet drivers is vital to organizations not only in the sense of lowered fuel expenses, but in terms of reduced maintenance costs as well. Three strategies to improve the long-term sustenance of eco-driving habits have been discussed below [43].

- Periodic refresher training – To continuously motivate and encourage drivers to practice fuel-efficient driving techniques, refresher training is recommended. These can be conducted either as dedicated sessions such as lunch-&-learn sessions as recommended by the Carbon Neutral Kootenays handbook [36], or being part of other sessions such as safety workshops or other transport-related events [8], [11]. In addition to organized refresher training sessions, the strategies followed by the Gosford City Council and Wyong Shire Councils such as periodic gentle email reminders, computer screensavers, stickers, signs, and keyrings may also be useful in keeping staff members motivated and up-to-date [11].
- On-board real-time monitoring and feedback technologies – As previously discussed, telematics systems provide real-time information directly to the driver, assisting them to improve their eco-driving instantaneously.
- Driver incentive programs – KPIs related to eco-driving such as idling time, number of hard braking and hard accelerations, and monthly fuel consumption targets could be established and monitored, and this data can be used to identify and reward drivers who demonstrate commendable eco-driving behaviors. Internal competitions conducted using eco-driving KPIs can also be a method of enhancing driver performance. Results of these incentive schemes and competitions can also be used to identify further performance improvement measures such as additional training. These activities should be executed in a manner fostering a positive work environment for staff members, motivating them to consciously adapt eco-driving techniques.

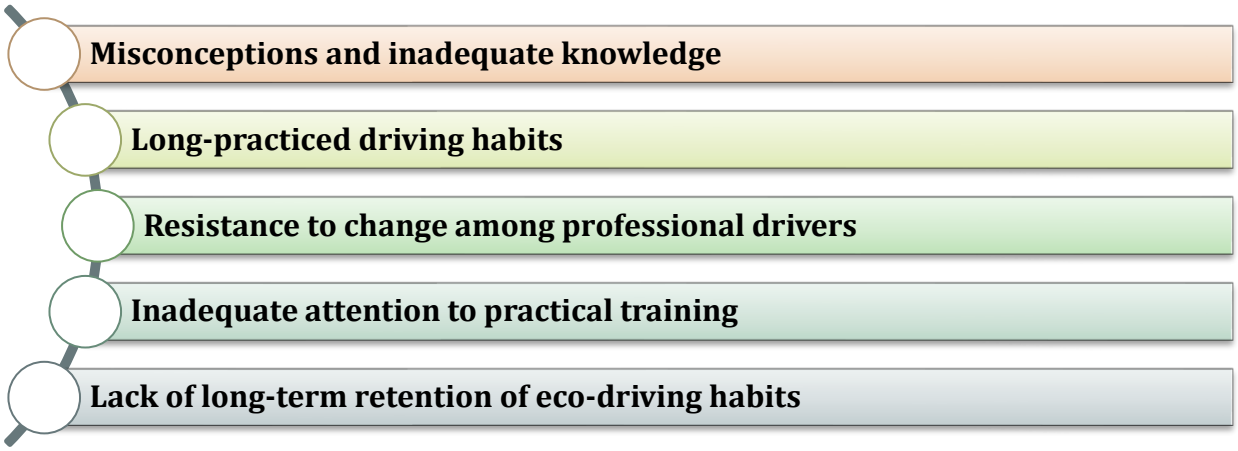

Figure 6 – Potential obstacles to successful eco-driver training programs

3.4 Summary

Eco-driving is an effective way of reducing emissions and fuel costs of individual vehicles as well as vehicle fleets. However, proper education and training of drivers is essential for achieving maximum potential reductions in both these factors. This literature review explored several global municipal fleet-based and other eco-driver training projects with a particular focus on the methodology of execution. From this analysis, several key attributes of successful eco-driver training programs such as flexible delivery methods, periodic reinforcement, and the vitality of practical training were identified, along with some potential barriers for success such as misconceptions on eco-driving and resistance to change. A prospective methodical framework for the implementation of an eco-driver training program within an organization was also proposed. The proposed framework of implementation commences from the analysis of prior training programs and the current level of knowledge on eco-driving within the staff members and provides training in an ongoing basis while continuing to monitor progress. The findings of this literature review will be beneficial for organizations in implementing their own eco-driver training initiatives.

4 Key Findings of the Focus Groups and Interviews

The second sub-objective of the project was to engage with staff members of the City of Coquitlam who routinely operate or oversee fleet vehicles, with the purpose of collecting information on current driving behaviors and identifying potential areas for improvement. A focus group, an interview, and two additional information gathering sessions were held with different personnel of The City. All participants occupied managerial roles within The City, supervising teams of varying sizes. The discussion focused on different types of vehicles belonging to The City, existing arrangements of using them and tracking their usage, different trainings provided to employees and their delivery methods, and prospective barriers for the successful delivery of eco-driver training. The complete questionnaires have been given in the Appendices B and C, and the key findings gathered from these interviews have been summarized below.

- The vehicle fleet of the City of Coquitlam currently consists of approximately 400-500 light-duty vehicles, 50 medium-duty vehicles, and 50 heavy-duty vehicles. Each department has different fleet vehicles assigned to them based on their needs. The number of low- or zero-emission vehicles in the fleet is expanding rapidly, aligning with the Green Fleet Strategic Plan; the number of BEVs in the vehicle fleet currently stands at 50 with 25 being acquired in 2025 alone.
- The City currently has an internal shared BEV program through which staff members can reserve and use a BEV for their work-related driving needs. However, the majority of participants in the focus groups were not familiar with this shared BEV program. Furthermore, the feedback from staff members who have used this program reveals BEV range anxiety; this stems from inadequate charging stations and lack of methods to locate available charging stations. Additionally, several participants were not up to date on the current locations of available BEV chargers. Nevertheless, The City is currently working on rapidly expanding their charging facilities for BEVs.
- The City currently tracks its fuel consumption of fleet vehicles and their distance driven separately. Therefore, specific information related to the fuel efficiency of a specific driver such as the number of instances of rapid acceleration and hard braking or minutes spent idling is currently unavailable, apart from any in-built tracking systems. Real-time telematics systems can be up to 5 times more expensive than the current systems used for fuel consumption and distance tracking.

- The organizational SharePoint platform known as the “CorQBoard” facilitates information sharing, vehicle reservations, and hosts numerous training materials for employees. Among the training materials, there is an existing training module on eco-driving which directs users to a free-of-charge online training module provided by NRCan. However, the participants of the focus groups admitted that they have not gone through this training themselves or have not directed any other staff members under their supervision to this training module since it has not been a mandatory training module.
- The focus group and interview participants possessed mixed levels of knowledge on eco-driving; some participants demonstrated extensive knowledge on eco-driving techniques, while some participants admitted to being not familiar with any sustainable driving habits.
- Several departments within The City already follow measures to convey knowledge on eco-driving to their staff members. Some departments hold monthly ‘crew-talk’ sessions and sustainable driving techniques have been discussed during these sessions. Also, some departments actively monitor their staff members’ driving behavior and follow up where unnecessarily excessive idling is identified, while this is yet to be implemented in other departments. Nevertheless, there are several cases where excessive idling is unavoidable. For instance, when conducting pre-trip inspections on vehicles with airbrakes, a certain period of idling is necessary to build up air pressure. Also, several inefficient driving patterns such as taking an excessive but avoidable number of trips have been identified. One such example is a team not having a green waste collection bin significant to their needs, leading to an increased number of lengthy waste disposal trips.
- As previously mentioned, some departments conduct monthly crew-talk sessions, and some other departments hold monthly safety-related meetings for all their members. These sessions provide an ideal opportunity to educate staff on sustainable driving techniques as they bring all members together despite their busy work schedules. These in-person training sessions are more ideal than self-paced online modules for most departments as the latter require employees to take time away from their predominantly outdoor work schedules.
- The onboarding process is a potential opportunity to direct newly hired employees toward the existing eco-driver training resources available on the CorQBoard platform. Furthermore, some departments hire batches of seasonal staff members during fixed periods annually; these hiring periods are an ideal opportunity to gather these newly hired staff members and educate them on sustainable driving techniques.

- Departmental Asset Managers and Foremen can be tasked with the responsibility of ensuring that all members under their supervision have taken part in the eco-driver training. In this regard, all participants agreed that providing periodic refresher training is an effective approach to ensure comprehensive delivery – including new hires – as opposed to a one-time training session.
- Younger staff members in The City are environmentally conscious and eager to learn how they can contribute to The City's climate change mitigation efforts; thus, they are more likely to embrace the training positively and adapt sustainable driving behaviors. However, experienced staff and employees in departments with low turnover may perceive that they have already completed all relevant training, which may reduce receptiveness to new initiatives and make positive changes more difficult to achieve. Therefore, the purpose of the training needs to be explained very clearly to all employees while broadening their awareness about the climate action items in the ESP, emission goals of The City, and how they can contribute towards these goals in an individual capacity.
- The training needs to be engaging and innovative for enhanced information retention and sustenance of audience attention and engagement.
- Inviting a guest speaker was recognized as an effective way of conveying the message since this would provide employees with a fresher perspective.

5 Proposed New Chapter for the Driver's Manual

Updating the current driver's manual of The City to include sustainable driving techniques and habits is one of the two main deliverables of this project. This is advantageous in terms of creating consistent standards and encouraging positive behavioral changes. The current driver's manual provides guidelines for driving in adverse weather conditions and defensive driving as chapters 'H' and 'I,' respectively. A new chapter 'J,' titled 'driving sustainably,' is proposed under this project to be included in the driver's manual. This new chapter will describe sustainable driving techniques and habits discussed in section 3.1 in a precise manner and as actionable instructions for readers. The information will be presented in two parts: 'before you drive' and 'while driving.' A draft version of the section has been presented below.

J. **DRIVING SUSTAINABLY**

Sustainable driving is essential for reducing fuel consumption as well as minimizing the wear and tear on vehicles. It is more than a cost-saving measure – it is also a commitment to reducing environmental impacts and enhancing safe operations. The following guidelines will assist you to improve efficiency, reduce fuel usage, and contribute to environmental stewardship.

J.1 Before you drive

1. Plan your route well in advance. Check real-time traffic conditions on online maps such as Google Maps or Apple Maps and choose the route with the least traffic congestion.
2. If there are multiple tasks to be completed, try to get as many as possible completed in one trip instead of multiple shorter trips. Ask your supervisor and colleagues about the possibility of carpooling.
3. Before getting in the vehicle, perform a visual check on the tires to ensure there are no underinflated tires.
4. Check inside the vehicle (including the trunk) to ensure there are no unnecessary items. Travelling with lower weights will improve the fuel economy.
5. Start the engine only when all passengers and equipment are in the vehicle. Avoid idling the vehicle for more than one minute to warm up the cabin or engine. Under the City of Coquitlam anti-idling bylaw, it is prohibited to idle vehicles for more than three minutes.

J.2 While driving

1. Take 5 seconds to accelerate to 20 km/h when starting to move from rest. This will reduce fuel consumption and minimize wear on the engine and transmission.
2. Maintain a constant speed while always adhering to posted speed limits. This will also reduce fuel consumption and minimize engine wear.
3. Look ahead 12-15 seconds ahead of you (about 2-3 city blocks) for signs to slow down such as traffic lights, brake or signal lights of other vehicles, crosswalks, and merging lanes. This will prepare you early to stop if needed, avoiding the need to brake hard.
4. When braking needs are anticipated well in advance, release the accelerator early to coast and reduce speed before gently applying the brakes to come to a complete stop. This will conserve fuel, improve ride comfort, and reduce wear and tear on brakes.
5. If driving an electric vehicle, ensure the regenerative braking mode is functioning. This will improve the available driving range. If you are comfortable, use one-pedal driving as this will maximize range. This is a mode which allows you to control the speed through the level of pressure on the accelerator pedal, and it is even possible to bring an electric vehicle to a complete stop without using the brake pedal while in this mode.
6. Keep the auto start-stop mode enabled if the vehicle is equipped with this technology. It is a measure of saving fuel, and modern engines are designed to withstand the impact of increased start-stop cycles.
7. Use air conditioning sparingly. Try to roll down the windows while driving within city limits whenever possible. If you do use air conditioning, ensure the recirculation mode is activated to reduce the strain on the air conditioning system.

6 Recommendations for Developing a Civic Driver Training Program

This section discusses several approaches for knowledge dissemination on sustainable driving among staff members. These strategies have been formulated specifically to The City, following the insights gathered during the focus groups, interviews, and the literature review.

6.1 Conduct a Series of Crew-talks

Based on the inputs of focus group participants, it was identified that the optimal method of delivering knowledge would be a 15-minute crew-talk session since a crew talk would be easiest to integrate into busy work schedules and the crew-talk format is already used by many City departments. This format is also advantageous in terms of better information retention as opposed to one longer session. However, it is not practical to discuss all eco-driving techniques in one session due to the extensive content. Therefore, it would be useful to arrange a series of crew-talk sessions for eco-driver training with one session focusing on a limited number of sustainable driving elements. An example for the proposed crew-talk series has been outlined in Table 3 (Appendix D), consisting of four separate sessions. Some of the major talking points for each session as well as potential questions for interacting with the audience have been included. Furthermore, an introductory crew-talk session has been outlined in Figure 7, which will provide staff members with the relevant background information and an overview on how they can contribute to attaining the emission goals of The City.

Background:

- In 2022, the City of Coquitlam approved its first ever Environmental Sustainability Plan. This consists of 135 action items in total under 5 major themes, with each theme consisting of different goals to support long-term environmental resilience and sustainability.
- The climate action theme focuses on reducing greenhouse gas (GHG) emissions and increasing the resilience of Coquitlam to withstand current and future climates. Under this theme, The City aims to reduce its GHG emissions by 45% by 2030 when compared to 2007 levels and attain GHG emissions neutrality by 2050.
- The vehicle fleet accounts for nearly half of the GHG emissions of City operations. The City should demonstrate leadership in lowering its environmental footprint, and reducing fleet emissions aligns with this need.
- There are two major ways to reduce fleet emissions: Embracing alternative technologies such as battery-electric and hybrid vehicles and adapting fuel-efficient driving techniques.
- The City is rapidly decarbonizing its fleet through the 'Green Fleet Strategic Plan,' but adapting fuel-efficient driving techniques is where YOU can contribute to reducing fossil fuel usage and associated transport-related GHG emissions.

How YOU can contribute to reducing fuel usage while driving:

- Increase your anticipation of traffic to avoid having to brake abruptly
- Gently accelerate and coast to decelerate in order to conserve fuel
- Maintain a steady speed at low engine RPMs
- Adhere to posted speed limits to avoid having to brake harder than necessary
- When warming up, cooling off, or working from the vehicle, avoid excessive idling to save fuel and comply with The City's anti-idling bylaw
- Remove unnecessary weights from the vehicle and maintain proper tire pressure
- Use air conditioning sparingly and ensure the recirculation mode is turned on
- Plan trips to avoid rush hour traffic and congested routes
- Combine and organize trips to maximize efficiency and reduce trip frequency

How can YOU make a difference? Ask yourself:

- What fuel-efficient driving techniques do you already practice?
- What would motivate you to adopt fuel-efficient driving techniques: environmental benefits, reduced fuel costs, improved safety and ride comfort, or all the above?
- Have you ever identified an instance of fleet vehicles being used inefficiently, such as making poorly planned and avoidable trips, having to backtrack, or using more vehicles than necessary due to poor coordination?
- Are there any routine tasks you perform which could be done with fewer or shorter trips?

Figure 7 – Introductory crew-talk session outline

6.1.1 Strategic Recommendations on Delivering the Crew-talk Sessions

During the focus groups and interviews, it was identified that some departments hire large batches of seasonal staff during specific months. Hence, it is possible to condense the series into one longer session to be delivered during the onboarding of those new hires. Additionally, previously conducted eco-driver training initiatives have highly recommended periodic refresher training as opposed to one-time sessions. This strategy is recommended for The City to ensure newly hired staff members also take part in the training, improved reinforcement of knowledge, and long-term adoption of sustainable driving habits. Moreover, identifying experienced drivers within departments and engaging them in the delivery of the sessions is another effective strategy. This can be achieved by involving them as presenters or co-presenters or directing them to reinforce key messages and share practical tips during regular vehicular operations. This will improve active participation in the program and adoption of sustainable driving techniques through peer learning.

6.2 Develop Visual Signage and Internal Digital Communications

As previously demonstrated in the eco-driver training project carried out in New South Wales, Australia [11], the development of visual signage and internal digital communications can be an effective strategy of conveying sustainable driving-related messages to staff members (refer section 3.2.2). These can serve as a reminder of the sustainability goals of The City and how employees can contribute to achieving these targets in their individual capacities. In the previous project, the signage was developed in the form of computer screensavers, stickers, and keyrings, and the internal digital communications were carried out in the form of a biweekly email newsletter. The visual reminders need to be aesthetically attractive with clear and concise benefit-oriented messages to motivate positive actions by fleet users. These can be displayed in strategic locations across The City's premises; examples include common areas such as lunchrooms and break rooms, inside elevators, vehicle keyrings, lobby TV monitors, and car parks including BEV charging points. However, periodically rotating the signs may be needed due to the possibility of stationary signs losing their effectiveness from employees becoming accustomed to them and causing them to blend into the background. Several prospective brief eco-driving messages have been crafted and shown in Appendix A of this report (Table 2), along with some of the visual signage including computer screensavers, flyers, and online information sheets used in the training program in New South Wales, Australia.

In addition to the usage of signage, internal digital communications are another effective strategy which can be used to convey reminders on eco-driving. In the context of The City, this can be carried out in the format of social media posts on the CorQBoard platform. Posting short tips, infographics, and success stories based on monthly or annual fuel consumption data on the CorQBoard can maintain the visibility of the subject without feeling like formal training. The posts can be designed similarly to the global messages and online information sheets developed during the project in New South Wales, Australia, which have been presented in Appendix A. These should be visually appealing and action-oriented, with the content and messages being similar to the messages for visual signage (Appendix A – Table 2). Additionally, posts should be reflective of the season and related driving challenges. For instance, the importance of limiting idling for warm-up purposes could be highlighted during the winter, whereas the advantages of using air conditioning sparingly could be conveyed during the summer.

6.3 Utilize Existing Online Resources

The following list of existing online resources can be used for eco-driver training. It is recommended to direct staff members towards these resources during the training sessions.

1. NRCan offers a ‘SmartDriver’ training series on reducing fuel consumption and GHG emissions in light-, medium- and heavy-duty vehicle fleets. This series focuses on eco-driving techniques previously discussed in section 3.1 through online, in-person, and in-vehicle sessions. This training is available for five different types of commercial fleets: long-haul trucks, work trucks, forestry trucks, school buses, and city fleets. Further information on the SmartDriver training series is available through the SmartDriver training series webpage [44]. The city fleet SmartDriver program is delivered via in-person sessions labeled as ‘tailgate talks’ of which the duration is approximately 10-20 minutes per session. However, this program is currently being revamped as an online training, as identified via email communication with NRCan. Further information on the SmartDriver Training for city fleets is available in the SmartDriver Training: City webpage [45].
2. NRCan has a webpage titled ‘Fuel-efficient driving techniques’ which consists of a comprehensive list of sustainable driving techniques and habits [18]. This webpage provides detailed insights into the previously discussed sustainable driving techniques.
3. Stantec Consulting Limited has developed a free video series titled ‘eco-driving online’ with the assistance of NRCan. This 35-minute video series aims to educate viewers on methods to consume less fuel and reduce GHG emissions and fuel costs. Furthermore,

this series provides a basic understanding of low- and zero-emission vehicle technologies such as hybrid vehicles, plug-in hybrid vehicles, and BEVs. This series consists of short online quizzes as well. This resource has already been posted to the CorQBoard platform of The City, and it is highly recommended for managers and supervisors to direct their team members to this resource.

4. Similar to NRCan, the Canadian Automobile Association (CAA) also maintains a webpage titled 'Fuel-Efficient Driving Tips' which consists of insights and short videos on numerous eco-driving techniques.

These online resources should be employed strategically to ensure the maximum audience engagement. One possible strategy is to integrate the video clips prepared by Stantec and the CAA into the crew-talk sessions. The use of short video clips during crew-talk sessions would assist in increasing knowledge retention. However, this will depend on the context of the crew-talk sessions conducted in different departments, and the requirement for multimedia to display video clips may be challenging for some departments. Another potential strategy would be to assign watching relevant video clips after the crew-talk sessions as a post-learning activity. This would be especially useful for sessions with time restrictions and limited multimedia facilities. An alternative approach would be to encourage staff members to view the relevant video clips prior to the in-person crew-talk sessions as a preparatory activity. Moreover, the links to video clips and webpages published by NRCan and the CAA can be shared with staff members as CorQBoard posts, as discussed in section 6.2.

7 Overarching Recommendations and Conclusions

Beyond recommendations specific for the driver training program, overarching recommendations for The City focusing on overall sustainable driving have been outlined in Figure 8 and further delineated below.

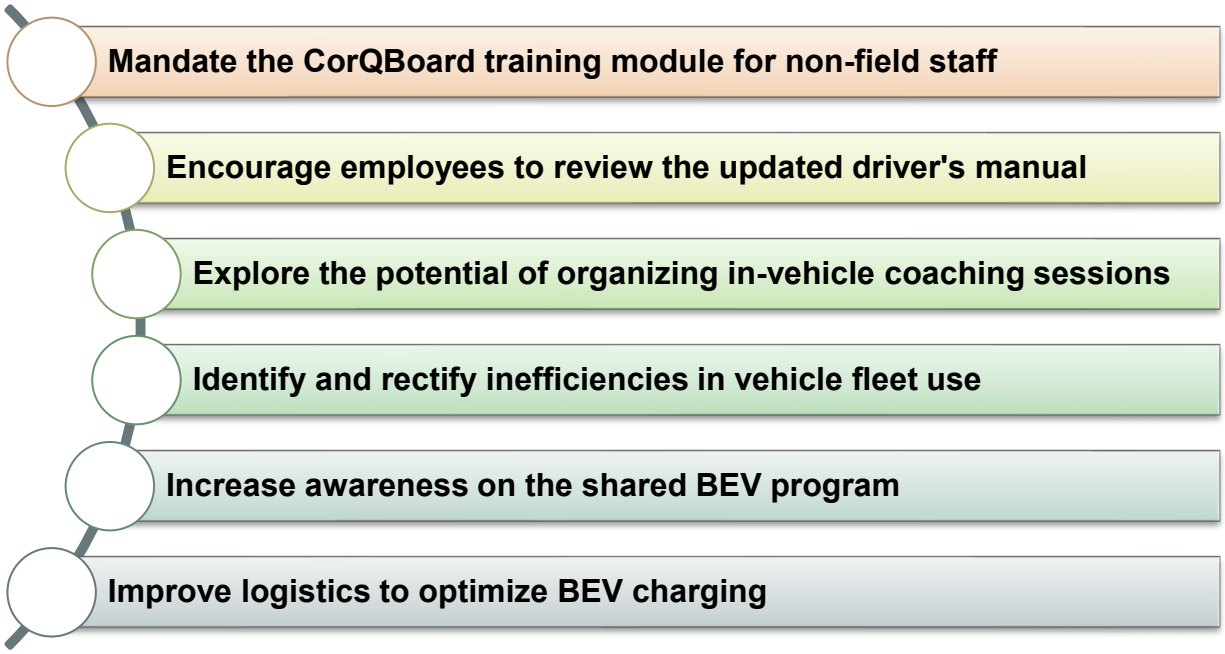

Figure 8 – Recommendations on overall sustainable driving

The focus groups and interviews revealed that the current level of engagement with the existing sustainable driver training resources is inadequate. Therefore, making the existing resources mandatory for staff members may serve as a fundamental first step in establishing sustainable driving habits within the vehicle fleet users. However, this may be problematic in the case of members working in outdoor roles or not having frequent access to a computer. Therefore, in-person training sessions will be ideal for those staff members. It is also important to make the employees aware of the updates made in the Driver's Manual to include sustainable driving habits and encourage them to review these updates to broaden their understanding of this topic. It is also worth exploring the prospects of organizing a few in-vehicle coaching sessions to maximize the benefits of eco-driver training, as identified through the literature review. This might be challenging to arrange given the varying availabilities and the vast natures of work undertaken by different employees and departments, but past projects have demonstrated increased benefits attained through in-vehicle coaching [8], [14], [36].

In addition to the direct driver training provided, other sustainable driving measures such as eliminating inefficiencies among fleet vehicles should also be actively pursued. In this case, managers, supervisors, and foremen should be encouraged to closely monitor the usage of fleet vehicles within their team and identify inefficiencies such as instances of unnecessarily excessive idling, poor route planning, and underutilized or oversized vehicles. Some inefficiencies within different departments were discussed during the focus groups and interviews. Gathering feedback from frontline employees in this regard is an effective method of engaging them in achieving the sustainability goals of The City.

Enhancing sustainability awareness across all levels of staff is crucial to fostering a sense of ownership, effectively communicating the sustainability goals and GHG emission reduction targets of The City, and encouraging active contribution. Moreover, following up with drivers when unnecessarily excessive idling is identified is another means of improving energy efficiency. While some departments have already implemented such follow-ups, others do not take action despite identifying unnecessary idling.

The City is focused on rapidly electrifying its light-duty vehicle fleet as part of the Green Fleet Strategic Plan. To supplement this transition, The City is expanding the BEV charging network for its fleet vehicles. However, a certain lack of coordination and awareness on logistics related to charging was displayed among the focus group attendees. In fact, it was revealed that some employees were returning to City Hall and spending considerable time there to charge their BEVs. Therefore, the staff need to be updated about the recent and ongoing expansions to the BEV charging network, and BEV charging logistics should be improved to optimize the utilization of the network.

In addition, the shared BEV program is a timely initiative which would assist in the transportation-related emission reduction and fleet electrification goals. However, the focus groups revealed that a considerable fraction of employees are not familiar with the program. Therefore, awareness about this program needs to be increased within all departments of The City. Moreover, as the program becomes more popular and the demand for shared BEVs rises, further advancements such as assigning the responsibility of overseeing battery levels and charging to a designated person may be required.

In conclusion, the development and implementation of a sustainable driver training initiative is a pivotal step in enhancing the environmental sustainability of the day-to-day transportation-related operations of The City. This initiative aligns with the broader sustainability goals of The City as

outlined in the ESP and will provide additional benefits for road users such as reducing wear and tear on vehicles and improving safety and ride comfort. Moreover, this program can serve as a foundation for further sustainability initiatives involving ongoing staff education.

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Appendices

Appendix A – Sample and Past Visual Reminders

Table 2 – Sample eco-driving messages for visual reminders

Eco-driving element	Sample concise messages for visual reminders
Gentle acceleration	• Accelerate smoothly, save up to 15% of gas: take 5 seconds to accelerate from 0 to 20 km/h. • Go easy on the pedal: accelerating gently reduces fuel costs and engine wear. • Smooth is safer: gradual acceleration reduces emission and accident risk.
Maintain a steady speed	• Keep it steady: frequent speed changes can burn up to 50% more fuel. • Consistency is key: frequent acceleration and braking uses more fuel. • Drive smooth, drive smart: a steady speed means lower fuel usage and engine wear.
Anticipate traffic	• Read the road ahead: expect slowdowns and avoid sudden stops. • Plan before you brake: look ahead to minimize energy wastage and brake wear and tear. • Drive smart, not hard: anticipate stops to avoid hard braking.
Adhering to speed limits	• Stay within speed limits: high speeds waste fuel and increase crash risk. • Speeding costs more than tickets: follow posted speed limits for reduced fuel costs and brake wear and tear. • Find the sweet spot: most vehicles get their best fuel economy between 50-80 km/h.
Coast to decelerate	• Lift off early: coasting saves energy and improves safety. • Coast into savings: smooth deceleration saves fuel and brake wear and tear.

	• Predict, then coast: smoother stops mean improved safety and ride comfort.
Avoid idling	• Idling gets you nowhere: turn off the engine when parked. • Don't burn while you wait: idling wastes fuel and creates unnecessary emissions. • Excessive idling is prohibited: turn off the engine if stopping for more than one minute.
Correct tire pressure	• Check tires monthly: proper pressure saves fuel and extends tire life. • Pump up tires for efficiency: underinflated tires can reduce gas mileage by up to 10%. • Gauge before you go: monthly checks keep tires in perfect shape.
Reduce unneeded loads	• Less weight, more efficiency: remove tools or equipment not needed for today. • Lighten your load: extra weight needs extra fuel.
Use air conditioning sparingly	• Be cool, park in the shade: excessive use of air conditioning can increase fuel usage by as much as 20%. • Roll down, chill out: skip the air conditioning and save fuel. • Chill smarter, not harder: the recirculation mode reduces the load on the air conditioning system.
Route and fleet optimization	• Plan before you drive: one planned longer trip beats several shorter ones. • Skip the jams: use Google Maps to find the most efficient route. • Share the ride, share the benefits: every shared ride improves air quality.

Figure 9 – Global messages from a previous training program[1]

[1] Images obtained from the online resource titled “Economic Driving Program - ‘How to’ Manual: A guide for developing your own eco-driving program” [11]

Figure 10 – Computer screensavers from a previous training program[2]

[2] Images obtained from the online resource titled "Economic Driving Program - 'How to' Manual: A guide for developing your own eco-driving program" [11]

Figure 11 – Advertisements from a previous training program[3]

[3] Images obtained from the online resource titled "Economic Driving Program - 'How to' Manual: A guide for developing your own eco-driving program" [11]

Figure 12 – Sample flyer from a previous training program[4]

[4] Images obtained from the online resource titled "Economic Driving Program - 'How to' Manual: A guide for developing your own eco-driving program" [11]

Figure 13 – Online information sheet from a previous training program[5]

[5] Images obtained from the online resource titled “Economic Driving Program - ‘How to’ Manual: A guide for developing your own eco-driving program” [11]

Appendix B – Questionnaire for the Interview with the Fleet Services Superintendent

- What is the composition of the vehicle fleet belonging to The City; how many light-duty, medium-duty, and heavy-duty vehicles, and out of those, how many are electric vehicles and how many are internal combustion engine vehicles?
- Are there any dedicated drivers currently employed in The City? If yes, how many?
- Currently, how is the fuel consumption of the vehicle fleet monitored?
- What is the basis used for tracking fuel consumption (e.g., tracking all individual vehicles versus tracking the entire fleet, tracking all individual trips versus a monthly or yearly basis)?
- How often is the tire pressure of the vehicles checked and filled to the recommended levels?
- Is there a pre-trip inspection checklist currently in place for fleet vehicles?
- Does The City have prior experience with vehicle telematics to track real-time fuel consumption information and provide this information to drivers?
- Is there any training currently provided to drivers, and if yes, what is the delivery method used to facilitate this training (online, in-person, etc.)?
- Are there any occupational briefings such as toolbox talks, lunch-and-learn sessions currently conducted for employees?

Appendix C – Questionnaire used for Focus Groups and Interviews

Introduction and general questions

1. Please provide a brief introduction about your role within The City.
2. What type of fleet vehicles do you or your team use, and for what purposes?
3. Are you primarily operating the vehicles yourself, or are you involved in training or overseeing others who use them?
4. Are you familiar with the concept of fuel-efficient driving techniques and habits, commonly referred to as “eco-driving?”
5. Have you received any kind of training on sustainable driving techniques and habits before (formal or informal, scheduled or own time, online or in-person)?
6. There is a training module available on the CorQBoard, titled “Eco-Driving training online (NRCan).” Have you ever accessed this module? If you are a manager, have you directed employees under your supervision to this training module?
7. Are there times when you or your team members have to leave your vehicle idling for more than 1-2 minutes (except when you are in traffic)? If so, under what circumstances? Is this something which occurs often?
8. Do you think you or your team might be currently taking more trips than necessary, or using the fleet inefficiently?
9. Do you think you and your team are using the right-sized vehicles for the tasks typically undertaken?

Fleet Use Practices

10. If you have used electric vehicles in the fleet, what are the issues you have come across and how have you resolved them?
11. Have you reserved and driven the shared electric vehicles available in City Hall? What are your suggestions to improve your experience of reserving and driving electric vehicles?

Readiness for Training / Feedback

12. How ready and open do you think your department/team members will be to receive training on sustainable driving habits?

Training

13. If a training program on sustainable driving practices was developed and offered, what kind of delivery method would work best for you and your team members based on work schedules and constraints? What would be the most engaging or effective methods?
14. What are the challenges or barriers to effective training?
15. Past projects show that continuous/ongoing training produces much better results as opposed to one-time training. But staff members may find it challenging due to busy work schedules. What are your suggestions to balance both these perspectives?
16. What are the characteristics of a good training program that are most likely to influence positive change? How would we know whether the training was successful?
17. What are your suggestions to make this training more effective for the fleet vehicle users? Are there any lessons learnt from past training initiatives which could be useful?

Appendix D – An Outline for the Proposed Crew-talk Series

Table 3 – A sample outline for the proposed series of crew-talk sessions on sustainable driving techniques and habits

Session	Eco-driving tip(s) discussed	Key discussion points for the session	Questions for audience engagement
01	Gentle acceleration, maintaining steady speed, and adhering to speed limits	• Harder accelerations consume more fuel. • Use 5 seconds to accelerate to 20 km/h from rest. • Frequent speed fluctuations consume more fuel and impact the ride comfort. • Steady speeds at low RPMs reduce fuel usage and wear and tear. • Speeding does not save time in cities due to traffic lights, other vehicles, and pedestrians. • Adhering to speed limits reduces the need for hard braking and increases safety.	• "What situations tempt you to accelerate hard?" • "In what situations do you find it hardest to maintain a steady speed?" • "Do you ever get tempted to exceed the posted speed limits?" • "When you find yourself driving faster than needed during work trips, what are the typical reasons behind this?"
02	Increased anticipation of traffic and coasting to decelerate	• Scan ahead as far as 12-15 seconds and attempt to predict what other road users may do. This mitigates the need to brake hard. • Maintain a safe distance from the vehicle in front. • Identify the need to slow down in advance, remove foot from the accelerator, and coast to reduce speed safely.	• "How far ahead do you typically scan for traffic changes?" • "What are some of the clues you should watch out for to predict traffic flows?" • "Can anyone share an occasion where anticipation prevented a hard stop?" • "Have you tried coasting to decelerate before? If yes, do you prefer coasting or braking, and why?"

03	Avoid idling, using air conditioning sparingly, and route optimization	• The City's anti-idling bylaw states idling beyond 3 minutes is not permitted. • Idling wastes fuel since the driven distance is zero. • Avoid warming up the engine and cabin beyond one minute in the winter. Driving warms up the engine much faster than idling. • Air conditioning can increase fuel usage by up to 20%. • Roll down windows during city driving. If using air conditioning, use the recirculation mode. • Try to find a shaded area for parking. Use a reflective sunshade if available. Before starting the vehicle and air conditioning in the summer, open doors of the vehicle to release trapped hot air. • Wait until all passengers are ready to start the engine. • Identify the most efficient route using online maps. Combine trips and avoid backtracking and peak hour traffic when possible.	• "What is the maximum number of minutes idling is allowed under The City's anti-idling bylaw?" • "What situations make idling necessary or hard to avoid?" • "Do you find it too difficult to drive with the windows rolled down during the daytime in Coquitlam?" • "If you are using air conditioning, do you pay attention to its settings such as the temperature it is set at, or whether the recirculation mode is turned on?" • "Do you plan routes in advance, or just drive as needed?" • "What are some online tools which can help plan trips, avoid traffic, and save time?"

04	Maintain correct tire pressure, avoid unnecessary weights, and eliminate inefficiencies	• Underinflated tires increase rolling resistance and fuel consumption. • If the tire pressure is 75% of the recommended pressure on all 4 tires, the fuel economy can lower by about 3%. • If the tire pressure is 50% of the recommended pressure on all 4 tires, the fuel economy can lower by about 10%. This is also a major safety risk. • Inspect once a month and ensure the tires are inflated to the correct pressure. • Remove unneeded heavy equipment from the vehicle. • Common inefficiencies in fleet operations include under-utilized or oversized vehicles, not carpooling when possible, and taking more trips than needed. • Supervisors and staff members need to work together to identify and eliminate inefficiencies to optimize fleet usage.	• "On your personal vehicles, do you perform a monthly check on tire pressure?" • "What is the heaviest thing you have found in a vehicle which did not need to be there?" • "What are some of the inefficiencies – oversized or under-utilized vehicles, instances of vehicles used, or trips taken more than needed – which you have observed within your department?"