CITY OF NORTH BATTLEFORD

PLANNING COMMITTEE AGENDA

Monday, October 17, 2022
5:15 P.M.

PLANNING COMMITTEE MEETING
TO BE HELD VIA ZOOM
MONDAY, OCTOBER 17, 2022, COMMENCING AT 5:15 P.M.

AGENDA

AGENDA	**:**	Approval
MINUTES	**:**	Planning Committee Minutes – June 20, 2022
DELEGATION	**:**	BRAD SWIFTWOLFE & TOM HOWARD, BATTLEFORDS REGIONAL COMMUNITY COALITION Re: BRCC Update
UNFINISHED BUSINESS	**:**	
NEW BUSINESS	**:**	CITY MANAGER Service Tracker Demo
CORRESPONDENCE	**:**	
REPORTS	**:**	DIRECTOR OF OPERATIONS AMI Project Update Fleet Equipment and Vehicle Optimization Study DIRECTOR OF PARKS & RECREATION Re: Playground Renewal and Expansion Project
INQUIRIES	**:**	
NEXT MEETING DATE	**:**	Monday, November 21st, 2022 @ 5:15 p.m.
FREEDOM OF INFORMATION & PROTECTION OF PRIVACY ACT	**:**	**Part III Exemptions**
ADJOURNMENT	**:**	

MINUTES OF THE REGULAR PLANNING COMMITTEE MEETING OF THE CITY OF NORTH BATTLEFORD HELD VIA ZOOM AND IN COUNCIL CHAMBERS, MONDAY, JUNE 20TH, 2022 COMMENCING AT 5:15 P.M.

MEMBERS PRESENT:	Mayor	David Gillan
	Councillors	Kelli Hawtin Thomas Ironstand Greg Lightfoot Kent Lindgren Ross MacAngus Len Taylor

ADMINISTRATION PRESENT:

Randy Patrick, City Manager
Jennifer Niesink, Director of Corporate Services
Stacey Hadley, City Clerk
Brent Nadon, Director of Finance
Lindsay Holm, Director of Protective Services
Cheryl DeNeire, Director of Parks & Recreation
Stewart Schafer, Director of Operations

OTHERS PRESENT:

Tania Lafontaine, Chief Executive Officer, Battlefords Agency Tribal Chiefs
Audrey Bouvier, Executive Assistant, Battlefords Agency Tribal Chiefs
Kyle Colburn, Urban Systems
Marilyn Richardson
Leone Neville

Deputy Mayor Taylor called the meeting to order at 5:15 p.m.

AGENDA

13/22 BE IT RESOLVED That the Planning Committee Agenda for June 20th, 2022, be approved.

Moved by Councillor Hawtin
CARRIED

MINUTES

14/22 BE IT RESOLVED That the Minutes of the Planning Committee Meeting held May 16th, 2022, be adopted.

Moved by Councillor Lightfoot
CARRIED

DELEGATIONS

MARILYN RICHARDSON & LEONE NEVILLE
Re: Proposed Street name – Railway Avenue West

Marilyn Richardson and Leone Neville were in attendance to provide an update surrounding the proposed street renaming of Railway Avenue West. Mrs. Richardson noted that a group of five (5) Elders selected Pēyak Trail (One Trail) representative of unity.

M. Richardson and L. Neville left the meeting at 5:25 p.m.

URBAN SYSTEMS
Re: Traffic Calming Measures

Kyle Colburn was in attendance to present information surrounding options, considerations, and the associated implications of implementing traffic calming measures in a community.

Discussion was held regarding traffic control devices, traffic calming methods for arterial vs. collector roads, curb extensions in the downtown area, and perceived speeding vs. actual speeding.

K. Colburn left the meeting at 5:51 p.m.

TANIA LAFONTAINE, BATTLEFORDS AGENCY TRIBAL CHIEFS
Re: BATC Health Update

Tania Lafontaine was in attendance to provide an update regarding the Battlefords Agency Tribal Chiefs (BATC) Health program noting that BATC is new to delivering health services and that they will be focusing on child, maternal, mental and sexual health, and addictions.

Ms. Lafontaine noted that conventional health care service delivery has not been effective for many First Nations citizens resulting in poorer health outcomes across all spectrums of health care, and that BATC is planning to deliver high quality health services through door-to-door engagement to alleviate any barriers caused by conventional health care services.

Ms. Lafontaine also noted that a long-term goal of BATC is to partner with the University of Saskatchewan to provide culturally responsive training to residents and interns in exchange for leading edge innovative health care services for their First Nations.

Discussion was held regarding prevention and education initiatives.

T. Lafontaine and A. Beaudry left the meeting at 6:03 p.m.

NEW BUSINESS

CITY CLERK
Re: Coalition of Inclusive Municipalities / Welcoming & Inclusive Plan Update

The City Clerk provided an update regarding the City's Welcoming & Inclusive Community Survey and the development of the Welcoming & Inclusive Community Plan and noted that by varying degrees the City is meeting the 10 Common Commitments as mandated by the Coalition of Inclusive Municipalities.

Discussion was held regarding survey participation and representation, and the proposed Truth and Reconciliation Committee 5 Calls to Action.

Planning Committee recommended that the proposed Calls to Action be brought forward to a future meeting for discussion.

Re: Optional Land Acknowledgements

The City Clerk provided information surrounding optional land acknowledgements for Planning Committee's consideration.

Discussion was held regarding the importance of accuracy, appropriate protocols and implementing a formal land acknowledgement moving forward.

Planning Committee recommended proposed changes to the land acknowledgements and requested that the discussion be brought forward to a future meeting for consideration.

DIRECTOR OF OPERATIONS
Re: SARCAN Household Glass Recycling

The Director of Operations provided information regarding the current practice in the Waste Management Facility with respect to the use of glass materials noting that it is crushed and utilized as a cover material in the landfill and noted that a glass recycling program would include regional collection at a cost to city of North Battleford property owners.

Discussion was held regarding efficiencies found in the Waste Management Facilities current process, separation programs, the potential for job creation if the program were to be subsidized, and it was noted that the provincial organization of SARCAN may transport the material to other sites for sorting and processing.

Planning Committee recommended receiving SARCAN's correspondence as information only at this time.

CORRESPONDENCE – None

REPORTS – None

INQUIRIES

Discussion was held regarding various inquiries of Council.

NEXT MEETING DATE – Monday, September 19th, 2022, commencing at 5:15 p.m.

IN CAMERA

There was no In Camera Session held during this meeting.

ADJOURNMENT

15/22 BE IT RESOLVED That the meeting adjourn at 7:34 p.m.

Moved by Councillor Lindgren
CARRIED

DEPUTY MAYOR

CITY CLERK

Battlefords Regional Community Coalition

City of North Battleford
Council Update

October 17, 2022

Personnel Changes

- **Senior Strategist Bonnie Evans** retired from the BRCC table in June
- Bonnie was a driving force behind formation of BRCC; we continue to work with the Battle River IRC, whom she still advises
- In September, the BRCC welcomed former Moosomin Chief **Brad Swiftwolfe** as **first executive director**

Funding Update

- In summer 2022, the BRCC received corporate sponsorship from **Prairie Merchant Corporation (ie: W. Brett Wilson)** and **Cenovus Energy** to fund future anti-racism workshops
- BRCC is currently in final year of Urban Programming for Indigenous Peoples (UPIP) Coalitions funding; replacement funding programs are in development at Indigenous Services Canada
- Two additional UPIP funding streams have opened this year – Organizational Capacity and Programs & Services
- **BRCC continues to scan for core funding opportunities**

Initiative Update: Emergency Management

- BRCC continues to coordinate the development of a **regional emergency response plan (ERP)**, funded by **Saskatchewan Targeted Sector Support Initiative**
- Contract for regional ERP awarded in June to **PMO Global Services**
- PMO recently conducted **Hazard, Risk, and Vulnerability Assessment (HRVA) workshop** with project team; workshop results will inform regional ERP
- Regional ERP will cover all BRCC member governments & the RM of North Battleford
- Completion date estimated early spring 2023

Initiative Update: Sharing a Vision (I)

- In June, the BRCC awarded a contract to Certes Natural and Applied Sciences for our **Sharing a Vision** initiative
- This initiative will entail conversations with both Indigenous and non-Indigenous communities on the current state of/future possibilities for **health, education, & recreation service-delivery**
- Community engagement process will culminate in a **gap analysis** on the above sectors, as well as a **conceptual plan** which outlines opportunities to address gaps

Initiative Update: Sharing a Vision (II)

- In September, the BRCC & Certes attended workshops organized by the Battle River IRC in **Little Pine, Lucky Man, and Moosomin**
- Workshops provided a "soft" introduction to the project in these communities
- BRCC & Certes have also held some **preliminary discussions with BRCC member governments & health, education, & recreation service-providers**
- Feedback is helping inform project methodology; initial responses have been supportive

Initiative Update: Sharing a Vision (III)

- Certes is conducting a **literature review of strategic planning & policy documents** with BRCC member governments and regional health, education, and recreation service-providers
- Lit. review will inform methodology for community engagement
- Lit. review will also create **document library of health, education, & recreation plans for Battlefords region**

Other Business

- Work continues to plan additional **anti-racism workshops** for regional executive leadership
- **Monthly regional health calls** have replaced **biweekly pandemic calls**
- Project team is planning for focusing on **internal capacity-building**
- BRCC continues to provide **advocacy, coordination, & special projects development** as directed by board leadership

Questions?

Thank you, City of North Battleford Council for your time and attention

North Battleford

For Information Only

MEETING DATE: October 17, 2022 **MEETING: Planning Committee**

TO: Stewart Shafer, Director of City Operations

FROM: Jeffrey Blanchard, Environmental Manager

SUBJECT: AMI Progress Update

Background and Explanation:

The City of North Battleford and KTI Limited (KTI) began installing Sensus smart meters throughout the City in March 2021. In July 2022 KTI exited North Battleford after completing the majority of installations and warrant. To date 5,245 of approximately 5,315, or 98.7%, meters have been exchanged.

Outstanding Exchanges and Ongoing Meter Service:

During much of the project City crews have been involved in completing meter exchanges at challenging properties. Since KTI exited North Battleford City crews have received additional training (September 2022) and continue to complete meter exchanges, repairs (some warranty), and service.

Of the approximately 70 remaining properties, 20 are City buildings, 10-15 are commercial or institutional, and the remaining 35-40 are residential properties. As of October 11, 2022 there are 104 properties with disconnected water service, 10 of which are shutoff for not having smart meters, 94 of which are shutoff as long-term vacant or unpaid accounts. Of the 94 disconnected properties many have been disconnected longer than 12 months.

When a new utility application or reconnection request is received, Administration verifies the status of the meter exchange. If a new meter has not been installed, it is installed prior to reconnecting water service.

City buildings and commercial/institutional properties are slow to exchange because of a shortage of larger diameter meter inventory and or complex installation requirements.

Bypasses:

KTI had identified approximately 15 bypasses. Bypasses are a contravention of our Waterworks Bylaw No. 1706. Administration continues to work with properties to address their bypasses.

Billing Integration:

Billing integration is still nearing completion and Administration is manually working with Sensus software to import AMI meter readings directly into our billing software. In the future this process will be automated. Administration continues to work with Vadim and Sensus to merge information and automate the process.

Customer/Public Software

The Customer Portal continues to face delays and Administration is actively negotiating with Vadim to bridge technical programming issues related to the synching of information. Administration does not have an updated timeline on when the Customer Portal will be live.

Ongoing Monitoring

Administration continues to monitor for customer leaks and in the absence of the Customer Portal is providing courtesy notifications. Further, Administration is monitoring the information from the AMI system and is evaluating current continuous flow alarm thresholds across multiple meter types, evaluating pressure alert thresholds, identifying and repairing communication alarms, and monitoring a variety of other alerts.

Respectfully submitted,

Jeffrey Blanchard
Environmental Manager

Approvals:

Director: ______________________ **Date:** October 13, 2022

City Manager: ______________________ **Date:** 10/13/22

August
2022

Final Report

Fleet Equipment and Vehicle Optimization Study

PREPARED FOR THE CITY OF NORTH BATTLEFORD, SK

AUTHORS: ROGER SMITH, JANA CERVINKA. CHIEF DATA ANALYST: HUGH ROBERTS

Fleet Challenge
Driving Change

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Terms and Abbreviations

B10 – A blend of 10% biodiesel and 90% fossil diesel
BAU – Business-as-usual
BEV – Battery-electric vehicle
BET – Battery-electric truck
CAC – Criteria air contaminants; a cause of ground level smog
CAFE – Corporate average fuel economy
Capex – Capital expense
CIF – Cost inflation factor
CNG – Compressed natural gas
CO_2 or CO_2e – Carbon dioxide or carbon dioxide equivalent
Downtime – Period when a vehicle is unavailable for use during prime business hours
E85 – A blend of around 85% ethanol and 15% gasoline
EV – Electric vehicle
EVSE – Electric vehicle supply equipment
FAR™ – Fleet Analytics Review™ (Fleet Challenge Excel software tool)
FTE – Full-time equivalent (employee)
GHG – Greenhouse gas (expressed in CO_2 equivalent tonnes)
GHG Intensity – A measure of GHGs produced relative to VKT or VMT (see below)
GVW – Gross vehicle weight
HD or HDV – Heavy-duty vehicle (Classes 7-8)
HEV – Hybrid-electric vehicle
ICE – Internal combustion engine
KPI – Key performance indicator
LCA – Lifecycle analysis
LD or LDV – Light-duty vehicle
LMHD – Light-, medium-, and heavy-duty vehicle
LPG – Liquified petroleum gas, more commonly referred to as propane
LTCP – Long-term capital planning
MD or MDV – Medium-duty vehicle
MHD or MHDV – Medium- and heavy-duty vehicle
MHEV – Mild hybrid-electric vehicle
MT – Metric tonne
NPV – Net present value
OEM – Original equipment manufacturer
Opex – Operating expense
PHEV – Plug-in hybrid electric vehicle
PM – Preventative maintenance
PMCVI – Periodic mandatory commercial vehicle inspection
ROI – Return-on-investment

Terms and Abbreviations (cont’d.)

Solution – A technology, best management practice, or strategy to reduce fuel use and GHGs
TCO – Total cost of ownership
Uptime – Period when a vehicle is available for use during prime business hours (opposite of downtime)
Vehicle availability – See “Uptime”
VKT or VMT – Vehicle kilometres/miles travelled
WACC – Weighted average cost of capital
ZEV – Zero-emission vehicle

Disclaimer

This Equipment and Vehicle Optimization study, including any enclosures and attachments, has been prepared exclusively for the use and benefit of the City of North Battleford (CNB) and solely for the purpose for which it is provided. Unless Fleet Challenge Canada Inc. (FCC) provides prior written consent, no part of this report may be reproduced, distributed, or communicated to any third party. FCC does not accept liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report.

Analysis in this report is based on fleet data prepared and submitted by the City of North Battleford. FCC is not responsible for errors or omissions, or for the results obtained from the use of this data. Where data gaps existed, as a workaround, FCC employed proxy data based on Canadian municipal fleet averages with CNB's consent. All information in this study is provided as-is, with no guarantee of completeness, accuracy, timeliness, or the results obtained from its use.

The information in the report is not an alternative to legal, financial, taxation, or accountancy advice from appropriately qualified professionals. For specific questions about any legal, financial, taxation, accountancy or other specialized matters, City of North Battleford should consult appropriately qualified professionals. Without prejudice to the generality of the foregoing paragraph, we do not represent, warrant, undertake, or guarantee that the use of guidance in the report will lead to any particular outcomes or results.

Foreword

The following Equipment and Vehicle Optimization study has been prepared specifically for the City of North Battleford (the City, CNB, North Battleford) by Fleet Challenge Canada Inc. of Toronto, Ontario (herein referred to as FCC, or Fleet Challenge). We include this foreword because we feel it is important for readers of this report to first have a full understanding of the situation and context.

About Fleet Challenge

Since 2005, FCC has collaborated with fleet managers, technology providers, subject matter experts, and auto manufacturers to find viable solutions, technologies, and best management practices for reducing operating costs and vehicle emissions. We have remained a self-supporting and independent fleet management consulting organization without commercial biases or influences, providing fleet review and consulting services to dozens of leading private and public sector fleets in Canada and the United States.

About Fleet Analytics Review™

For the development of the Equipment and Vehicle Optimization study, FCC employed our innovative, leading-edge data-modelling techniques and our proprietary software, Fleet Analytics Review™ (FAR). FAR is a software tool designed and developed by our company specifically for complex fleet planning. Data-modeling in FAR enables our team to simulate the impacts of short- to long-term fleet options by calculating return-on-investment (ROI) for various best practices, operational changes, vehicle technologies and other interventions, driven by actual historical data. In turn, through simulation, FAR allows us to evaluate the viability of the business cases for each solution and provide meaningful recommendations for long-term capital planning (LTCP).

The FCC team has made considerable effort to make the Equipment and Vehicle Optimization study as meaningful and relevant as possible to City of North Battleford. Our team analyzed and evaluated baseline fleet results to determine the fleet's current state. We then modelled potential solutions/opportunities that make economic sense and are reasonably attainable in the short- to long-terms. Results of all scenario analyses are presented herein for the City's consideration.

FAR has been designed to efficiently estimate the cost-benefit and greenhouse gas (GHG) emissions-reduction potential of best management practices (BMPs) that have been proven to be beneficial to commercial and municipal fleets. As well, a transition to battery-electric vehicles (BEVs, EVs) was modeled and evaluated. The Equipment and Vehicle Optimization study provides a viable roadmap and several options for consideration by the City's management personnel.

We have made every effort to ensure that the business assumptions employed in our analysis are as accurate as possible and based on our years of experience working with commercial and municipal fleets. All estimates are based on published studies, research, and historical data. Data sources are noted throughout this document.

It is important to keep in mind that fossil fuel-use reduction translates directly to greenhouse gas reduction[1] (hereafter referred to as GHG reduction, carbon reduction, or CO_2 reduction). Therefore, all references to fuel savings include the consequential GHG impacts (i.e., increase or decrease).

Cautious Approach

All solutions explored in this report represent what our team considers to be possible, each with its own set of potentials. However, there are many variations that would modify capital expenses, operating expenses, and emissions projections over time (e.g., switching vehicle types - such as from a heavy-duty pickup to a lighter-duty unit, or from gas or diesel to alternate/renewable fuels, or other changes taking place earlier/later than modelled, phasing in battery-electric vehicles earlier/later than modelled or for segments of the fleet as opposed to fleet-wide implementation, etc.). Therefore, actual financial and environmental impacts are tied to the degree of successful achievement in implementing each of the solutions and the timing of their implementation.

Challenges to Green Fleet Planning

Globally, leading public and private sector fleets everywhere are “greening up” and working diligently to reduce their fleet’s greenhouse gas (GHG) emissions. Regarding green fleet, emissions reduction options for the City, regardless of which solutions, if any, are recommended in our report are ultimately selected by City of North Battleford, the reality is that each will require some degree of extra staff effort, and some will require additional cost to implement. For example, although flex-fuel units can use E85 ethanol (85% ethanol and 15% gasoline), finding a source for this alternate fuel may bring significant operational challenges that must be resolved. Other examples are the cost of installing electric vehicle charging stations, or the majore expense of compressed natural gas (CNG) refuellers.

Emissions Calculation Methods

Internationally, there are two main reporting methods for vehicle GHG emissions modelling: (1) tailpipe combustion, and (2) lifecycle (often referred to as well-to-wheel). Modelling of lifecycle GHG emissions of motor fuels is used to assess the overall GHG impacts of the fuel and the vehicles which use it. Lifecycle emissions generally includes the impact of vehicle assembly and transport, and the materials in the vehicle, which is using the fuel, in addition to the fuel used to power a vehicle.

Modelling of tailpipe emissions includes only the actual emissions produced by the vehicle itself through combustion. Lifecycle GHG emissions are, therefore, usually greater than tailpipe emissions.

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[1] The terms greenhouse gas, GHG, carbon, CO_2e, and CO_2 are synonymous for the purposes of this report.

While lifecycle emissions have been established for most fuel types, lifecycle emissions are very difficult to quantify for management practices, and this adds a level of complexity. For this reason, to assess the potential GHG reduction on an apples-to-apples basis for each proposed solution, we employ the tailpipe combustion method. Although not providing a complete well-to-wheel picture of GHG emissions, the results of our modelling employing the tailpipe combustion method gives a clear indication as to which solutions offer the greatest GHG reduction potential. Using this method, battery-electric vehicles (BEVs, EVs) emit zero emissions.

For renewable fuels (i.e., biodiesel, ethanol, and RNG), we use net vehicle operation emissions factors, which account for the change in airborne carbon that occur due to the combustion process. This approach considers the sequestration of carbon through the growth of biomass (or decay of biomass in the case of RNG) and the re-release of carbon through vehicle combustion; the result is a more complete picture of airborne carbon and significantly lowered overall operative emissions for higher renewable fuel blends.

Of Further Consideration

In the Equipment and Vehicle Optimization study, we calculated City of North Battleford's fleet baseline and determined optimized economic lifecycles for different vehicle categories based on the City's fleet data. Where there were data gaps, we backfilled with proxy municipal fleet average data where appropriate.

With the baseline established, we identified key areas for improvement relative to best-in-class fleet management practices. To find solutions, we then data-modelled many go-forward capital budgeting scenarios over a 15-year budget period to provide a roadmap for implementation of possible fleet management enhancements. The interventions/solutions encompass three groups:

- Group One: Fleet modernization, optimized lifecycles, long-term capital budget balancing
- Group Two: Fleet right-sizing, downsizing, fuel switching, leasing some units
- Group Three: Transitioning to battery-electric vehicles

We expect that City of North Battleford may wish to evaluate unique combinations of these solutions based on practicality, availability of models, corporate budgets, vehicle conditions, etc. For this purpose, the FAR software tool will be provided to the City for its own internal use post-project. The tool will be useful for efficiently evaluating any number of fuel-saving solutions under consideration.

As a backdrop to the financial maintenance, and service delivery improvement objectives of the Equipment and Vehicle Optimization study, our goal is to stimulate City of North Battleford's interest in moving its fleet towards a zero-carbon, electric vehicle future.

We have made every effort to ensure our analysis is as accurate as possible, but at the time of actual implementation the business assumptions we have employed may have shifted. Therefore, we strongly urge the City to complete cost-benefit analyses at any time in the future when considering implementing the recommended interventions/strategies we have outlined. Furthermore, for each recommendation, we suggest that a slow-start, cautious approach be taken, which would include pilot testing any changes in a small control group over at least four seasons of operation, monitoring performance and assessing the effectiveness of any change under consideration prior to wide-scale implementation.

Focus on Corporate Social Responsibility

Fleet Challenge Canada's (FCC's) corporate position is that a fleet can and should be managed around the three pillars of corporate social responsibility. We see these as intertwining issues. These are:

(1) **Fiscal:** Our fleet management plans/strategies and recommendations are designed to reduce costs.
(2) **Environmental**: We ensure that our plans/strategies are environmentally sound and focused on reducing greenhouse gas (GHG) emissions.
(3) **Social**: How any proposed changes to the fleet will affect the working lives of drivers and equipment operators.

Fleet vehicles and equipment were initially intended to make our work lives less burdensome. Therefore, the impacts on a municipality's workers, dependent on fleet vehicles and equipment to get their jobs done daily, concern us. Consequently, we always consider the human side in making our recommendations.

Vision, Goal, and Objectives

As stated in the City's RFP, the overall goal of the engagement will be to improve operations and reduce costs while ensuring the City of North Battleford is providing vehicles and equipment that are suitable to the users' needs, available when needed and achieve citizens' realistic expectations regarding service, reliability, safety, and environmental responsibility.

To guide City of North Battleford in achieving this goal, we thoroughly analyzed the City's in-scope fleet and equipment data. We have identified and assessed several operational improvements and other enhancements and prepared recommendations for fleet management's consideration, as we will present in this report.

Executive Summary

In April 2022, the City of North Battleford engaged Fleet Challenge Canada Inc. (FCC) of Toronto, Ontario to complete an Equipment and Vehicle Optimization study for its fleet and equipment assets. As the City described in its RFP, through the development and implementation of the study, the City aims to improve its fleet management practices by evaluating the size, usage, effectiveness and efficiency of the equipment and vehicle fleet.

The report is based on our team's detailed data analysis of one-year of historical data for 425 in-scope City of North Battleford fleet vehicles, trailers, mobile equipment, and small work equipment units.

Fleet Makeup

The high-level makeup of the City of Battleford's fleet is typical for municipalities everywhere and shown in the table below.

Fleet Vehicle Type	Number of Units (baseline yr.)
Class 1 (Light-duty Vehicles)	5
Class 2 (Light-duty Vehicles)	53
Class 3 & 4 Light & Medium-duty Trucks)	21
Class 5 & 6 (Medium-duty Trucks)	7
Class 7 & 8 (Heavy-duty Trucks)	20
Mobile Equipment (heavy equipment, large mowers, ATVs, etc.)	74
Mounted Equipment	31
Small Equipment (e.g., weed whackers, chainsaws, etc.)	178
Trailer	36
Total:	425

High Level Description of our Approach

In preparing this report, our team:

- Reviewed current management practices to identify potential areas of improvement
- Conducted a fleet maintenance technician labour demand-versus-capacity study to calculate how many technicians are required to meet current fleet maintenance demand, and in the future given population growth estimates for the next 10 years
- Completed a garage bay study to determine if the number of service bays is matched with current maintenance demand, as well as evaluate potential future demand with population growth in the next decade
- Developed and distributed a fleet management practices survey to gauge the current view and opinions of management and unionized employees on various matters including the current level of service and fleet vehicles
- Developed a fleet fuel usage, operating cost, and emissions baseline for current fleet assets, as well as a peer fleet comparison to assess the relative performance of City of North Battleford's fleet
- Undertook a lifecycle analysis (LCA) study to determine optimal replacement cycles for select vehicle categories
- Completed discounted cashflow analysis to study the cost impacts of purchasing vs. leasing vs. renting and to assess the total cost of ownership (TCO) for each option.
- Data-modeled all potential solutions over a 15-year budget cycle to estimate their impacts (capital expenses, changes in operating expenses, and reductions in GHG emissions) relative to the baseline
- Data-modelled several possible options to address the fleet's advanced age, and as well, the extreme backlog of vehicles due, or past-due for replacement including downsizing, right-sizing, and leasing
- Data-modeled electric vehicles (EVs) and electric supply equipment (EVSE) requirements on a unit-by-unit basis and estimate charger and charging infrastructure costs
- Prepared recommendations to improve the operational, financial and environmental sustainability performance of the City's fleet

Fleet Statistical Baseline

The report is based on our team's detailed data analysis of one-year of historical data for 425 City of North Battleford in-scope fleet vehicles, trailers, mobile equipment, and small work equipment units as submitted by the City[2].

Key fleet-wide statistics from the one-year baseline review period are listed below[3]. For a more detailed breakdown of select key performance indicators (KPIs) for each vehicle class, type, and equipment type, please review the FAR 1x(a) baseline data model which we provide separately to the City of North Battleford.

- For the baseline review, there were 425 in-scope City of North Battleford fleet vehicles, trailers, mobile equipment, and small work equipment units
- All units were owned, except three which were leased
- Total kilometres-travelled was 886,992 kilometres
- Original purchase price for the fleet was $11,106,000
- Current-day replacement cost (like-for-like replacements) was $14,628,612
- Market/trade-in value was $2,962,724
- Cost of capital was $125,159
- Cost of preventive maintenance (PM) was $119,139
- Cost of reactive repairs was $455,622
- Cost of fuel was $681,729
- Controllable operating costs[4], including repairs and maintenance, fuel, capital, and downtime combined were $1,578,376
- Fuel used was 356,587 litres
- Tailpipe GHG emissions were 956.7 metric tonnes CO_2e
- Average utilization for on-road units was 5,368 kilometres/year
- Corporate average fuel consumption for all on-road units was 49.5 l/100km
- Average age (on-road vehicles and equipment) was 12.6 years
- Average age of on-road vehicles was 13.9 years

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[2] Where data was not available, with approval of the City, we backfilled with peer fleet average data from the Fleet Challenge municipal fleet database.
[3] All values are estimated and calculated on data provided by the City. Where data gaps existed proxy data from peer Canadian municipal fleets was used as a workaround.
[4] Controllable operating costs are those which fleet management has direct control including fuel, maintenance, repairs, cost of capital and downtime.

Fleet Maintenance Technician Labour Demand Study

Currently, the City of North Battleford now employs two licenced journeymen mechanics and one unlicensed fleet maintenance person. FCC completed analysis to determine if the number of Fleet Maintenance Technicians (mechanics) today is adequate. We also calculated the number of technicians that would be required to meet the demand of an increased fleet size commensurate with expected population growth of 1% per year, for the next ten years.

Through our fleet maintenance labour demand analysis, we estimated that the number of technicians that make up the City's fleet maintenance team today is not in alignment with maintenance demand. Based on the current fleet size, to fully attain the low estimate of maintenance demand, six technicians would be required. We determined that as many as 10 persons would be needed to meet peak maintenance demand for the current fleet size of 425 fleet units.

We calculated the number of technicians that would be required given 10-year population growth expectations and an increased fleet size to meet the needs of an expanded number of residents. We learned that, in ten years at the expected rate of growth, seven technicians would be required at low demand and as many as 11 persons would be required at peak demand.

Garage Bay Capacity Study

At the present time, City of North Battleford has one fleet maintenance garage with five double service bays, with a total capacity of 10 light-duty vehicles. The total capacity decreases when large vehicles are present in the garage for maintenance.

From our analysis of current needs the available number of bays is adequate at times of low demand. However, garage bay space is inadequate during times of peak demand – as many as 15 bays are needed.

In consideration of extrapolations around projected community growth for the next 10 years, 12 bays will be required during times of low demand by year 2032. And, as many as 20 bays would be required to meet the peak needs of a growing fleet in the future.

Fleet Management Practices Survey

FCC prepared three online surveys; one survey was designed for Fleet staff, a second for unionized drivers/operators and a third for management personnel. The purpose of the surveys was to gather views and opinions about the fleet from staff and fleet stakeholders in various roles and responsibilities. Survey respondents were assured of their anonymity.

In general, survey respondents from the unionized drivers/operators and management user groups are satisfied with the service and professionalism and quality of service provided by the City's fleet management team. However, dissatisfaction was expressed as far as the *frequency* of preventive maintenance and the *age* of fleet vehicles. Please see *Section 3: Fleet Management Practices Survey* of this report for additional details.

Lifecycle Analysis

Lifecycle analysis (LCA) was undertaken by FCC to calculate the optimal economic lifecycles for vehicle replacements. LCA was completed for select vehicle categories where sufficient historical data was available from the City of North Battleford. Peer municipal fleet data from our database was used to fill numerous data gaps.

The LCA took into consideration the cost of downtime (as caused by reduced reliability), the year-to-year "rollup" of the cost of capital, inflation, worker cost/hour, salvage and market values, inflation, and average kilometres-driven data.

The results are summarized in *the table below*. In *Appendix D*, we have included LCA charts for each applicable vehicle category in City of North Battleford's fleet.

Category	Current Replacement Cycle (years)	Optimal Economic Lifecyle (years)	Optimal Economic Lifecyle Recommended (total kilometers)	Change (+ or - years)
Pickups - Class 1 & 2	11	11	110,407	no change
Class 3 Trucks	11	10	75,270	-1
Class 4 Bus / Truck	12	12	36,132	no change
Class 8 Trucks w/Mounted Equipment	12	11	81,202	-1
Class 8 - Fire	12	12	47,784	no change

Fleet Capital Budget Planning

The City of North Battlefords fleet is of an advanced age relative to peer municipal fleet across Canada. Sixteen of the City's 106 identified on-road units – 15% of the fleet - exceed 20 years of age, four units are more than 30 years of age, and one is more than 40 years old.

Of the entire fleet of 425 vehicles and equipment, almost 40%, or 165 units, are either due or past-due for replacement based on age replacement criteria. More than 100 of these are on-road vehicles; the remainder are mobile and small work equipment. The estimated cost to replace all of these aged vehicles would exceed $8m.

Peer Fleet Comparisons

We compared statistical data for the City of North Battleford to a group of 31 urban municipal fleets selected from our database for comparison purposes.

(1) The City of North Battleford's on-road vehicle fleet average age[5] is 13.9 years -- more than double the average age of the peer group fleets[6] which is 5.8 years.

(2) The City of North Battleford's utilization rate is very low – average utilization is 5,368 kilometres/year[7] which is 1/3 of the average utilization relate of 16,092 km/yr. for the same group of 31 municipal peer fleets.

(3) At $2.28 per kilometre, North Battleford's average operating cost per kilometre is 34% higher than the peer fleet average cost/km of $1.51

(4) Each of the City's on-road vehicles serves 131 residents compared to the peer fleet group which serves an average of 1,061.

(5) Each of the City's on-road vehicles services 0.3 km^2 of land area compared to the peer fleet group for which each vehicle on average services 4.9 km^2.

In reviewing the City's fleet, we see the interplay of these five statistical indicators at work. It's essentially a "perfect storm". As vehicles age, reactive repairs (e.g., unplanned repairs and breakdowns) and downtime increase, while operating expenses escalate. Due to decreased reliability/downtime, spare vehicles are needed as backups. With the spare units, the overall fleet size increases while average utilization decreases.

[5] Average age is for on-road vehicles
[6] As complied from FCC municipal fleet database
[7] Includes on-road fleet units

The "Just-in-Case" Fleet

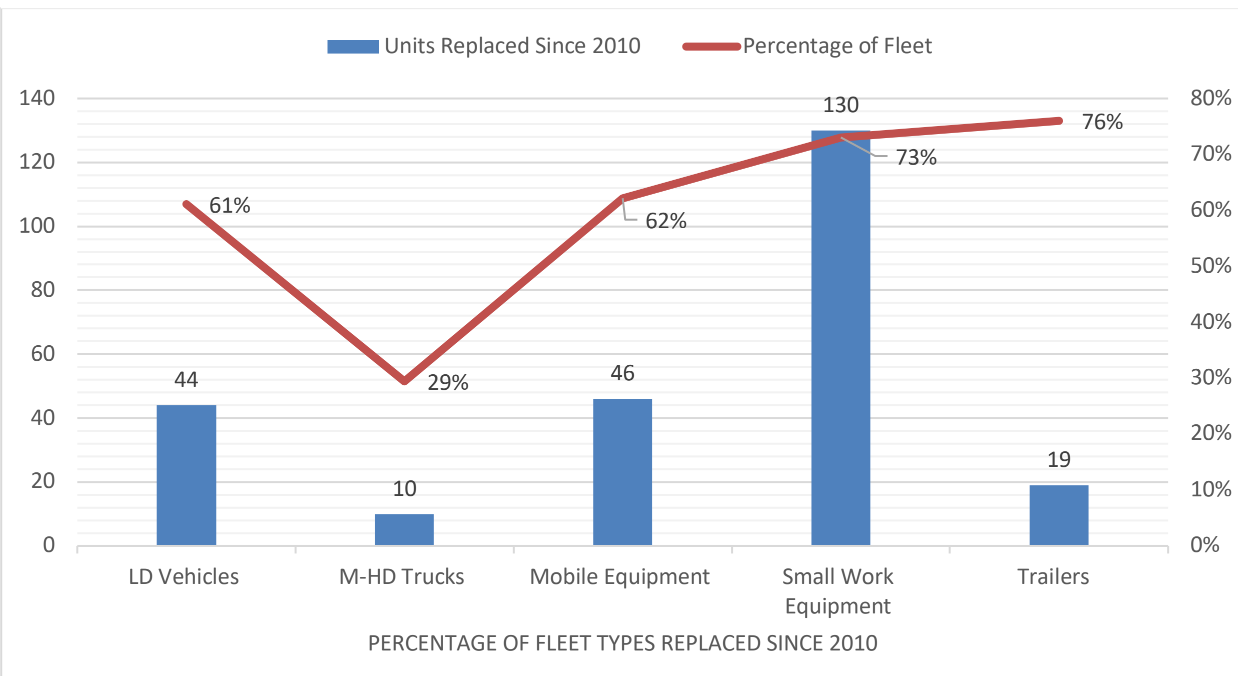
Maintaining the right number of fleet units and restraining unbounded fleet growth are challenges faced daily by fleet managers everywhere. Well-meaning user-group managers want to ensure they have enough vehicles for their staff to complete their work each day without interruption from failed vehicles. This means that an ample number of spare vehicles must be on hand "just in case" to allow for breakdowns and peak periods.

For the reasons we have described, ongoing, uninterrupted capital re-investment in modernizing the fleet each year is critical to any organization that depends on a reliable fleet of vehicles to achieve its objectives and mission, as is the case for all municipalities.

The benefits of a newer fleet include better fuel economy, increased vehicle uptime, lower cost of reactive repairs, increased safety, lower emissions and, possibly, improved employee morale. Moreover, a more modern and reliable fleet results in a reduced fleet size since fewer spares will be necessary. Within our report we will provide our analysis and recommendations.

Currently, 165 of 425 fleet units meet or exceed the City's average replacement age. Looking at the past 12 years, as shown in *Table 1- Fleet Replacements Since 2010* (below), since 2010 only 61% of light-duty, and 29% of medium- and heavy-duty trucks have been replaced.

Table 1-Fleet Replacements Since 2010



As shown in the *Table 1* (*above*), at this time, 39% of light-duty vehicles and 71% of medium- and heavy-duty trucks remain in active duty despite being past their optimal economic lifecycles (for details please see *Section 6: Lifecycle Analysis*). These units are escalating the City's fleet operating expenses due to their advanced age.

Business Case Optimization

We calculated that the estimated replacement cost of all 165 units that are due/past-due for replacement is almost $8.1m. We assume spending this large amount of capital is out of the question for the City.

To reduce the $8.1m capital required for vehicle replacements, in FAR we attempted to balance long-term capital vehicle replacement budgets. For data-modelling purposes our team's approach was to defer replacement of vehicles until full value would be received from each unit.

Once optimized economic lifecycles were modelled and input into the FAR software, it was apparent that, if replaced, some vehicles would deliver better return-on-investment (ROI) than others. In our data-modeling, and without knowledge of the physical condition of units due for replacement, our analysts deferred units showing low/no ROI to balance the annual budgets in the long-term. This step was intended to demonstrate our approach to balancing long-term budgets using optimized economic lifecycles and ROI. In practice, all fleet managers must make similar decisions each year based on vehicle condition assessments and other available information[8], such as maintenance history, as does City of North Battleford's fleet management.

Assuming that spending $8.1m in capital funds for vehicle replacements would be unacceptable to the City, in FAR 3x data model we selectively and strategically made vehicle replacement deferrals based on ROI. We simulated deferment of many vehicle replacements to future budget years to maximize operating expense (Opex) benefits and balance long-term capital expenses (Capex). Despite deferring replacement of 101 of 165 fleet units that now meet or exceed average replacement ages, the capital required in 2022 would be ~$3.8m - far less than the original estimate of $8.1m, but still a significant amount of capital.

By deferring replacement of 101 units to later years, (as described in the previous paragraph), we estimated that ~$3.8m would be required for fleet replacements in the next budget cycle. When we balanced that amount with the capital that would be required in each of the ensuing 14 years of a long-term plan, the projected *average* annual capital budget over a 15-year horizon would be $1.6 million/year.

[8] Canada's long-term inflation rate forecast based on: https://www.bankofcanada.ca/2022/07/mpr-2022-07-13/

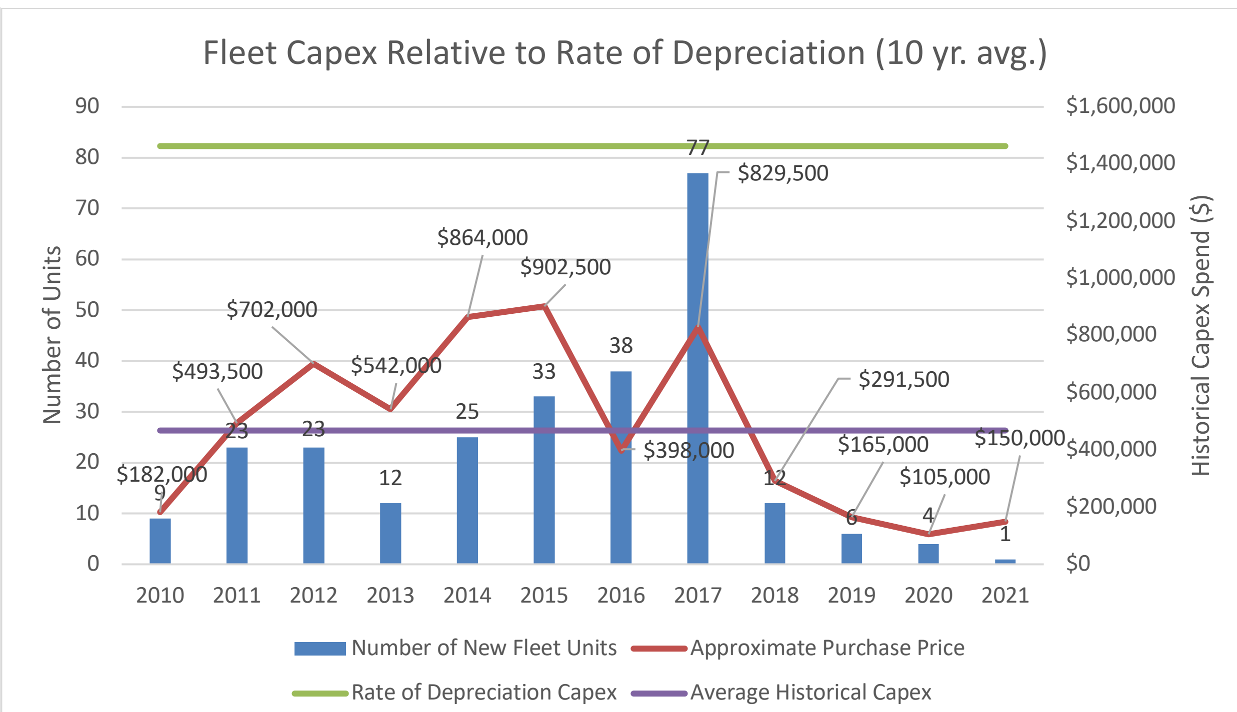
Replacing Fleet Units at the Rate of Depreciation

Our rule-of-thumb for sustainable fleet capital budget planning is to align capital budget spending with the rate of depreciation – in effect, this approach means funding vehicle replacements at the rate they are wearing out. For example, in rough numbers, given that the City's fleet replacement value is close to $15m, and if the average lifecycle was 10 years, then $1.5m would be required each year (e.g., $15m / 10 years = $1.5m/year.) Instead, looking at the past, by our estimates, on average *less than $500k* has been applied each year to the City's fleet replacements since 2010. This short funding has resulted in a fleet which is aged beyond optimal economic lifecycles.

We studied the City's historical trends starting in 2010 as far as fleet vehicle capital spending. We determined that, historically, the average capital spending for the City's fleet replacements since 2010 was an estimated $468k per year. Following the guideline of replacing units at the rate of depreciation (as described in the preceding paragraph), since 2010 vehicle fleet replacements have been short funded by $1.03m on average each year ($1.5m/yr. minus $468k = $1.03m).

Please refer to *Table 2* (below) that depicts the historical trend. As shown, since 2010 the average Capex spend was estimated to be $468k; in some years the capital spending greatly exceeded average (see 2017) and other years spending was less (see 2010, and from 2018 to present).

Table 2 – Historical Trend



Opex versus Capex

Generally, as vehicles age, they become more costly to maintain and operate. In almost all cases, reduced capital expenditures (Capex) in vehicle replacements increases operating expenses (Opex). We completed data-modelling to simulate the impacts that would result if the average rate of Capex spending since 2010 of $468k continued in 2022. Based on Canada's current rate of inflation, we estimate that the fleet's controllable annualized *Opex will increase by $134,021*.

Purchase vs. Lease vs. Rent Analysis

As we describe in *Section 8: Purchasing vs. Leasing vs. Renting Analysis* of this report, data modelling results showed that the option of purchasing would provide the lowest total cost of ownership (TCO). However, with that stated, several key business assumptions for the leasing and rental options are unknown, and these could influence the outcomes.

We determined that leasing vehicles costs more than purchasing. However, although it brings an operating expense increase, leasing may be an alternative that the City wishes to explore in order to reduce the fleet's average fleet without major capital investment. In doing so, uptime would increase through fleet modernization. Also, in some high mileage applications, the option of renting units can bring more cost certainty and control since the rental agency is obliged to provide new, fresh vehicles. Therefore, leasing and renting may be *temporary* options to consider at this time to modernize the fleet.

Electric Vehicles

Globally, numerous jurisdictions have already legislated the end of the internal combustion engine (ICE) vehicles – some as soon as 2030. On January 28, 2021, General Motors pledged to cease building gasoline and diesel cars, vans, and SUVs by 2035. And more recently, on June 29, 2021, the Canadian government announced a mandatory target for all new light-duty cars and passenger trucks sales to be zero-emission by 2035, accelerating Canada's previous goal of 100 percent sales by 2040.

Electric vehicles (EVs) have zero tailpipe emissions. EVs have a fraction of the moving parts of an ICE vehicle, cost far less to maintain, offer better performance, and can have a much lower total cost of ownership (TCO) in the right applications. It is no longer a question of *"if"* EVS are coming; it is now a matter of *"when"* they will be available.

Today, only light-duty (cars, SUVs), transit buses, and a handful of medium- and heavy-duty (MHD) truck EV models are available. However, by the mid 2020s the types of vehicles that comprise a major portion of the City of North Battleford fleet, including pickup trucks, will be available as EVs.

Therefore, the time is now to begin preparing for the transition to EVs by investing in electric vehicle supply equipment (EVSE) (chargers) while awaiting suitable EVs to become readily available.

Over the next 10-15 years, we recommend allocating capital towards charging infrastructure required for the transition to EVs for all vehicle categories, with a focus on lighter-duty units in the short-term. Much of the additional capital costs associated with electric vehicle supply equipment (EVSE) will be offset through lower operating costs (e.g., fuel and maintenance savings).

Recommendations

The recommendations we provide herein are based on analysis of the City of North Battleford fleet's historical data to forecast long-term impacts (the "past predicts the future"). They are pragmatic and fiscally prudent, based on research, data-driven analysis, and sound economic principles and practices.

Summary of Key Recommendations

In *Table 3* (below), we summarize our recommendations for City of North Battleford's Equipment and Vehicle Optimization study. Recommendations include: (1) opportunities for improvement of the City's current management practices; (2) considerations for purchasing vs. leasing vs. renting fleet assets; (3) potential green fleet solutions; (4) approaches for the transition to battery-electric vehicles (BEVs); and (5) considerations for electric vehicle supply equipment (EVSE), better known as charging infrastructure.

Table 3: Summary of recommendations for City of North Battleford's Equipment and Vehicle Optimization study

Best Management Practices – Asset Management

- Invest in fleet modernization. Base vehicle replacement decisions on lifecycle analysis (LCA) by adopting the LCAs developed by our team to serve as a guideline – the first pass at vehicle replacements for each year of the 10-year capital budget plan. Using the LCAs developed by Fleet Challenge, then compare the recommended replacement ages to vehicle condition assessments (see Appendix A).

- Consider leasing vehicles as a temporary solution to the problem of advanced fleet age. Leasing vehicles will result in increased operating costs but reduce the great amount of capital now required to bring the average age of the fleet to a reasonable level due to many years of short funding the fleet.

- Downsize the fleet. Identify and decommission chronically under-utilized units to reduce the number of fleet vehicles (downsizing). This should be a top-down directive.

- When the average age of the fleet is eventually reduced, and availability (uptime) is eventually increased to a satisfactory level, plan for a Capex spend at the rate of depreciation in all future years.

- Invest in data. Fleet management needs information and data to be successful and manage costs. Therefore, the City should Invest in a dedicated, best-of-breed, purpose-designed fleet management information system (FMIS).

- In the FMIS, verify that Vehicle Maintenance and Repair Standard (VMRS) codes are used to benchmark vehicle costs accurately with other peer fleets, identify trends, enable exception management, and reduce costs.

- Develop interfaces in the new FMIS with the fuel dispensing system and corporate systems such as purchasing/procurement, and human resources systems.

- In the FMIS, employ industry-standard categorization protocol for all vehicles (i.e., Class 1-8). These classes can be identified through Vehicle Identification Number (VIN) decoding, and they are essential to enable peer benchmarking. Vehicle charge rates should also be based on vehicle classes.

- Track acquisition costs in the FMIS and configure the software to calculate the current book values of all units.

- Post kms-travelled by each unit to the operating costs for each unit in the FMIS.
- Use FCC's lifecycle analysis (LCA) software provided to City of North Battleford at the conclusion of the fleet review project in future years, when LCA data should be revisited.

Best Management Practices – Fleet Maintenance

- Employ a progressive system of minor and major PM inspections (e.g., A and B, etc.).
- We recommend that as "living documents," PM worksheets should continue to be reviewed and updated regularly (as they are now) and suggest revisions should be visibly identified by displaying the date on each PM worksheet each time they are amended.
- We recommend PM worksheets to be electronic, as is the case in most contemporary fleet management information systems (FMIS') today. Technicians can enter their remarks regarding the work they completed, plus the vehicle's mileage on a shopfloor PC or a tablet.
- Continue the best management practice of determining optimal timing for oil changes through engine oil sampling and lab testing. Changing oil prematurely is wasteful and costly; extending oil drain intervals too long can cause expensive damage to equipment.
- Monitor downtime and its associated costs for all vehicles in the FMIS.
- A robust FMIS is essential for precise PM scheduling.
- Consider tracking the ratio of PM: reactive repairs as a way of determining the optimum frequency/intensity of PM activities. If reactive repair costs and downtime are trending upwards, increase the focus on PM.

Garage Bay Capacity

- In the FMIS, track the unproductive time spent by Fleet Maintenance Technician waiting for garage bays to become available. As unproductive time increases it will flag the need for improvements to the fleet maintenance facilities, as far as additional garage bay space.

Best Management Practices – Vehicle Specifications

- When tendering for new vehicles, consider a total cost of ownership (TCO) approach to optimize the use of capital. Instead of the lowest-compliant bid approach, procurement should consider allowing TCO in its competitive bidding proposal structures.
- When tendering for new vehicles, consider each make/model's rated fuel consumption and GHG emissions (directly related to fuel economy) as essential parts of the TCO. The preference should be for more fuel-efficient and lower emission vehicles.
- Consider fleet vehicle standardization; limiting the number of brands is known to reduce costs and challenges relating to preventive maintenance (PM) and repairs.
- Ensure the size of vehicles needed is based on their use case when going to tender for a specific unit; specifications should be aligned with vocational and load requirements. When appropriate, select a smaller vehicle sized appropriately for the task at hand.
- On a case-by-case basis, consider the cost-benefit of re-building and re-mounting truck bodies and ancillary equipment that are in good condition at the time when truck chassis are due for replacement.

Best Management Practices – Finance

- Create a reserve fund for the fleet. Fund the fleet Capex reserve with fully bundled lease rate charge out rates for vehicles and equipment.
- The vehicle and equipment chargeback system should include all City of North Battleford user groups/ departments directly assigned units.
- Form a fleet pool for any vehicles that cannot be assigned to user groups. Hourly/daily/weekly usage rates, adequate to offset all operating costs of each spare unit, should be calculated for fleet pool vehicles and posted to users who ‘borrow’ them from the Fleet Dept.
- Capture vehicle costs in a dedicated fleet management information system (FMIS) once the software is fully integrated into Fleet.
- Post all costs in the FMIS to each unit. Vehicle and equipment charge-out rates can then be calculated based on this information.

- Include inflationary increases in each year of the unit(s) lifecycles for the reserve fund to be adequate for vehicle replacements.
- Consider Service Level Agreements (SLAs) for all vehicle user departments.
- Consider transferring the direct cost of fuel used by each assigned vehicle, plus at-fault accidents and negligent damages costs, as pass-through costs to user departments with directly assigned vehicles.
- Funds recovered from the sale of end-of-lifecycle surplus fleet units should flow back into the Fleet vehicle reserve fund.

Best Management Practices – Fleet Management Information Systems

- Invest in a purpose-designed, “best of breed" dedicated, fleet management information system (FMIS).
- Develop interfaces between the FMIS to any other systems in use such as fuel dispensing, accounting, and human resource systems.
- Expand GPS based telematics (Nero) to all units.
- Consider real-time connection of the telematics/GPS (Nero) system which may offer increased worker safety and better visibility into fleet’s operations.
- We recommend that City of North Battleford should seek advice from its legal counsel regarding the issue of electronic logging devices (ELDs), driver’s daily vehicle inspections, hours of service and the use of electronic logging devices.
- Whether using ELDs, or paper-based systems, ensure that driver’s daily circle checks are in place, that evidence of the fleet mechanics follow ups and corrections are in place if/when defects are reported by drivers, and documentation is maintained in the event of a safety audit.

Best Management Practices – Human Resources

- Consider an apprenticeship for the Fleet Maintenance person now employed by the Fleet and Maintenance Department.
- Leverage the FMIS to monitor Fleet Technician job times, and delays caused by insufficient personnel, or an inadequate number of garage bays to maintain the fleet.
- We recommend that fleet staff be encouraged to get involved with industry associations, attend informative and educational events and trade shows (post-Covid).
- Consider electric vehicle training for Fleet Maintenance Technicians when such courses and upgrades become more readily available.
- City of North Battleford's SGI rating should be reviewed annually at a minimum.
- Review driver abstracts annually at a minimum or, better, quarterly.
- Consider engaging a driver trainer for regular driver/operator training, whether in-house or from an external service provider.
- Segment collision data into vehicle categories (light-duty vehicles, medium and heavy trucks). Study the trends to determine the drivers requiring more focused training.
- Consider posting costs for at-fault vehicle collisions or negligent damages to user departments whose drivers were responsible, thereby potentially incenting departmental managers to take part in and support remedial actions for their drivers.
- Consider requiring Professional Driver Improvement Course (PDIC) training for all vehicle and equipment operators as part of their onboarding.
- Consider including fuel-efficient driver eco-training to add to driver safety training.
- Enforce the anti-idling policy and monitor vehicles that idle unnecessarily.

- Consider an incentive program that recognizes drivers who idle their vehicles the least or whose units have the best fuel economy.

Best Management Practices – Fuel Management

- Consider fuel hedging strategies or financial hedging of the fleet's fuel budget.
- Review fuel purchasing co-operative options that leverage the combined fuel volumes of the lower tiers and/or neighboring communities.
- Fuel usage must be reconciled routinely and regularly. This means reconciling the fuel bulk purchases versus the amount of fuel dispensed to fleet vehicles and the amount remaining on hand (in storage).
- In the FMIS, track the fleet's CAFE regularly as a key performance indicator (KPI) aimed at reducing fuel usage.
- By means of the FMIS, monitor the higher-than-average fuel users – which are the fleet exceptions – and take corrective actions.

Long-Term Capital Planning

- Consider adopting FCC's lifecycle analysis (LCA) approach to extract maximum value from each vehicle in conjunction with the weighted point system currently in place.
- When the fleet's average age and uptime rates are determined to be at acceptable levels, consider re-investing in the fleet at the rate of depreciation.

Purchasing vs. Leasing vs. Renting

- If City of North Battleford is considering leasing as an alternative to purchasing or renting, management should first issue an RFP or RFQ to determine these costs with absolute clarity. Then, with certainty around these assumptions, lease versus buy DCF analysis should be recalculated.

- Carefully prepare bid specifications for a vehicle leasing RFP/Q so that all cradle-to-grave leasing costs, including all service charges and extra fees, can be identified, and evaluated.

- In RFP/Qs, consider adding a requirement for potential lease vendors to state their beginning-to-end, total-cost-of-leasing projections, including all fees and surcharges over the entire lease term in their proposals.

- To ensure consistent bid responses in RFP/Qs, employ a standard response format, such as a fillable .pdf template, for bidders to list their charges, rates, additional fees, and surcharges in the same way so competing bidders' responses will be comparable.

- Require vendor proposals to include their proposed fixed or floating interest rate and their proposed percentage of profit "adder" (markup).

- Require vendors to guarantee that all applicable service charges and other fees that may be applied over the leased vehicle's entire lifecycle have been stated.

Green Fleet Strategy – Best Management Practices

- As a first step to reducing fuel consumption and GHG emissions, implement fleet-wide driver eco-training and anti-idling policy/technologies, as these solutions were shown to have the greatest fuel- and GHG-reduction potential and the lowest impact on Opex of all “house-in-order” fuel-reduction solutions, if fully implemented.

Green Fleet Strategy – Biodiesel

- As an interim GHG-reduction solution, while awaiting the availability suitable electric vehicles, consider using B5 biodiesel in winter and B20 in the summer and shoulder months (B10 annualized) for diesel vehicles and, if appropriate, equipment units.

- Consider a pilot project with several units switched to higher-blend biodiesel (B20); if successful, switch other appropriate units – particularly those with several years of useful life remaining (i.e., ones that will not be replaced with a BEV in the short- to mid-term).

Green Fleet Strategy – Plug-in Hybrid-Electric Vehicles

- Consider purchasing plug-in hybrid vehicles (PHEVs) for lower-mileage units which would be able to fulfil daily duties on battery-power only and recharge overnight – essentially functioning like pure battery-electric vehicles.
- As battery-electric vehicle (BEV) options increase – with light-duty trucks (pickups) on the horizon and the market availability of medium- and heavy-duty trucks forecasted by the mid-2020s – we recommend that City of North Battleford focus on allocating more capital towards BEVs than HEVs or PHEVs, except for high-usage applications that may currently and in the near-term require hybrids due to range limitations.

Green Fleet Strategy – Battery-Electric Vehicles

- Given the advanced age of the fleet, if possible, extend internal combustion engine (ICE) vehicle lifecycles until electric vehicle replacements become available. For units due for replacement that are still in good condition, conduct a temporary pause on purchasing new internal combustion engine (ICE) vehicles while awaiting battery-electric vehicle (BEV) versions to become available and considering longer procurement timelines. The exception is for light-duty (LD) passenger BEVs which are currently available with sufficient range, such as the Kia Soul and the Chevrolet Bolt.
- Through a lens of achieving deep GHG emissions reductions, allocate the majority of fleet capital spending on BEVs for appropriate vehicle categories as BEV models become available.
- Strictly through a lens of fiscal planning, prioritize replacement of ICE units with EVs only if they would deliver ROI – typically ones that have relatively high annual mileage and less demanding duty cycles.
- Conduct a pilot project for several BEVs when they become available (e.g., pickups) to track range capabilities and cost savings and assess the units' performance for all seasons and varying weather conditions. If the pilot project is successful, acquire BEVs in bulk to replace units that would provide the greatest ROI.
- Monitor the acquisition costs for BEVs and re-evaluate the business case (cost-benefit) for individual units as prices change/ come down.

Green Fleet Strategy – Change Management Approaches

- Develop EV educational and outreach materials for employees and operators summarizing the reasons and benefits of transitioning to BEVs, in terms of the environment (improved air quality and greatly reduced lifecycle GHG emissions), reduced fuel and maintenance expenses (the business case), improved performance (e.g., instant torque, little noise, regenerative braking), greater reliability due to fewer moving parts than internal combustion engine (ICE) vehicles, and continuously expanding charging infrastructure.
- Since operator feedback and employee engagement are essential, invite frontline employees to take BEV test drives to familiarize them with fully electric vehicles and charging, as well as to give them first-hand experience of improved performance (e.g., instant torque, little noise, regenerative breaking).
- Provide operators with a BEV orientation before releasing new models into the fleet to enable to become familiar with the different driving experience (e.g., instant torque, little noise, regenerative breaking) and charging, as well as to alleviate/eliminate any apprehension or uncertainties such as range anxiety.
- As is recommended for the phasing in of BEVs, we recommend a pilot project for several BEVs as they become available (e.g., pickups) to track range capabilities and cost savings and assess the units' performance for all seasons (one year) in varying weather conditions.

Electric Vehicle Supply Equipment Planning

- We recommend that City of North Battleford should begin addressing charging infrastructure requirements soon to meet the demand in the mid-to-long-term.
- Over the next 10-15 years, allocate capital towards charging infrastructure required for the transition to BEVs for all vehicle categories, with a focus on lighter-duty units in the short-term. Much of the additional capital costs associated with electric vehicle supply equipment (EVSE) may be offset through lower operating costs (fuel and maintenance savings), as can be seen in the BEV Transition Plan shown in *Section 9*.

- Ensure that EVSE installation is outpacing the number of new BEVs added to City of North Battleford's fleet to allow for a smooth and seamless transition.

- Identify the vehicles in greatest need of Level 3 charging on a unit-by-unit basis, in conjunction with the charging analysis tool provided by our team.

- Assess existing electrical capacity at facilities to determine whether substantial upgrades for charging multiple vehicles are required, as well as standby generator capacities (outside the scope of this report). A qualified electrical professional should be consulted to assess the situation and make recommendations.

- Explore supplying power on two separate feeds from the grid to reduce the risk of local failure taking power away from the whole site[9].

- To mitigate the risk of power grid failure or local failure at a site, ensure backup generators have sufficient capacity to deal with short power outages, and assess the need for higher-capacity generators for longer outages.

- Monitor upcoming funding opportunities from NRCan's Zero Emission Vehicle Infrastructure Program (ZEVIP), which may offset the capital costs required to install charging infrastructure. This information can be found at https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876.

- Provide high-voltage and EV training for Fleet technicians and closely monitor the launch of new EV training programs.

[9] Source: https://www.plugincanada.ca/electric-bus-faq/

Section 1: Introduction and Background

In September 2021, the City of North Battleford engaged Fleet Challenge Canada Inc. (FCC) of Toronto, Ontario, to develop an Equipment and Vehicle Optimization study for its fleet and equipment assets.

As described in its RFP, the overall goal of the engagement is to improve operations and reduce costs while ensuring the City is providing vehicles and equipment that are suitable to the users' needs, availability when needed and achieve citizens' realistic expectations regarding service, reliability, safety, and environmental responsibility.

About Fleet Challenge

Since 2005, FCC has collaborated with fleet managers, technology providers, subject matter experts, and auto manufacturers to find viable solutions, technologies, and best management practices for reducing operating costs and vehicle emissions. From the beginning, we have remained a self-supporting and independently funded fleet management consulting organization without commercial biases or influences, providing fleet review and consulting services to dozens of leading private and public sector fleets in Canada and the United States.

Through the combination of our experience and the use of our proprietary Fleet Analytics Review™ (FAR) software tool, herein, we are providing an advanced Equipment and Vehicle Optimization study for City of North Battleford with recommendations that are realistic and achievable.

The Environment and the Fleet Sector's Impact

Low-carbon transportation is essential to both short-term GHG and fuel-use reduction and long-term decarbonization of the economy. In 2020, the transportation sector accounted for about 25% of Canada's greenhouse gas (GHG) emissions, second only to the oil and gas sector[10]. Municipalities can play a leading role in cutting emissions by transitioning their fleets to low-carbon and/or electric vehicles, while saving fuel and maintenance costs.

The transition to battery-electric vehicles (BEVs, EVs) of all classes will be a game-changer as these vehicles take up more of the market in the next several years, both in terms of operational cost savings and the deep GHG emission reductions required to curb the most severe impacts of climate change. Significant and growing commitments to integrating EVs into fleet operations will be a driving force in the transition to EVs[11]. Moreover, continued improvements in range capability and charging infrastructure will accelerate the electrification of fleets.

[10] Source: https://climateactiontracker.org/countries/canada/
[11] Source: ChargePoint. Trends & Prediction in Fleet Electrification [pdf]. June 2020.

In preparing this report, our team:

- Reviewed current management practices to identify potential areas of improvement
- Conducted a fleet maintenance technician labour demand-versus-capacity study to calculate how many technicians are required to meet current fleet maintenance demand, and in the future given population growth estimates for the next 10 years
- Completed a garage bay study to determine if the number of service bays is matched with current maintenance demand, as well as evaluate potential future demand with population growth in the next decade
- Developed and distributed a fleet management survey to gauge the current view and opinions of management and unionized employees on various matters including the current level of service and fleet vehicles
- Developed a fleet fuel usage, operating cost, and emissions baseline for current fleet assets, as well as a peer fleet comparison to assess the relative performance of City of North Battleford's fleet
- Undertook a lifecycle analysis (LCA) study to determine optimal economic replacement cycles for select vehicle categories
- Completed discounted cashflow analysis to study the cost impacts of purchasing vs. leasing vs. renting and to assess the total cost of ownership (TCO) for each option.
- Data-modeled many potential solutions over a 15-year budget cycle to estimate their impacts (capital expenses, changes in operating expenses, and reductions in GHG emissions) relative to the baseline
- Data-modelled several possible options to address the fleet's advanced age, and as well, the extreme backlog of vehicles due, or past-due for replacement including downsizing, right-sizing, and leasing
- Data-modeled electric vehicles (EVs) and electric supply equipment (EVSE) requirements on a unit-by-unit basis and estimate charger and charging infrastructure costs
- Prepared recommendations to improve the operational, financial and sustainability performance of the City's fleet

Section 2: Review of Fleet Processes and Practices

In this section of our report, we lay the groundwork for the Equipment and Vehicle Optimization study with our review of City of North Battleford's fleet processes and practices. This step of the fleet review was aided by our signature process we call "Best Management Practices Review™" (BMPR). BMPR is a standard practice that begins every fleet review project we undertake.

About Best Management Practices Review™

Best Management Practices Review™ (described by the acronym "BMPR," or referred to as the "management practices review," the "review") is a Fleet Challenge (FCC) process designed to provide our project team with an inside look at City of North Battleford fleet's operations. BMPR is a critical first step in the fleet review and green fleet plan. The BMPR management practices review is intended to identify opportunities to improve the City fleet's "4 P's" - *practices, policies, programs, and procedures*.

The BMPR process is an efficient way for our team to become familiar with City of North Battleford's fleet. In addition, it helps us understand which staff members are responsible for each area of responsibility.

The review is designed to highlight potential gaps, areas of risk, where attention may be needed, or where changes may be beneficial. Moreover, the BMPR step informs and guides our team's work and recommendations for the City of North Battleford, helping to develop a realistic, practical, and viable roadmap for the City.

This management practices review is based on in-depth discussions with City of North Battleford's management staff in the early stages of the fleet review project. Our conversations with the City's team followed a methodically and carefully prepared script which helped guide the talks and ensure thoroughness. It was centred on the following specific areas of interest, each with its own set of focal points/topics, as below:

2.1 Business Structure
2.2 Asset Management
2.3 Fleet Maintenance
2.4 Vehicle Specifications
2.5 Fleet Finance
2.6 Fleet Management Information Systems
2.7 Human Resources
2.8 Fuel Management
2.9 Green Fleet and Garage Planning

In each of the following sub-sections, from our discussions with City of North Battleford's management staff, we provide an overview of key learnings and observations; these appear in bulleted points in each area.

Aligned with each topic being reviewed in each sub-section *(2.1 though to 2.9)* of our review, we will describe the best management practices of the country’s leading fleets, discuss the features and benefits of each management practice we propose, and describe opportunities for improvement along with providing tips, guides, and helpful advice on implementation. From our review of fleet management business practices and procedures at the City, we provide detailed recommendations for management's consideration.

2.1 Business Structure

To begin the management practice review session, we became familiar with the business structure regarding fleet management at City of North Battleford through staff discussions.

Overview

From our discussions with City of North Battleford management, and from its RFP document key learnings included:

- The City directly oversees the fleet services for the North Battleford Fire Department, Community Safety Officers, Roadways, Airport Services, Water Treatment and Distribution, Wastewater Treatment and the Parks and Recreation departments.

- The City owns the buses used in the transit system. Departments across the City own and operate vehicles in support of their work with some sharing occurring across the departments.

- The Fleet and Maintenance Department provides maintenance support for many, but not all departments.

Best Management Practices

Business Structure

The Fleet and Maintenance Department has a reporting structure typical of most municipalities and private sector organizations. Management personnel includes:

- A Fleet and Maintenance Manager
- An Equipment Supervisor

Unionized personnel include:

- Two licenced journeymen Mechanics
- One unlicensed Fleet Maintenance person

The Fleet section also has a part-time administrative support person who assists the Fleet Equipment Supervisor with data input.

Within the fleet team, there are clearly defined lines of responsibility, beginning with the shopfloor fleet mechanics and maintenance person. Upward reporting is hierarchically and logically stratified and includes a Fleet Equipment Supervisor and the Fleet and Maintenance Manager.

Potential Issues

From our surveys of Fleet staff, we heard the following comments:

Comment1: "*More technicians [are needed] to repair more equipment internally rather than hiring 3rd party companies that offer subpar repair service and a high shop rate. In house repairs allow best quality and potential modifications to address the root cause of failure.*"

Comment 2: "*I feel that we have great techs with a fantastic level of standard[s], but where we are very lacking is in the manpower to do the job. Since I started, we have increased the frequency of preventative maintenance, but it's nowhere near enough. We lack people.*"

Recommendations

A full assessment of City of North Battleford's human resources and management structure is out of scope for our fleet review. However, based on our corporate experience and the evaluation of a member of our team who is a human resources generalist, collectively, we agree that the current management structure would ensure accountability and good governance. In addition, there are clearly defined levels of authority and responsibility. However, we calculated the number of Fleet Maintenance personnel and determined it is insufficient for peak maintenance demand estimates based on current fleet size. Please see *Section 2.7* of this report for further details.

2.2 Asset Management

Asset management has been described as "a systematic process of deploying, operating, maintaining, upgrading, and disposing of assets cost-effectively." Managing assets effectively depends on having ready access to operating data and then making wise asset-management decisions based on, and informed by, that data.

Overview

From our discussions with City of North Battleford's management staff, we learned of City of North Battleford's business processes and procedures for making choices around vehicle replacements.

From our meetings with City fleet management staff, we noted the following:

- Regarding fleet asset information systems, the City uses Nero www.nero.com, which is described by the company as a Global Tracking Vehicle & Asset Tracking Management Solution
- Regarding vehicle and equipment asset replacement planning, a long-term (10-year) capital budget planning is in place.
- When a new unit(s) is being acquired, a specification is prepared by the Fleet Equipment Supervisor and a competitive bid process is initiated in https://www.sasktenders.ca
- When bids for new unit(s) are received, they are evaluated using a weighted scoring system.
- Once bid evaluations are completed, a purchase recommendation is made – if over $100k the award recommendation must be approved by Council.
- There are no formal vehicle replacement lifecycles in place or a formal vehicle replacement policy. Replacement decisions are made one-by-one when the cost of repairs to an existing unit(s) become excessive.
- When a user department wishes to add another vehicle to their department, fleet management has established a process: a vehicle request form is completed and submitted by the requestor. With the request, given that capital for vehicle purchases has been minimal in the past, fleet management's practice has been to attempt to find a suitable unit from within the existing fleet.
- Fleet management seeks the input of user group representatives in the new vehicle procurement processes. Although there is no Fleet committee, management includes

feedback on vehicle selection from drivers and arranges demos that include the vehicle operators to attain their feedback. They also involve the supervisors in the process of looking at new models and getting demos.

- There is no reserve fund in place specifically for vehicle or equipment replacements.

Best Management Practices

Lifecycle Analysis

Lifecycle analysis (LCA) is a process completed by data-modelling historical repair, maintenance, fuel, and capital costs over a vehicle's lifecycle. LCA is based on actual historical data, and we believe it is essential for staff to determine the optimal economic replacement ages for all vehicle types/categories through LCA.

Fleet Challenge completed a lifecycle analysis study for City of North Battleford as part of our fleet review project. In doing so, we calculated the optimal economic lifecycles for replacing vehicles based on LCA. A complete description and recommendations regarding lifecycle analysis and optimal economic lifecycle is in *Section 6 of* this report.

Limitations of LCA

Although LCA is a robust capital budgeting aid, it should not serve as the only vehicle replacement criteria. LCA is based on average vehicle-type/category costs, and for this reason, it is not a "one size fits all" solution. Although some vehicles may be the same year, make, and model, each unit is unique. Some may be in better (or worse) condition than others. To balance annual capital budgets and derive maximum value from each fleet asset, vehicles in better condition may remain in service longer than those in worse condition.

Each year, the best choices for vehicle and equipment replacement should begin with a capital budget "shortlist" using LCA data-driven guidelines as the starting point (as provided by FCC in this study – see *Section 6*). Following that step, unit-by-unit condition assessments should be considered for all units on the shortlist of assets that have reached the end of their lifecycles.

Condition assessments should be based on a weighted points system (see example in *Appendix A*). When optimized LCAs are combined with condition assessments, vehicle replacement prioritization decisions will be made logically and strategically. In this way, maximum value will be received for each unit. This approach will reduce operating costs and ensure maximum fleet uptime/reliability.

Refreshing the LCA Models

LCA models should be refreshed from time to time as more data becomes available in the fleet management information system (FMIS). For this purpose, FCC's lifecycle analysis software will be provided (at no cost) to City of North Battleford at the conclusion of the fleet review project for use in future years when LCA data should be revisited. Instructions on its use will be provided.

Managing Growth of the Fleet

Unless policies and procedures are in place to manage the growth of the fleet, it may grow in numbers in an unrestrained way. Therefore, when new, additional vehicles or equipment units are being considered to add to the fleet, it is essential to ensure that cost comparisons have been made to alternative options, rather than adding another City-owned vehicle (or equipment) to the fleet. For units with limited time of use, a cost-benefit analysis that looks at the total cost of ownership (TCO) may reveal that it is less expensive to engage a local contractor to do the work than to own and manage an additional vehicle or equipment unit.

User groups or department managers seeking to increase their assigned vehicle count should be required to submit their rationale with business cases that are supported and endorsed at the highest level of their section (e.g., Director level), the CAO/COO/CFO and Council. The business case should confirm the need for the additional vehicle(s)l, the financial rationale, and all options that have been explored.

Managing Fleet Utilization

If a vehicle or piece of equipment is not utilized fully, operating costs will accrue while little or no value is received from the asset for the municipality. Under-utilized vehicles may seem to be costing very little to own when in reality, they may be stranded assets and a drain on the operating budget.

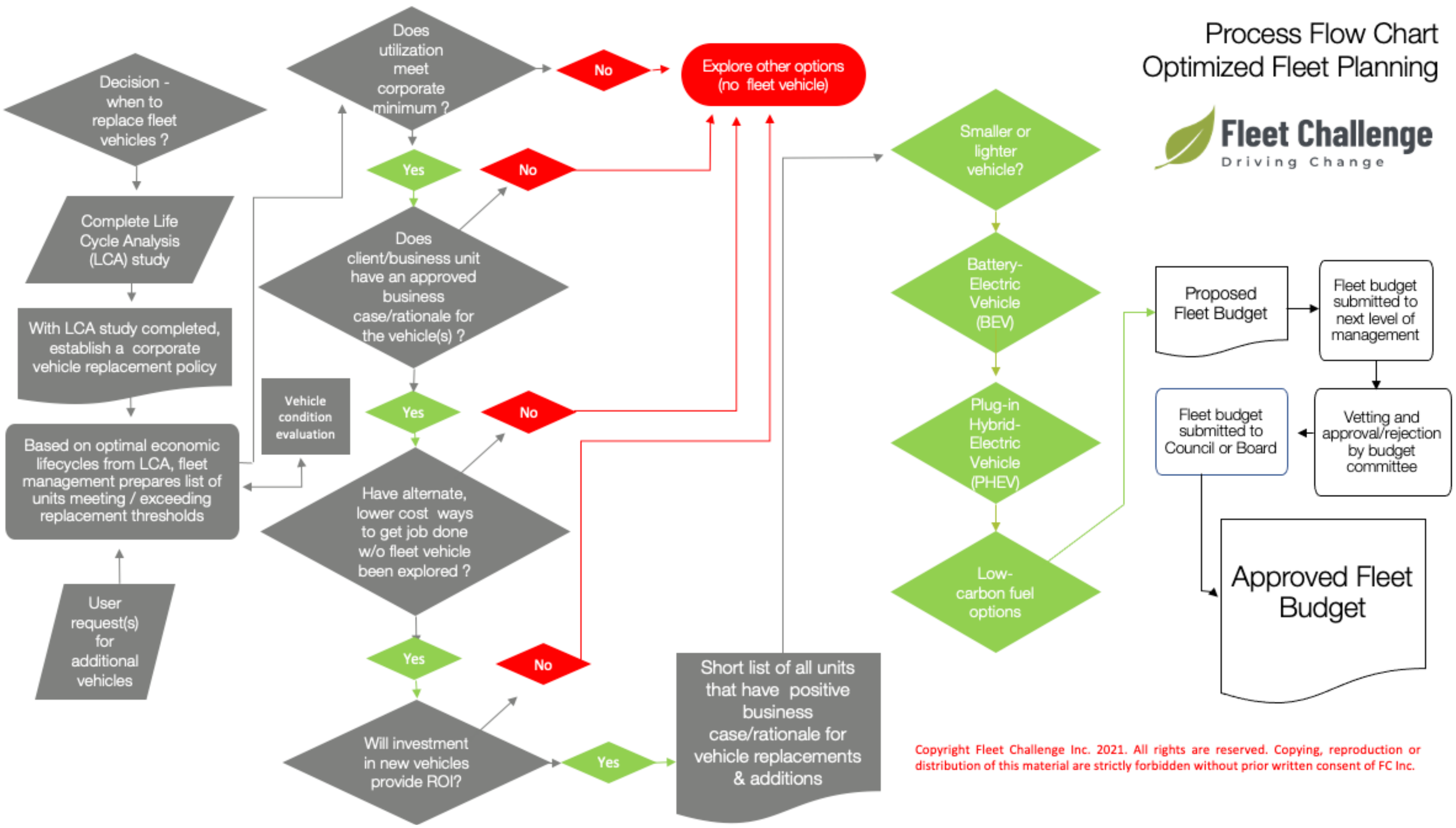
Whether used or not, all vehicles require maintenance, insurance, licensing, and a space to park – all of which have costs. Therefore, it is essential to track the utilization of all units regularly. The ability to monitoring utilization and maintenance costs in a robust fleet management information system (FMIS) is essential to success in this regard.

Fleet Asset Management Practices Flowchart

Fleet asset management best practices recommended by FCC are illustrated in a process flow chart (*Figure 1*, overleaf). This chart outlines a step-by-step guide for determining the optimal time to replace a fleet vehicle, as well as the most effective unit replacement type. Following these processes will result in a fleet that is right sized, cost-efficient and ‘green.’

We recommend that the business processes shown in *Figure 1* should be adopted as a standard operating practice (SOP) at City of North Battleford.

Figure 1: Process Flow Chart for Optimized Fleet Planning



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Recommendations

Vehicle Replacement Planning

Vehicle and equipment replacement decisions should be a two-step process, as follows:

1) In *Step 1*, a replacement 'shortlist' should be prepared using lifecycle analysis (LCA) via the lifecycles recommended by FCC. This will serve as a guideline – the first pass at vehicle replacements for each year of a 10-year capital budget plan. Please see *Section 6* of this report for more details on LCA.

2) In *Step 2,* the LCA shortlist should be compared to unit-by-unit vehicle condition assessments based on a weighted condition rating system (see *Appendix A*). Units in poor condition should be prioritized for replacement and the lifecycles of those in better shape may be extended.

Fleet Size

The City's current fleet size may be excessive in terms of vehicles based on the utilization comparisons and statistics we described previously in this report, which we see as 'red flags'. Our recommendation, therefore, is to Identify and decommission chronically under-utilized units to reduce the overall number of fleet vehicles (downsizing).

- Downsizing the City's fleet should be a "top-down" driven corporate directive, at the direction of the highest level of City management. A downsizing directive by Fleet management may create an adversarial relationship between user group managers and fleet management which is counter-productive and should be avoided.

- User group department managers should be required by senior-most management to conduct a review of their assigned units and either: (a) surrender those that are superfluous or under-utilized, or (b) provide business case-based rationale for keeping the under-used unit(s) in the fleet.

Fleet Management Information Systems

- Improvements are needed regarding the City's fleet management information systems (FMIS'). The current methods are inadequate as far as analytical capabilities or for providing management reports. Current methods are onerous to maintain and provide little information on which to base fleet management decisions.

- To improve the current practices, Fleet should start with an FMIS needs-analysis review. From the review, compare defined needs with the fleet management functionalities of the Nero system to determine if it can provide the full suite of functionalities required for modern fleet management. Our review of Nero tells us it's only a partial solution; much more functionality is required to manage the fleet. Please see *Section 2.6 – Fleet Management Information Systems* for more details.

- Verify that Vehicle Maintenance and Repair Standard (VMRS) codes are enabled in the FMIS used by Fleet management. Using VMRS will enable benchmark vehicle costs accurately with other peer fleets, identify trends, enable exception management, and reduce costs. For more information about VMRS, please see *Section 2.6 – Fleet Management Information Systems.*

- Based on the findings of the above points, consider investing in a dedicated, best-of-breed, purpose-designed fleet management information system (FMIS). Many excellent FMIS solutions are available.

- In the FMIS, employ industry-standard categorization protocol for all vehicles (i.e., Class 1-8). These classes can be identified through Vehicle Identification Number (VIN) decoding, and they are essential to enable peer benchmarking. Vehicle charge rates should also be based on vehicle classes. For more details, please see *Section 2.5 – Finance*.

- Ensure the kilometers-travelled by each unit are tracked regularly via the fuel dispensing system entries made by drivers, fleet maintenance work orders, or via Nero/telematics, etc., and uploaded to the FMIS. In addition, kms-travelled by each unit should be posted to the operating costs for each unit in the FMIS. Doing so enables cost-exception reporting and benchmarking relative to vehicle usage, a management practice that will help rationalize and reign in operating expenses.

Total Cost of Ownership Approach

Cost-effective fleet asset management requires cradle-to-grave cost-optimization of assets. For example, buying new vehicles for the best (lowest) possible price and disposing of units at the right time and for the right price minimizes the total cost of ownership (TCO). Therefore, it is essential for management to know asset values at any time in each fleet vehicle's planned lifecycles. As so, we recommend that acquisition costs are tracked in an FMIS, and the program is configured to calculate the current book values of all units. Knowing the current book value of assets during their lifecycles will help determine optimal replacement cycles for different vehicle classes and help to better manage the total cost of ownership (TCO) over each unit's lifecycle. *We re-iterate the importance of having a proper and robust Fleet Management Information System (FMIS*).

2.3 Fleet Maintenance

A prime indicator of fleet management success is a high level of vehicle uptime. In fleet management, there are just two ways managers can maximize uptime:

(1) Acquire newer, "younger" vehicles, or
(2) Increase preventive maintenance (PM) inspections, in terms of frequency and intensity

If funds are not available for purchasing newer vehicles, then Fleet management must ramp up PM activities; otherwise, availability and reliability will drop while operating costs increase. Also, safety may be affected as vehicles age, despite good PM programs.

Overview

We learned about City of North Battleford's fleet garage operations and preventive maintenance practices from our discussions with staff. Their comments are noted below.

- In general, fleet maintenance is completed in-house. There is also outsourcing as required.
- Fleet maintenance is performed during day shifts on weekdays.
- Regarding preventive maintenance (PM) intervals now in place, heavy equipment is maintained at 250 engine hour intervals (e.g., trucks, loaders, graders.)
- Fleet management feels 100-hour PM intervals would be better.
- Maintenance intervals and scheduling was based on fluid (oil) sampling.
- Maintenance scheduling is managed through the Nero system and a calendar app.
- PM worksheets are used to guide the mechanic's PM inspections.

Best Management Practices

Through preventive maintenance vehicles are inspected, repaired, and maintained to prevent defects and failures which could lead to accidents and violations. If preventive maintenance is not performed regularly, vehicle life spans will be reduced.

Some vehicles may be prone to excessive breakdowns requiring expensive repairs causing a vehicle to be out of service when least expected and possibly when needed most. Vehicles may become unsafe due to a lack of PM.

Proper maintenance will help avoid litigation from negligence[12]. Preventive maintenance is as necessary as a driver safety program. If a vehicle becomes unsafe due to lack of maintenance or repair, the fleet manager can be liable for negligent entrustment.

As defined, liability is premised upon providing an employee with a dangerous tool or instrument, such as a vehicle, while knowing or having reason to know that use of the vehicle creates unreasonable risk or harm to others. Simply stated, vehicles must be safe to operate. Should, for example, the brakes fail, causing a severe crash or fatality, authorities may impound the vehicle for investigation.

If the investigation should determine defective brakes or other vehicle malfunctions contributed to the accident, authorities can seek a court order to obtain vehicle maintenance records. If the fleet manager fails to produce evidence that they practiced preventive maintenance, under these circumstances, he/she could be prosecuted for negligence.

For these reasons and without exception, all leading fleets employ a progressive system of minor and major PM inspections. PM events are often designated as A, B, C, D, etc. As one moves down the alphabet from A to B and so on, the PM (and completion time required) increases in complexity. The actual maintenance portion of PM is composed of scheduled, standardized inspections and maintenance.

An "A" level PM ("A" is usually a minor PM) generally consists of a safety check and lubrication as well as checks of critical components such as brakes, lights, steering, tire condition and inflation, fuel filter replacements and fluid level checks. It also includes checking and adjusting high-wear components.

A "B" inspection is more complex and includes all aspects of an "A," but is a deeper level of checks that may include a wheels-off brake inspection, battery and alternator testing, transmission and differential servicing, filter changes and breather servicing and fuel filter changes among other procedures determined by the vehicle's manufacturer. A "B" level PM may also include a download of the electronic control module (ECM) and taking action on any trouble codes or problems reported by the ECM (if applicable).

Reactive Repairs vs. Preventive Maintenance

When a vehicle is brought into a garage needing something unexpected or unplanned, it is described as a reactive (i.e., unplanned) repair. Reactive repairs are based on failures, which result in downtime and costs associated with idle equipment.

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[12] Source: www.fleetowner.com

A PM program, on the other hand, brings vehicles in for inspection and maintenance on a schedule and repairs any items that meet or are approaching a fixed cut-off point. Being proactive about PMs means making repairs on a pre-determined schedule, preventing violations and accidents, and keeping the vehicles rolling.

In leading fleets, management uses its fleet management information software (FMIS) system to determine which, and when, vehicles are due for preventive maintenance. Frequency is determined through legal requirements, manufacturer's recommendations, and observation of past vehicle reliability histories relative to preventive maintenance inspection scheduling (i.e., when inspections are not completed frequently enough, or with insufficient thoroughness, failures and breakdowns will occur).

Another PM scheduling consideration is the matter of truck air brake adjustments. Today, MD and HD trucks are equipped with either air disc brakes or drum brakes with automatic slack adjusters. Both types of brakes still need to be inspected, and for the latter type (drums with auto slack adjusters), the brakes still need to be manually adjusted, inspected, lubricated, and serviced from time to time. This is a basic operation in most fleet's "A" and "B" PM routines.

Leading commercial fleets place the highest level of importance on preventive maintenance (PM). Effective PM programs are designed to avoid reactive repairs and resultant downtime. Reactive repairs include vehicle breakdowns and other unexpected failures, which are costly. This is not only because of the costs of unplanned repairs but also due to the cost of spare vehicles or rentals, plus the costs associated with the loss of productivity (such as the driver – or an entire crew – unable to complete his/her/their work that day).

Identifying whether the costs for work performed by mechanics are either PM (planned) or reactive (unplanned) is another easily adaptable, world-class best management practice that we strongly recommend. By separating reactive repair and PM costs, analysis and decision-making can be informed around the effectiveness of PM programs:

- Are the frequency and intensity of PM inspections adequate to reduce downtime?
- Are reactive repairs increasing as vehicle(s) age, and causing increased downtime costs?

PM Scheduling

Most fleets synchronize their "A" and "B" PMs with routine oil changes to avoid multiple trips to the shop and extra downtime. Typically, a minor "A" inspection should be carried out several times per year. For light-duty vehicles, the usual interval for "A" level PM is between 2,500 to 5,000 kilometers, coupled to a time interval not to exceed a pre-determined threshold (such as 30-120 days depending on utilization levels), and between 8,000 and 16,000 kilometers for medium- and heavy-duty vehicles, also coupled with a time-interval (days/weeks/months) threshold.

In some settings, such as utilities, municipalities, and other low mileage applications, km-based PM intervals may take a very long time to occur. Therefore, if kms-traveled are the primary (or only) maintenance trigger, insufficient PM events may be scheduled, and failures (reactive repairs) may result. Time-based (days/weeks/months) parameters for PM would be the better choice of trigger points for low-mileage fleets like municipalities.

Conversely, a potential problem is when time-based intervals are the sole maintenance trigger, some high-usage vehicles may be under-maintained, while for low usage units the interval could be extended. A second, or even third, parameter should be employed. For this reason, some low-mileage fleets opt to base their PM scheduling on engine hours-operated (this is the City of North Battleford’s practice) and on a second time-based parameter (days/weeks/month) since the last PM to prevent units "falling through the cracks."

Maintenance scheduling is an elaborate and exacting science: under-maintaining or over-maintaining vehicles can both be very costly. That is why leading fleets employ fleet management information software (FMIS) systems with robust and complex PM scheduling capabilities. For example, if a large fleet of 500 trucks conducts just one premature PM per year per truck at the cost of say $1,000 each, including downtime, the annual cost would be 1/2 million dollars.

Under-maintaining has its own costs, which could include failed engines, breakdowns, or worse. Either of these scenarios is costly – if a vehicle is under-maintained, it can lead to expensive failures and potential safety issues. If a unit is over-maintained, it means that premature and unnecessary costly inspections may be occurring while wasting resources.

Scheduling PMs based on engine hours can make sense for fleets with widely variable usage patterns, but again should be based on dual parameters (such as kms travelled, engine hours operated *and* a time-interval such as days, weeks, or months) to ensure no PM inspections are missed.

We suggest that a solution is to use a minimum of two parameters for PM scheduling. When either of the two parameters are reached, a PM event will be triggered. If the first parameter is missed and the threshold exceeded, the second parameter will become a failsafe. An example is to schedule a vehicle's next PM event when it reaches the first of two parameters. For example, regardless of whether a vehicle travels "x" thousand kilometers or "y" number of months first, a PM event will be triggered in either case. In this way, vehicles will not be over-maintained or under-maintained.

Maintenance Ratio

Maintenance ratio is a performance indicator that informs fleet managers about the ratio between the cost of preventive maintenance (PM) and reactive repairs (i.e., breakdowns). This KPI is used to determine whether PM activities are sufficient to avoid costly and unplanned reactive repairs and breakdowns.

While there is no perfect ratio, FCC has studied this statistic over the past years and concluded that a ratio of .5 (50 cents spent on PM work of every $1.00 spent on reactive repairs) results in the highest levels of vehicle uptime.

If reactive repair costs and vehicle downtime are seen to be increasing, this may be an indicator that PMs need to be completed more frequently or more thoroughly (or both) to reduce the reactive repair rate and increase uptime.

Engine Oil Sampling & Lab Analysis

By tracking downtime and maintenance ratio as described in the previous section, fleet managers can assess the frequency with which specific units need PM inspections and oil changes. The City of North Battleford has completed oil sampling & lab analysis to pinpoint the optimal oil drain intervals and FCC strongly supports this decision. Laboratory oil sampling is inexpensive and confirms precisely when oil and filter replacements should be completed to reduce engine wear and extend life.

Laboratory oil analysis could mean extending the intervals between oil changes, which would save considerable resources and money. With oil sampling completed, the City's fleet maintenance team makes well-informed decisions regarding optimal maintenance intervals.

PM Worksheets

The City of North Battleford employs PM worksheets. Leading fleets employ standardized PM worksheets designed to guide their technicians in completing PM inspections to ensure nothing is missed and provide an audit trail.

A well-designed PM worksheet should be a "living document," which evolves over time and, at minimum, includes vehicle manufacturer recommended inspection tasks. Tasks that are set out on the PM worksheets should include inspection of, and making corrections to, items that have been troublesome in the past.

By carefully reviewing repair histories, trends emerge that may require the need to add additional tasks to PM worksheets. This is the essence and science of preventive maintenance – heading off problems before they happen.

Predictive Maintenance

Once adequate historical data exists in a fleet's management system (FMIS), fleet management can perform database searches and run reports to identify repetitive equipment failures and pinpoint when they are likely to occur. In this way, failures can be predicted with some degree of certainty and repairs executed in advance to head off imminent breakdowns (hence the name "predictive" maintenance).

An example of predictive maintenance might be having the ability to forecast an alternator failure before a costly and disruptive breakdown. Another is replacing a heavy truck's brake linings or pads before costly brake drums or rotors become scored and require replacement.

Downtime

Downtime and its cost impacts should not be ignored or under-estimated. Leading fleets monitor vehicle downtime and their associated cost impacts on a per-unit basis, including direct (e.g., towing, service calls, rental/loaner vehicles), and indirect costs which include the cost of work disruption and loss of productivity for the user department/division, the wages of the driver of the vehicle, and more.

This practice is especially important to measure the effects of PM efforts relative to fleet aging and provides essential information for fleet managers since it directly reflects the effectiveness of fleet management decisions and vehicle age and preventive maintenance activities.

Once a history of downtime and maintenance ratios is available in the FMIS for all vehicles in the fleet over a period, management can then make well-informed decisions about the level of downtime that is acceptable to maintain good service for vehicle user-departments.

By comparing the downtime and maintenance ratio for each vehicle, trends will in time emerge. Historical data will show which types of vehicles are less reliable and costlier. Fleet management is then able to complete causal analysis. In some cases, preventive maintenance may need to be ramped up with more intensive PM inspections or intervals of a higher frequency.

Recommendations

- We recommend that as "living documents," PM worksheets should continue to be reviewed and updated regularly by the Fleet Equipment Supervisor (as they are now) and suggest revisions/updates/versions should be visibly identified by displaying the date on each PM worksheet each time they are amended.

- We recommend PM worksheets to be electronic, as is the case in most contemporary fleet management information systems (FMIS') today. Technicians can enter their remarks and the work they completed, plus the vehicle's mileage on a shopfloor PC or a tablet.
- Continue the current practices of determining optimal timing for oil changes through engine oil sampling and lab testing.
- Monitor downtime and its associated costs for all vehicles in the FMIS.
- A robust FMIS is essential for precise PM scheduling.
- Consider tracking the ratio of PM to reactive repair costs as a way of determining the optimum frequency/intensity of PM activities. If reactive repair costs and downtime are trending upwards, increase the focus on PM, in terms of increased frequency or intensity.

2.3.1 Garage Bay Capacity Study

Fleet Challenge conducted a garage bay study to determine if the number of bays at the fleet garages is matched to current maintenance demand. Like the process we employed to calculate Fleet Maintenance Technician labour demand (Please see *Section 2.7 - Human Resources*), we sought to determine if there was sufficient service bay capacity today. In addition, we calculated for an anticipated increase in fleet size that may be required to meet an increased population in the next ten years.

Approach and Methodology

By calculating the frequency, and the estimated labour hours required for PM inspections, and the number of each type of vehicle in the fleet we calculated total preventive maintenance demand (in terms of person/hours). From this value, knowing from experience and past data that a PM Ratio of .50 delivers a high level of uptime, we calculated reactive repair demand (also in terms of person/hours).

By adding PM and annual SGI mandatory inspections demand to reactive repair demand (PM Ratio of .50) we calculated the total number of fleet maintenance service bays required today, and in ten years.

Garage service bay requirements are driven by four key considerations:

(1) The number of available fleet maintenance technicians

(2) Fleet size - the number of units currently requiring maintenance

(3) The number of maintenance events required annually (i.e., scheduled preventive maintenance, mandatory SGI inspections, and reactive repair events)

(4) Lower and upper estimates of total labour time for technicians to complete each maintenance event

At the most basic level, one service bay is required for each on-duty technician to complete his/her work – a ratio of 1:1. This concept is analogous to other occupations such as a dentist's office where one dental chair is required for each on-duty dental practitioner and his/her patient. As another example, haircutting establishments require one chair for each hairstylist/customer.

The embedded flaw in this logic is that if a 1:1 ratio was used to calculate garage bay demand, it would result in vacant garage bays at many times. A 1:1 ratio (i.e., one person to one workspace) would mean an excessive number of workspaces – and garage service bays would sit empty while staff are off-duty (such as during vacations etc.), and this would mean excessive and superfluous bay capacity.

The 1:1 bay per technician ratio, to an extent, facilitates calculations regarding the total number of bays required. Calculating the total hours of fleet maintenance **demand** and then simply dividing by the number of hours of technician **capacity** results in the number of bays required. However, the calculation is more complex – vacations, statutory holidays, absences due to illness, unpaid leave and other factors diminish each technician's on-duty time and must be considered.

For instance, if technicians were each entitled to three weeks of vacation each year plus nine statutory holidays, it would mean that for each technician, one bay would be idle for 24 workdays - almost five work weeks each year, per person. Multiplying that by three technicians means that, for ~15 weeks, almost 30% of each year, one garage bay would lie dormant. It is our position that, fiscally, this would be wasteful and is a situation that should be avoided.

Garage service bay demand should, therefore, be calculated by total capacity minus annual leave entitlements and all other absences (i.e., vacations and statutory holidays, sick leave, etc.) for all technicians.

Planning for Incidents of Extraordinary Demand

If Fleet Technician *net* productive capacity was the sole determining factor used to calculate the number of bays required, *theoretically* less bays would be required (i.e., reduced technician productive capacity = less bays required). Fewer bays are attractive because it introduces the possibility of reduced capital costs for a larger garage capacity – but it would also introduce a potential risk.

Our risk assessment is that, if an incident of extraordinary demand – such as a disaster, a flood, an extreme weather event or some other catastrophic situation occurred, fleet management would likely take an "all hands-on deck" approach to ensure the fleet is fully available. Management would likely deploy all available skilled technicians to keep the fleet on the road during the incident. Meetings, vacations, training and other non-productive activities would temporarily cease or at least be minimized until the situation stabilizes.

For the reasons described in the preceding paragraph, if garage space was based on the number of work bays required for *net* technician capacity, and if an incident of extraordinary demand occurred, there would be insufficient service bays for the full complement of technicians to carry out emergency repairs and maintenance during the event. Therefore, for our analysis we opted *not* to base total bay calculations on *net* productivity to head off the risk. We more prudently based the analysis on technicians on-duty hours.

Calculating Fleet Maintenance Labour Demand

With Fleet Technician capacity calculated, we tallied total fleet maintenance demand in terms of labour hours. Our analysis included lower and upper (peak) estimates of technician labour required to maintain the fleet to optimal levels of uptime, as we will explain next.

Fleet Maintenance Tasks – Labour Time Variances

The numerous vehicle and equipment categories/types within City of North Battleford's diverse fleet each have varying levels of labour time demand for fleet technicians to complete routine maintenance tasks. Within each category/type, individual vehicles may require less or more labour to complete routine maintenance due to vehicle complexities such as ancillary equipment added to the base vehicle(s). Therefore, there is no one-size-fits-all solution in terms of fleet maintenance job times.
For example, a PM inspection that requires two hours of labour on one vehicle may take four hours to complete on a similar category/type vehicle due to additional complexities or unique vehicle configurations.

Lower and Upper Job Time Estimates

As described earlier in this report, we know that labour *demand* (i.e., the total number of labour hours required to maintain the fleet) translates directly into garage bay. Moreover, specific maintenance functions require varying amounts of labour for completion (as described in the previous paragraph).

Fleet maintenance technicians, like all humans, may perform at different rates. An inexperienced apprentice, for example, may take longer to complete a maintenance function than a fully trained and experienced mechanic. A more elderly technician, or one with a disability, may also perform at a reduced rate. Therefore, we felt that, for optimal accuracy, our labour demand study should include lower and upper estimates. For this reason, we calculated the minimum (low) level of technician labour hours for completion of standard repair and PM tasks, and we calculated upper (high, or peak) estimates for all maintenance activities.

Maintenance Ratio

Our position is that fleet management's primary job is ensuring its vehicle user-group departments receive the highest levels of vehicle uptime possible during prime business hours. To accomplish this, more frequent and/or more intense preventive maintenance (PM) activities would reduce costly work disruptions and loss of productivity due to failed vehicles for employees who are dependent on fleet vehicles for their work. With increased PM effort, higher levels of uptime will be achieved.

Fleet Challenge has tracked and studied the relationship between reactive repairs (i.e., unscheduled repairs, equipment failures) and preventive maintenance (PM) for almost two decades. From our study of this relationship, we know with relative statistical certainty that a maintenance ratio of .50 will provide uptime levels up to 98%. That is, if $0.50 of every dollar spent on all fleet maintenance was for PM, maximum uptime is most likely to be achieved. Using this ratio, we calculated the number of technician hours required to complete sufficient PM to ensure the fleet attains the highest levels of uptime. From this, we calculated reactive repair labour hour demand.

We calculated low and high estimates of labour demand for these standard maintenance activities:

- Preventive maintenance (PM)
- Reactive maintenance (unscheduled repairs)
- Government mandated SGI commercial vehicle inspections (only for vehicles requiring these inspections)

Calculating Demand and Capacity

Our approach began with a fleet maintenance demand-versus-capacity study. We based the analysis on:

- Types/categories of vehicles and equipment
- Fleet size (i.e., the number of each category or type of vehicle/equipment)
- Lower and upper (peak) estimates of maintenance demand based on types/categories of fleet units and annual kilometres driven/ hours-operated by each
- Lower and upper (peak) estimates of the number of scheduled preventive maintenance (PM) events

- Reactive repair demand (i.e., the ratio of reactive, unscheduled repairs relative to preventive maintenance demand)
- Annual SGI mandatory commercial vehicle inspections requirements
- The number of currently available service bays (10 light-duty bays)
- Expected population growth estimates over the next decade (1% per year)
- Extrapolations for fleet growth to serve an expanded population in the next decade

The Impacts of Electric Vehicles

The world is moving quickly and steadily away from internal combustion engine (ICE) vehicles that are powered by traditional and polluting fossil fuels (i.e., gas and diesel), towards zero-emission electric vehicles (ZEVs, EVs).

Several makes and models of EVs are now available for purchase and many more are slated to become available in the coming years, including the types of vehicles that City of North Battleford requires.

The advantages of EVs are numerous including lower overall cost of operation, better performance, and reliability – and they have a fraction of the moving parts as compared to traditional ICE vehicles. Moreover, EVs seldom require brake lining replacements (due to regenerative braking) and do not require oil changes, tune ups, or filter changes.

The shift to EVs in the coming years will translate to reduced maintenance demand for the Fleet team. Exactly how great the impact will be is unknown today and almost impossible to calculate with any degree of accuracy. There is simply not enough, if any, documented history of EV maintenance demand in commercial fleet operations to draw upon.

We know with obvious certainty that oil changes and tune-ups will not be required for EVs, but all other maintenance activities will likely be very much as they are today. Brake linings will still need to be replaced – but not nearly as frequently as before since EVs feature regenerative braking as opposed to relying on friction surfaces for stopping.

At this time in EV history, we know that brake lining replacements will be protracted. However, in a commercial fleet operation there is no documented evidence to show exactly how long an EV's foundation brakes will last before replacement is required.

EVs will require steering and suspension component replacements as do ICE vehicles, plus running maintenance of items like wiper blades, lights, and safety and convenience items. Like ICE vehicles, heating, ventilating and air conditioning systems will continue to require maintenance. EVs have motive battery cooling systems that will need maintenance, and, like ICEs, they still require an onboard charging system to power up their accessory batteries; these will all need to be maintained. EV trucks over 4,500 kg will require annual SGI inspections, as required by the government.

It is our opinion there is no question that maintenance demand will decrease for EVs; to learn exactly how much less maintenance will be needed, the commercial fleet industry will have to wait and see. Based on this nebulous picture for the future of commercial fleet EV operation, our recommendation is that in years ahead, the City of North Battleford fleet team should carefully monitor its actual labour time based on vehicle types, with a lens focused on the maintenance demand of any EVs acquired. Informed by this data, fleet maintenance labour projections should be re-evaluated frequently. Again, this points to the need for a robust fleet management information system (FMIS).

Spare Bay Ratio

In calculating total garage bay demand, it is critical to include a margin for bays tied up for any reason, including delays waiting for parts and materials, etc. Parts tie-ups and other delays are the reality in fleet maintenance and, unfortunately, an unavoidable part of typical garage workflow.

Other considerations which increase the need for additional garage bay demand include vehicle staging (in preparation for repairs/PM), space for thawing frozen vehicles in winter, bays used for small engine or equipment repairs, welding bays, seasonal changeover area and bays tied up when management desires the repairs started by one technician to be completed by the same person[13]. All of these add to garage bay demand and must be taken into consideration.

Architect Larry Jacobsen[14] of Schemmer Associates is a garage subject matter expert with considerable expertise in designing fleet maintenance garages. According to Mr. Jacobsen[15], on a single shift operation, it is an ideal practice to provide two maintenance bays per mechanic. This provides the opportunity to stage one vehicle while the other is being serviced, or if delivery of parts delays one vehicle, the technician can work on the other one. The arrangement may also maximize the mechanic's efficiency and keeps more vehicles awaiting maintenance out of the weather.

It is our position, based on more than three decades of fleet maintenance experience, that a 1:1 spare bay ratio is a 'perfect world' scenario. It would mean the added capital cost for a garage that is double the required size based on actual demand with increased ongoing costs of operation. While spare bays are essential to positive workflow, and a 1:1 spare bay ratio would be wonderful, it seems excessive, at least from our experience.

[13] At times fleet management may determine that a vehicle repair started by a technician would be best completed by the same individual due to that individual's specialized skill set, expertise, experience, or other such circumstances.
[14] William (Larry) Jacobsen AIA, FCSI provides architecture and engineering planning expertise for The Schemmer Associates Inc., where he is a principal. https://www.schemmer.com/portfolio-category/transportation/
[15] Source: https://www.petrolplaza.com/knowledge/1698

Profile of the CNB Fleet Maintenance Garage

- There are five double service bays in the garage facility with a total capacity of 10 light-duty vehicles.
- The total capacity of the garage decreases when large vehicles are present for maintenance.
- There is one 4-post hoist for small, and six mobile column lifts.

Calculating City of North Battleford's Maintenance Bay Requirements

In calculating the number of bays required today and in the next decade we began by estimating low and high (peak) total maintenance workload demand for the baseline year and in ten years. We then based an increase in fleet size in alignment with population growth estimates - 1% per year.

Given that each hour of labour necessitates a commensurate amount of garage bay time, we started by calculating the number of bays required to meet attainment of fleet maintenance activities, based on current fleet size. To that number, we added a 0.5:1 ratio for spare bays.

At the present time, City of North Battleford garage has ten light-duty vehicle service bays. From our analysis, the number of bays required, including an allowance for spare bays, based on *low* demand and current fleet size, 10 bays[16] are necessary. But as many as 16 bays would be required at times of *peak demand*, including a 0.5:1 spare bay ratio. Please see *Table 4 – Garage Bay Analysis* (below)

For full maintenance demand, and given the current fleet size, the garage seems to be aligned with low maintenance demand. However, garage bay space is inadequate during times of peak demand, for which up to 16 bays may be required. For peak performance, more bays are required – given the *current fleet size.*

We prepared a scenario that calculated the service bay demand considering population growth predictions for the next decade. With low demand, and a spare bay ratio of 0.5:1, from 12 bays at low demand and as many as 20 bays at high demand would be required in ten years. Please see *Table 4 – Garage Bay Analysis* (below)

Note: A shift in the future towards electric vehicles (EVs) is expected to reduce maintenance demand, and consequently the number of bays and technicians. Further, a downsizing of the fleet would also reduce maintenance bay and labour demand.

[16] 9.3 was bays rounded up to 10 since a portion of one bay would not be adequate

Table 4 - Garage Bay Analysis

Garage Bay Analysis	Current Population		Population Growth in 10 years	
	No. of Bays Required - 1 Shift per Day, 5 days per week LOW (baseline yr.)	No. of Bays Required - 1 Shift per Day, 5 days per week HIGH (baseline yr.)	No. of Bays Required - 1 Shift per Day, 5 days per week LOW (+ 10 yrs.)	No. of Bays Required - 1 Shift per Day, 5 days per week HIGH (+ 10 yrs.)
Bay Demand - no spare bays	6.2	10.3	8.1	13.3
Bay Demand - 0.5:1 spare bays	10 (9.4)	16 (15.5)	12 (12.1)	20.0

Garage Bay Space Shortage - What are the Options?

Option 1 - Satellite Garage

A satellite garage is an option; however, it is an option that in our assessment is less than ideal. A satellite garage would require additional, unproductive labour to move vehicles to and from the remote operation. It may also mean additional supervisory personnel would be required to oversee an additional site, since workers should not be expected to work alone or in an unsupervised site.
In this scenario each service visit would require that Fleet personnel pick up each vehicle to be serviced at the satellite garage and return the vehicle after maintenance. This process would entail a considerable amount of unproductive time. Travel to and from a satellite garage would increase risk exposure from traffic collisions. Risk would increase further when slow-moving mobile equipment such as off-road loaders, backhoes and the like would need to travel to a satellite garage in the same traffic lanes intended for on-road motor vehicles.

If a satellite garage was the choice operating and capital costs may further reduce the potential savings or negate the savings altogether when combined with the cost of an additional supervisor and a parts/inventory person. The same applies if additional bays were to be constructed onto existing fleet maintenance facilities.

Calculations around the full cost of building an additional fleet maintenance facility or adding bays to an existing facility are beyond the scope of this fleet review. However, we suggest that to do so should begin with site evaluation and expert review of existing properties held by City of North Battleford to determine if current land would be suitable for additional fleet maintenance bays, or whether a new property must be purchased. With that matter decided, and if the notion still seems feasible in the context of cost-benefit, to proceed to the next step a design–build contractor or architect-led design–build (ALDB) firm should be consulted to determine the capital cost for changes under consideration.

Option 2 - Two-Shift Operations

The reduced number of bays that would be required for a two-shift per day operation may seem appealing in terms of optimal utilization of workspace, but whether in practice it is viable is questionable. If a two-shift option is ever being considered by City of North Battleford, it should be approached cautiously. If, for any number of reasons one (or more) bays became unavailable for an extended period (i.e., major, or lengthy repairs, parts delays, etc.), it could impede the fleet maintenance operation, potentially causing setbacks in completing timely preventive maintenance and legally mandated government inspections, as well as disrupting workflow and productivity. In addition, adding a second shift may cause dissatisfaction in the fleet technician workforce, making employee retention and new technician recruitment more challenging.

Option 3- Increased Outsourcing

Increasing the amount of outsourcing to local vendors would reduce in-house maintenance demand. However, outsourcing brings a whole new set of issues that must be managed. These include additional labour costs (compared to inhouse technicians), quality-control and monitoring the work of the external service-providers.

Summary of Garage Bay Analysis

The above analysis is a best estimate based on present-day realities combined with cautious business assumptions and extrapolations around projected community growth. The requirements for service bays must be based on actual labour and fleet size data as it becomes available. Making go-forward decisions around service bay requirements without verification of business assumptions is a risk to be avoided.

Going forward, the fleet management information system (FMIS) should be leveraged to track Fleet maintenance technician labour on work orders and conduct regular reviews around productivity, and any loss of productivity resulting from the unavailability of garage service bays to conduct maintenance activities.

We suggest instituting a labour code in an FMIS for which Fleet maintenance technicians would use to record their unproductive time spent whenever they waited for a garage service bay to become available, or time spent juggling vehicles to free up a bay. Tracking wasted time in this way would highlight and signal the need for additional garage bay space.

Recommendation

- Track the unproductive time spent by Fleet Maintenance Technician waiting for garage bays to become available. As unproductive time increases it will flag the need for improvements to the fleet maintenance facilities, as far as additional garage bay space.

2.4 Vehicle Specifications

Fleet management should always prepare detailed specifications for new vehicles being tendered with consideration for past performance of similar units (i.e., the past predicts the future). Fleet managers should give preference to units that have demonstrated the lowest historical total cost of ownership (TCO) and highest reliability. Confidently knowing the operational costs of all vehicles is an important function of the fleet management information system (FMIS), again highlighting the need for such a system at the City of North Battleford.

Overview

From our management practices review meetings with City of North Battleford fleet staff, we learned the following about vehicle specifications and the tender/bidding practices for new units:

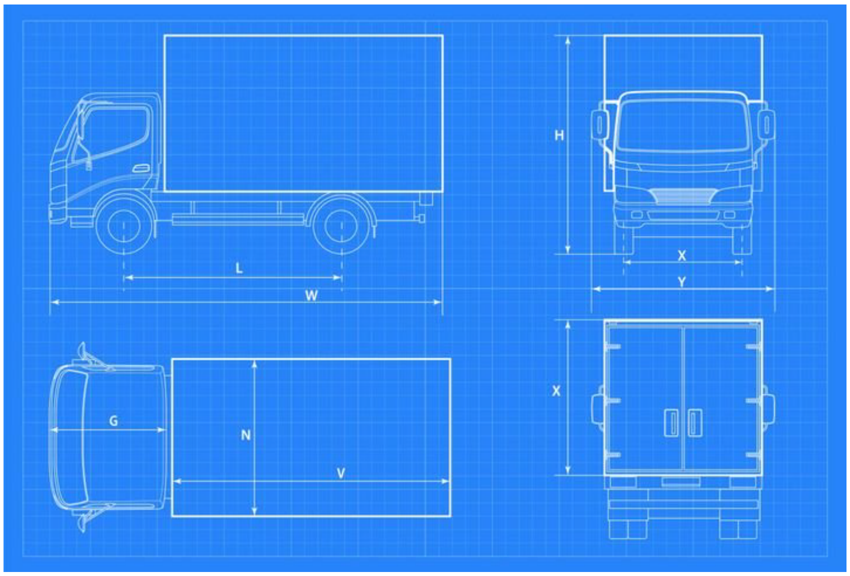
- The Fleet Equipment Supervisor prepares specifications for new vehicle purchases.
- Fleet management takes into consideration the past performance of vehicles, engines, drive trains etc., based on personal observations; however, no data systems are available for management to determine the best performing vehicle types.
- Generally, when replacing vehicles with mounted equipment, the whole unit (including truck body, mounted equipment etc.) are replaced as one unit.
- The City has detailed purchasing policies and spending limits; processes are challenging, but a case can sometimes be made for superior units despite higher purchase price.
- There is no standardization in terms of the brand; instead, specifications are generic, open to all brands.

Best Management Practices

Fleet Management should avoid the pitfall of buying vehicles that simply cost the least to acquire and meet only basic requirements. Historical cost information about makes, models, and components should be frequently reviewed in a fleet management information system (FMIS) (again pointing to the need for the City to consider investment in a FMIS). This step enables informed procurement decisions based on total cost of ownership (TCO) concepts, instead of purchasing vehicles based on lowest price.

Vehicle Standardization

Standardizing vehicle specifications wherever possible delivers numerous benefits. Standardization minimizes spares inventory, increases driver and mechanic familiarity, and increases the fleet's buying power with OEM vendors. Standardization may also reduce vehicle acquisition costs through volume buying.



Technical Drawing - Getty Images

Most fleet managers must follow corporate budgetary and procurement guidelines. Sometimes those guidelines dictate the choice of the vendor or the product that will be procured for a specific application. While purchase price is a key component, it should not be the only consideration.

Fleet managers should expect to get a realized return on investment (ROI) on investments in units. As so, management must understand the total cost of ownership (TCO) for the vehicles being selected through the competitive bidding processes (i.e., RFQ, RFP, tenders).

If an organization bases its procurement decisions purely on up-front acquisition costs, it can result in significant, often costly, challenges throughout the vehicle's lifecycle.

Vehicles that have been selected for lowest purchase price may be under spec'd for their intended job function leading to safety risks, increased maintenance costs, unforeseen downtime, shorter lifecycles, and reduced end of lifecycle resale value. While a fleet may be able to reduce costs at the time of the acquisition, it will likely experience significantly higher costs and reduced productivity throughout the vehicle's time in service.

Municipal fleets deal with a wide variety of vehicles and equipment, including everything from passenger cars to medium-duty trucks, heavy-duty trucks, and off-road equipment. When there are multiple different makes and models of each, keeping track of assets and their service parts can seem impossible. Some fleets combating this problem through standardization[17]. By narrowing their fleet operations to a few standard vehicles or critical components, fleets can increase efficiency and save money on inventory, training, and repairs.

[17] Source: Government Fleet February 2017

An example out of the U.S. stands out to us for its basic logic. Before he was fleet manager for Osceola City, Fla., Hector Morales became familiar with standardization while in the U.S. Army, where all vehicles were standardized. According to Morales, "*If you maintain the same equipment, your parts inventory will be smaller, and you will be able to have an idea of how many maintenance parts and specialty tools you need for your fleet. The maintenance of your equipment will be similar, and you will not need to have 20 different codes in your software for preventive maintenance. The readiness of your equipment is important; you need to have your trucks in service and having technicians well-trained with the right parts in stock will reduce downtime."*

Osceola City is standardizing its medium- and heavy-duty vehicles so they use the same engine, transmission, and tires. Morales began the process this year and expects to reduce his parts inventory by 25%, saving about $75,000 (USD) the first year.

Total Cost of Ownership Approach

When competitively bidding (such as RFP, RFQ, or tender) for new vehicles and equipment for the fleet, it is a best practice to require bidders to state the total lifecycle cost of ownership (TCO) of their vehicles which have been offered.

Lowest TCO is better than the lowest purchase price, and this would naturally deliver the lowest possible cost to City of North Battleford, making TCO the better method of vehicle selection, albeit more complex and difficult to prepare for RFQs/tenders and assess vendor bids.

Recycling Mounted Equipment

Used truck service bodies and mounted equipment (such as cranes, dump bodies, salter/sanders, power tailgates) can potentially last for two (or more) truck chassis lifecycles after being rebuilt and remounted on new chassis. By "recycling" truck bodies and mounted equipment in this way, we estimate up to $20,000 or more (depending on the complexity and value of the equipment) could be saved on each new truck purchase. Although there is a potential for cost-savings, the practice of rebuilding and remounting add-on equipment should be approached cautiously – it can lead to reliability and, potentially, safety problems.

We acknowledge that some truck bodies and mounted equipment are subject to severe-duty usage (road salt exposure, for example). Despite that, we suggest that the concept of remounting ancillary equipment should not be overlooked. We recommend that unit condition assessment (see *Appendix A*) should be undertaken for mounted equipment on units due for replacement. If the condition assessment for the installed equipment is still "good," the option of remounting should be considered.

We suggest obtaining vendor quote(s) for rebuilding and remounting ancillary equipment. Then use this information to decide whether there is a business case for re-using truck bodies and other mounted equipment on new truck chassis – or if the more practical option is to replace the unit(s) in their entirety.

Right-Sizing Vehicles

In the past, some fleet managers subscribed to the adage "*identify the size of truck you need for the job —then buy one bigger.*" This anachronistic thinking resulted in fleets with oversized vehicles, poor fuel economy, and higher operating costs.

Today's savvy fleet managers know that the old approach is wrong. The correct approach is to right-size the fleet vehicles – that is, correctly specify the right-sized vehicles for the job at hand, which will lead to optimal fuel efficiency and lower overall operating costs.

In FAR 6x, we data modelled the potential impacts of downsizing the City of North Battleford's Class 2 full-size pickups (e.g., E250 or 2500 series) to Class 1 full-size pickups (e.g., F150 or 1500 series).

We calculated that the switch to lighter-duty full-size pickups would yield the City an annual operating costs savings of $66,273. Further it would reduce GHGs by 184.5 metric tonnes CO_2e. However, we acknowledge that lighter-duty pickups may not be adequate for some applications, in terms of load-carrying and trailer-towing capabilities.

Light-Weighting Vehicles

According to the U.S. EPA, every 10 percent reduction in truck weight[18] reduces fuel use between five and ten percent. Generally, an empty truck makes up about one-third of the total weight of the truck. Using aluminum, metal alloys, metal matrix composites, plastics, and other lightweight components can reduce empty truck weight (tare weight), improve fuel efficiency, and reduce greenhouse gas emissions.

[18] Source: US EPA SmartWay https://www.epa.gov/sites/production/files/2016-06/documents/420f16028.pdf

Low-Emissions Vehicles

There is no question that the world is moving away from the internal-combustion engine (ICE) vehicles. Some jurisdictions have already legislated the end of the ICE. Many organizations and governments have committed to 100% zero-emission (battery-electric or hydrogen fuel-cell) fleet vehicles within very short timelines. Acquisition of high-efficiency, low-emissions vehicles that meet operational needs (e.g., hybrids, plug-in hybrids, battery-electric vehicles, or compact cars) should be prioritized now.

Fuel-Saving Technologies

Green vehicle technologies such as idle shutdown devices, battery backup systems for DC loads, auxiliary heaters, auxiliary power units (APU) and others, will increase fuel-efficiency. Fuel cost savings most often offset their extra cost.

New vehicles should have these green technologies installed by the vendor and the cost included in the purchase price. This would mean that the cost would become a capital budget expense amortized over the entire lifecycle of the vehicle(s) instead of becoming an operating expense in a single budget year.

Diesel-Powered Vehicles

Diesel engines have been the traditional choice of fleet managers for decades owing to their durability in *high mileage applications*. However, diesel engines come at a considerable price premium over gasoline engines. Municipal fleets are *low mileage applications* therefore the longevity of diesel engines may be a moot point.

If fleet management's primary end-goal is saving fuel costs (as opposed to reducing GHG emissions), they may opt for the diesel option – not just for medium and heavy-duty trucks but also for light-duty vehicles (cars and pickups). Although the upfront cost is considerably more for diesel engines, they are inherently more fuel-efficient than gasoline-powered equivalents.

Diesel engines are 20% or more fuel-efficient than gasoline engines and today's diesel engines produce radically lower smog-causing emissions than earlier models. On the flipside, diesels produce 23% more carbon emissions than gasoline engines on a per unit basis (gasoline produces 2.2 kg/l and diesel 2.7 kg/l).

Unfortunately, in a GHG reduction scenario, the additional fuel economy for diesel engines does not (in most cases) offset their increased CO_2 emissions. That said, for those diesel vehicles now in the fleet, the use of cleaner-burning biodiesel or renewable diesel are both excellent solutions for carbon reduction. Otherwise, gasoline engines may be the better option today for light-duty units, pickups, and Class 4 to 6 trucks because of their lower fuel and acquisition costs and potentially less GHG emissions.

Recently, manufacturers have announced the launch of new medium-duty trucks models equipped with gasoline-powered engines; some are equipped with air compressors to provide air for brake systems and air accessories. Gasoline powered trucks in low-mileage applications will cost less to purchase and will reduce both GHG emissions and fuel costs. Today, gasoline engines may have an advantage over diesel in the municipal fleet operating environment.

In FAR 5x, we data modelled the impacts that may be possible by switching the City's diesel-powered medium-duty trucks (e.g., Class 4, 5 and 6) to gasoline-powered equivalents when they are due for replacement. We determined that an operating expense reduction of ~$110k and a reduction of 73 tonnes CO_2e would be possible.

Exception Units

Leading fleets routinely conduct reviews of fleet "exception" vehicles that drive up their costs. They take remedial actions on a case-by-case basis. Reports from a fleet management information system (FMIS) should identify the problem units and determine their root cause(s), thereby enabling appropriate action(s).

Waste Stream

When creating specifications for new fleet vehicles a review of the vehicle manufacturer's waste stream should be considered. The percentage of recyclable materials used in the manufacturing of vehicles should be part of the new vehicle selection process. Most manufacturers today place a degree of emphasis on this issue and should be able to provide this information for the asking.

Paints

When creating specifications for new vehicles, ensure that environmentally friendly and compliant waterborne paints will be used. The government has stringent regulations regarding Volatile Organic Compounds (VOC), and it's essential to know about the OEMs handling of this matter. The same applies to the repainting of in-service vehicles.

Principles of Vehicle Specifications

In the interest of fair and open competition, specifications should be written so that more than one supplier can satisfy the requirement. Doing so will increase competition and therefore achieve better value for money. It is essential to comply with corporate requirements for fair competition.

Precise, easy-to-understand vehicle specifications yield the best bidder responses. Therefore, it is imperative to develop adequately detailed specifications to form the basis of vendor bidding.

Unclear, unnecessarily detailed, and biased specifications will decrease the number of suppliers participating in the RFP/RFQ/tender and reduce the overall quality. Vague specifications will confuse bidders, which may cause rejection of bids or make the bid responses challenging to rate. Proposals that cannot be appropriately evaluated may mean that all submissions must be rejected, and rescheduling of the bid request would be necessary, with consequent time delays.

Overly detailed bid specifications may discourage responses from perfectly suitable bidders. Within reason, try to keep technical bids to the point and concise using plain language wherever possible.

The specifications should be definitive, not restrictive. The objective of writing technical specifications is to explain to the suppliers what is required. Even a simple item such as an office chair requires technical specifications. Bidders need to know what the material of the item will be (plastic, wood, metal, etc.), the material used, if it has feature "x," if it has feature "y," if it has feature "z," etc.

If the detail is insufficient or unclear, the bidder may be confused and will probably offer the cheapest available option (since, usually, selection criteria and Purchasing/Procurement policies require buying the lowest cost item that meets technical specifications).

At the same time, specifications should not be too detailed to restrict the bidders unnecessarily as many bids as possible must be received to improve competition and increase the chances of purchasing equipment that meets the requirements at the best possible price. Specifications must be detailed enough to leave no question about what is required in the bidder's mind. Still, they should be generic enough to attract offers from multiple manufacturers and vendors.

For full details regarding our recommended approach to preparation of vehicle specifications, please see *Appendix B – Guide to Preparation of Vehicle Specifications*.

Recommendations

- When tendering for new vehicles, consider awarding bids using a total cost of ownership (TCO) approach to optimize the use of capital. Instead of the lowest-compliant bid approach, procurement should consider allowing TCO in its competitive bidding proposal structures.

- When tendering for new vehicles, consider each make/model's rated fuel consumption and GHG emissions (directly related to fuel economy) as essential parts of the TCO. The preference should be for more fuel-efficient and lower emission vehicles.

- Consider fleet vehicle standardization; limiting the number of brands is known to reduce costs and challenges relating to preventive maintenance (PM) and repairs. Standardization reduces training and new unit familiarization requirements for fleet technicians as well as vehicle drivers, and it reduces the number of spare parts required in inventory.

- Ensure the size of vehicles is based on their use when going to tender for a specific unit; specifications should be aligned with vocational and load requirements. When appropriate, select a smaller vehicle sized appropriately for the task at hand. With the user group's co-operation, precisely what is needed to perform specific job duties can be outlined.
- On a case-by-case basis, consider the cost-benefit of re-building and re-mounting truck bodies and ancillary equipment that are in good condition at the time when truck chassis are due for replacement.
- Consider gasoline-powered medium-duty trucks for reduced costs and emissions.

2.5 Finance

One of the biggest challenges facing fleet managers in the public sector is fiscal sustainability. The fleet operating expense (Opex) budget must be adequate to prevent cost overruns. And the capital expense (Capex) budget must be sufficient for vehicle replacements to maintain the optimal average age of the fleet. Therefore, a primary goal for fleet managers is to reduce or hold the line on rising vehicle Opex and Capex without negatively affecting service levels (i.e., uptime). It's a delicate balancing act, and the successful attainment of each depends on many intertwining factors.

In this section of the BMPR discussions with management, we aimed to learn about vehicle Opex and Capex and how vehicle costs are recovered at City of North Battleford.

Overview

Vehicle Ownership

- All 425 City of North Battleford in-scope units for our review are owned, except for three leased units.

Fleet Budgets, Chargeback System & Reserve Fund

- There is no fleet reserve fund.
- There is a vehicle charge-out rate from years ago, but it hasn't been reviewed recently.
- For every unit, fuel used is charged to user departments. Maintenance & repairs are also charged to departments.
- Fleet management can obtain cost reports and budget data from the City's Vadim system.
- Budget reports include line items for labour, parts, fuel, maintenance, licenses, etc.; it shows budget and actual variances.
- Fleet maintenance parts are purchased by the Fleet Equipment Supervisor using a corporate procurement card.
- Ten years is the capital budgeting timeframe.
- Surplus vehicles are sold via www.GovDeals.com.
- Surplus vehicle sales proceeds go into the City's general fund.

Best Management Practices

Cost-Neutral Fleet Department, Full Cost Recovery

Several Canadian public sector fleets have successfully separated fleet management from their core activities by establishing a semi-autonomous fleet department or division. In this business model, for which Fleet Challenge is a strong proponent, the Fleet Department is structured as an internal 'business support service' with strategic goals and objectives aligned with, and in support of, the overarching corporate vision/mission. There are multiple benefits to this business model, including the Fleet Department becoming cost-neutral to the municipality.

The Total Cost Recovery Business Model

Several successful examples of fleet departments/divisions have structured their business models to mimic external fleet service providers in Canada. We will discuss these examples in this section of our report and the many advantages of the *total cost recovery business model*.

The key feature of this business model is an internal Fleet Services Department structure that functions like a third-party commercial fleet management provider, but without the profit motivation that a retail provider would require. The advantages of this business model include:

- Separation of the fleet from the municipality’s core functions, thereby enabling greater focus on primary municipal goals
- Fleet department becomes a cost-neutral, total cost recovery, internal service provider
- Reduced vehicle costs
- Support for the municipality’s vehicle needs to the fullest
- Provision of the highest levels of service to internal clients
- Potential for reduced fuel use and greenhouse gas (GHG) emissions

There are several examples in which this business concept has been shown to earn the buy-in of line department managers, empowering them to reduce their vehicle, fuel, and accident costs for vehicles assigned to their areas of responsibility.

Examples of successful implementation of this business model include:

- Winnipeg Fleet Management Agency (an early adoptor)
- City of Hamilton, Ontario
- Toronto Hydro-Electric System, Fleet Management Services

In this section of our report, we will highlight the Toronto Hydro fleet because we are closely familiar with its financial structure. Toronto Hydro is a client for which we have completed several past (and current) fleet management consulting projects. Also, Toronto Hydro is a municipal electric utility

(MEU) of which the City of Toronto is the sole shareholder. MEUs operate in very similar ways to municipal fleets – their vehicle mix, and operating characteristics have many parallels to municipal fleets, including the City of North Battleford.

In Toronto Hydro's example, the business model we describe herein was implemented several years ago. The concept was, and still is, described as a '*fully bundled, total cost recovery, vehicle lease program*.'

The fleet finance treatment at Toronto Hydro features full-service vehicle 'lease' charges transferred to all of Fleet's internal user groups. As a result, the utility's in-house fleet services department became structured in a way resembling a retail full-service fleet management (leasing) company. A key element is that monthly full-maintenance vehicle lease charges are issued to internal user groups/ 'cost centers' (departments). At Toronto Hydro, the change resulted in strikingly positive results.

Key features of the concept include *fully bundled* monthly vehicle lease charges. Lease charges for assigned vehicles are posted to the cost centers/departments of its user departments monthly via journal entries. The lease charges are calculated by activity-based costing (ABC) based on the estimated cost of:

- Vehicle end-of-lifecycle replacement (apportioned over the planned life cycle allowing for inflationary increases, and sufficient to fund vehicle end-of-lifecycle replacement)
- Capital (or third-party lease costs if applicable)
- Preventive maintenance (based on historical average PM costs for each vehicle's class)
- Reactive repairs (based on historical average reactive repair costs for each vehicle class)
- Management and unionized Fleet staff salaries and wages (which are embedded within the monthly lease charges to user departments and, as so, fully recovered)
- Fixed expenses and overhead costs like facilities costs, electricity, insurances, capital expenses (aside from vehicle capital), parking, administrative fees, and so on)

At Toronto Hydro, as a companion business tool, Fleet Services also developed Service Level Agreements (SLAs) for its user groups; these SLAs define Fleet's service commitments to each user department.

Fully bundled lease charges for directly assigned vehicles at Toronto Hydro were (and are today) easily transferred monthly by journal entries for all vehicles assigned to each user department/division. In this business model, the fully bundled total cost recovery vehicle charges became the full responsibility of the user departments to which vehicles are assigned.

When this plan was implemented, many of Toronto Hydro's line managers became motivated to reduce their departmental costs. They were quick to surrender under-utilized vehicles. They also became supporters of acquiring new vehicles of lower cost and/or higher efficiency that would cost their departments less to purchase and maintain.

For Toronto Hydro, this practice was a visible reminder to managers of vehicle user departments regarding their vehicle costs. As a result of this change, Toronto Hydro's fleet rapidly downsized from over 1,000 units by more than 25%. The fleet's operating costs decreased by several million dollars annually while vehicle utilization rates increased dramatically. The company, then serving in a newly deregulated business environment, continues this successful business structure today and has continued to benefit from even further reductions in fleet size and cost.

Fuel Costs

As an option to the total cost recovery lease rate concept we've described, it is worth considering that, in addition to their vehicle lease charges, vehicle user departments/divisions should be invoiced separately for the fuel consumed by their assigned vehicles. *We understand that this is the current practice at the City of North Battleford.*

By transferring fuel costs directly to user groups and reporting each group's fuel-use and GHG emission statistics across the organization, department/division managers become acutely aware of the fuel efficiency of their vehicle assignment and their fuel costs. Consequently, some may become interested in, and empowered to help reduce their vehicles' fuel usage and GHG emissions. This practice reduces their department's costs and, as such, the entire municipality becomes the beneficiary.

> ***Why Fuel Use Reporting?***
>
> Fuel is generally the second highest single cost for commercial vehicle fleets, next to wages. For this reason, detailed fuel usage reports as we've described are a standard reporting function within fleet management information systems (FMIS').

Departmental fuel usage reports (see sidebar) should be provided monthly to each user department/division to inform managers about the fuel efficiency, consumption and GHG emissions produced by each of their assigned vehicle(s).

These reports should highlight the exception units that are under their control. Such statements have been shown to create awareness which ensures buy-in for reducing fuel costs (and GHG emissions) at the end-user levels of the organization. This type of reporting is standard functionality in fleet management information systems (FMIS'), in which generating the reports we are recommending is simple and easy.

For example, suppose a user department does not buy into fuel-use and GHG reduction practices or fails to urge its drivers to act responsibly around fuel conservation. In that case, only their department suffers the costs, instead of all user groups. Conversely, departments that encourage fuel conservation will benefit from lower operating costs for their assigned fleet vehicles.

At-Fault Accidents and Negligent Damages

The full cost of *at-fault* accidents and *negligent* damages to fleet vehicles should be charged directly to the user department/division whose driver caused the damages. Costs for *preventable* damages to fleet units should not be included in vehicle lease charges.

This best management practice encourages line managers to take responsibility for their drivers who display bad driving behaviours or those who may be habitually abusive toward vehicles and equipment. The approach places responsibility for driver behaviours where it belongs – in the hands of their managers who are best-positioned to deal with the issue of their drivers' poor driving habits.

Service Level Agreements

Service Level Agreements (SLAs) manage user group expectations by defining precisely what they should expect to receive from the Fleet Department. For example, an SLA might include language stating that vehicles will be replaced every "x" number of years or that vehicle charges include maintenance, repairs, insurance, licensing, driver training at specific intervals, and more.

SLAs that precisely define what will be provided by the Fleet Department to the vehicle user departments will help level the playing field between user departments. Therefore, SLAs are a recommended best management practice.

Fully Bundled Lease Charges versus Reserve Funds

In the fleet finance treatment we've described, *fully bundled total cost recovery vehicle lease charges*, including all fixed and variable costs, are passed on to each user department/division each month for their assigned vehicles. In turn, user departments post hourly vehicle charges to their capital projects or other activities, just as they do for their employees' time on jobs, materials, and third-party costs.

In a sense, fully bundled, total cost recovery vehicle charges, as described, resemble a traditional reserve fund in that assigned vehicle operating costs are applied, which should fully offset the fleet department's fees for all vehicles and provide capital for replacements at the end of their useful life cycles. However, that's where the resemblance stops. Reserve funds may create a sense of entitlement in line managers. For example, user group managers may feel entitled to receive a new replacement vehicle despite their assigned unit still having remaining useful life. They may feel this way because their user department/division has contributed to their assigned vehicle's capital replacement fund from the beginning.

Reserve funds are typically topped up through hourly vehicle charge-out rates captured on work orders/time tickets. However, department(s) are known to hold the keys to a vehicle(s) for full days while only posting their hourly charges for a fraction of each day. This practice prevents shared usage of vehicles by other departments. Consequently, if this occurs repeatedly, with hourly charge out rates, there will be a shortfall in the reserve fund when the time comes for replacing the vehicle(s).

In the *fully bundled total cost recovery vehicle charges* concept we're recommending; the Fleet Department is the asset 'owner' of all fleet units. Fleet transfers bundled vehicle lease costs to user departments/divisions each month, identically to the way a retail vehicle full-service lease provider would.

There are numerous advantages to this business structure. Key features of the *fully bundled, total cost recovery* business model concept are:

- May instill user-department manager’s interest in surrendering chronically under-utilized vehicles assigned to their area of responsibility/department or sharing/pooling them with other departments
- User-department managers feel less entitled to receive new, replacement vehicles when their units still have remaining usable service life
- User-department managers may share in the goal of keeping capital costs down for new, replacement units because vehicle acquisition costs will ultimately translate into higher costs for their own departments/divisions
- Encourages fuel conservation by placing responsibility for fuel costs within the user department/division to which the vehicle's drivers report
- Encourages accident and damage reduction by placing responsibility for costs within the user department/division to which the vehicle's drivers report
- User-department/division managers who more carefully manage their assigned fleet vehicles can decrease their department/divisions' operating budgets
- The Fleet section can become cost-neutral to the municipality

Vehicle Leasing and Renting

Vehicle leasing or renting can be attractive options as ways of reducing a fleet's average age without investing capital. The aging of a fleet results in high costs, poor reliability and, potentially, decreased safety. Leasing or renting are ways to quickly modernize a fleet that has been allowed to age excessively.

The decision to lease or rent vehicles must be approached cautiously. A full review of the leasing/renting options is necessary, and it should be based on discounted cash flow analysis using standard accounting principles. Within the current scope of work of our City of North Battleford fleet review project, we have prepared an example of discounted flow cash flow analysis of buying-versus-leasing vehicles (please see *Section 8*).

Leasing vehicles can have a significant impact on financial performance. In general terms, based on our past research into this issue, we have determined that leasing or renting vehicles is costlier for municipalities than buying units (see text box below). That stated, there are some exceptions where leasing or renting may be beneficial.

Example: In a discounted cashflow analysis study Fleet Challenge completed for an Ontario municipality's Parks and Recreation Dept., we calculated that renting/leasing their 68 seasonal-use pickups would cost over $200k more each year than buying them. With the right combination of elements and reasonable fleet management control, a municipality can generally fund vehicle replacement Capex and maintain the fleet more economically than a third-party lease or rental service provider.

If City of North Battleford should ever consider leasing or renting options, the matter should be analyzed thoroughly. First, detailed specifications should be prepared for each specific service requested from potential lessors/rental agencies, and then formal bids/quotes from potential vendors are obtained. These steps will help ensure that vendor prices and proposals are based on apples-to-apples comparisons.

For example, competing vehicle lessors/rental agencies should be required to state their total cradle-to-grave lifecycle costs, including interest rates (i.e., lease interest rates based on prime interest rates and floating/fixed), plus mark-up, carrying costs, acquisition costs, registration fees, end-of-cycle disposal fees, reconditioning fees, and environmental fees. Fleet management can then accurately assess which lease vendor offers the best prices with this information. In addition, this approach will avoid surprise costs and extra fees that may emerge after the contract is signed. Often, the savings offered by a vehicle leasing vendor with a lower interest rate can be negated by its numerous extra fees and surcharges.

In FAR 6x(a) we data-modelled the impacts that would result if the City of North Battleford leased 23 new pickup trucks. We estimated that operating expenses would increase by $164,144. However, on the positive side, the reduced emissions from 23 new vehicles would reduce the City’s GHG footprint by 211 tonnes CO_2e.

Total Cost of Ownership Approach

Preference should be given to acquiring new vehicles with the lowest total cost of ownership (TCO). For example, when new vehicles are selected through the competitive bidding process (e.g., tenders, requests for quotations), units with the lowest TCO should be chosen from vendor offerings.

Although some units offered by vendors may have a higher purchase price, they may have a lower TCO. Lower TCO will result when vehicles have one or more of the following:

(1) Lower or less costly maintenance requirements
(2) Better fuel economy
(3) Historically higher levels of reliability (less downtime)
(4) Historically higher end of lifecycle resale value

Historical cost information from the fleet management system (FMIS) should be reviewed to identify vehicle makes and models with the lowest TCO. This information should include the salvage value, trade-in or auction proceeds recovered from end-of-lifecycle vehicles.

When bidding for new vehicles, prospective vendors should be required to state the manufacturer's fuel consumption ratings and the estimated cost of scheduled maintenance requirements of their offered new vehicles.

Proceeds from Surplus Vehicles

It is a best management practice that proceeds realized from the disposal of end-of-lifecycle surplus units flow back into Fleet's reserve fund. In this way, the fleet management team will become vested with the responsibility and empowered to recover the maximum amount from surplus fleet units.

Synopsis – Fleet Finance

As described in this report, we feel strongly that a cost-neutral Fleet Department will deliver many advantages to an organization. In this business model, the Fleet Department prepares its annual operating and capital budgets as usual. *Total cost recovery vehicle lease charges* applied to user departments throughout the fiscal year will offset the fleet's Opex through vehicle user charges fully, thus making the fleet cost neutral.

We believe that user departments should carry the total vehicle operation costs, and this practice ensures their buy-in. That said, we do not suggest abdicating responsibilities for fleet management to the user departments. The City's Fleet and Maintenance Department, with vehicle subject matter expertise, must maintain control over critical decisions relating to fleet vehicles, including replacement cycles and maintenance. The Fleet Department should be the organization's 'go-to' resource as an internal service provider and in-house subject vehicle and equipment matter expert.

Recommendations

- There should be a dedicated Fleet and Maintenance Department reserve fund to ensure capital for vehicle replacements is available each year.
- Expand the current chargeback system to include all City of North Battleford user groups/ departments directly assigned units. Assigning vehicle costs to user groups often motivates managers to reduce their department's operational expenses.
- Form a Fleet and Maintenance Department pool for any vehicles that cannot be assigned to user groups. Hourly/daily/weekly usage rates, adequate to offset all operating costs of each spare unit, should be calculated for fleet pool vehicles and posted to users who 'borrow' them from the Fleet Dept.
- Capture vehicle costs in a dedicated fleet management information system (FMIS)
- Post all costs in the FMIS to each unit. Vehicle and equipment charge-out rates can then be calculated based on this information.
- Include inflationary increases in each year of the unit(s) lifecycles for the reserve fund to be adequate for vehicle replacements.
- Consider Service Level Agreements (SLAs) for all vehicle user departments.
- The direct cost of fuel used by each assigned vehicle, plus at-fault accidents and negligent damages costs, should be pass-through costs to all user departments with directly assigned vehicles.
- Funds recovered from the sale of end-of-lifecycle surplus fleet units should flow into a Fleet and Maintenance Department vehicle reserve fund.
- Consider a total cost of ownership (TCO) approach when tendering for new vehicles.
- Consider leasing some new units as a temporary solution to lower the average age of the fleet. Leasing would modernize the fleet, increase uptime, and reduce emissions but likely increase operating expenses.

- If the City of North Battleford considers leasing or renting options, the matter should be analyzed thoroughly. First, detailed specifications should be prepared for each specific service requested from potential lessors/rental agencies, and then formal bids/quotes from potential vendors obtained. These steps will help ensure that vendor prices and proposals are based on "apples-to-apples" comparisons.

2.6 Fleet Management Information Systems

We reviewed the software systems used by the City of North Battleford Fleet and Maintenance Department to manage fleet operations. Highlights from our BMPR discussions with staff are listed below.

Overview

- The City's Fleet and Maintenance Department has a variety of methods to track fleet assets including Nero www.nero.com which
- Nero is described by the company as a Global Tracking Vehicle & Asset Tracking Management Solution.
- Maintenance scheduling takes place in MS Outlook™ Calendar and via a board mounted on the garage wall.
- The Equipment Supervisor tracks work orders in MS Excel™.
- Excel is used to capture details as far as labour hours, the maintenance that was completed and by whom, parts used, mileage.
- Technicians' labour is charged to work orders.

Best Management Practices

Many municipalities have embraced best practices in contemporary asset management. Their business management processes are usually supported and enabled with 'Enterprise Asset Resource Management Software' (EARMS) or 'Enterprise Resource Planning' programs (ERPs). Examples include Asset Works, SAP, Oracle, Ellipse, and others. Some corporate asset management EARMS/ERP systems can meet the needs of fleet management but may require extensive customization and configuration to adapt to and fully address the specific requirements of fleet management.

In most municipalities, for data and information needs, Fleet management usually employs either: (a) the organization's asset resource management system (EARMS/ERP) or (b) a "best-of-breed," purpose-designed fleet management information system (FMIS). In some cases, an FMIS is interfaced with the corporate EARMS/ERP system, an arrangement that provides the optimal information for fleet management's needs while keeping enterprise/corporate EARMS/ERP systems informed (for accounting, timekeeping, payroll, human resources, and other purposes).

Fleet assets are dynamic with shorter lifecycles and higher maintenance demand than, for example, buildings and municipal infrastructure. Although managing a fleet can be a challenge, a fleet maintenance information system (FMIS) can make the entire process easier and more efficient.

Managing a very small fleet that may be comprised of a few small passenger vehicles and a handful of trucks can usually be handled using paper-based or spreadsheet options. Such a management style is highly dependent on the intuitive knowledge of the fleet manager and their good memory to ensure that nothing falls through the cracks. The information needs of a medium-sized, complex, diverse municipal fleet like City of North Battleford stretch manual methods' capabilities beyond reasonable limits and are untenable in today's business world.

A robust FMIS, when appropriately configured, can provide massive benefits. Saving money on fuel, optimizing productivity through efficient time management, and improving service quality are just some benefits an organization can enjoy when an FMIS is implemented.

No matter what type of fleet, getting the most from fleet assets in today's economy is a must. Fleet managers need to have ready access to the correct information presented in actionable reports, whether the goal is to maximize profitability and productivity or minimize cost and waste.

A well-configured, purpose-designed FMIS will:

- Reduce downtime and maintenance costs
- Extend the life of the equipment
- Reduce parts costs and inventory
- Increase productivity
- Reduce fuel and tire costs, and cost per kilometer/hour
- Decrease administrative burden
- Increase regulatory compliance
- Provide historical cost data that can be used to conduct lifecycle analysis and determine the optimal economic ages for vehicle replacement
- Help to ensure the fleet is legislative compliance audit-ready (i.e., SGI)

A suitable and effective FMIS allows businesses and municipalities to control costs, improve productivity, lower risk, and maintain compliance in their vehicle fleets. For example, studies have shown that using a properly designed FMIS, along with a review and streamlining of business processes, can reduce a fleet's operating costs by as much as 20%.

About GPS, Telematics and Satellite Technologies

Today, many fleets employ FMIS software solutions along with other onboard technologies. These systems include electronic data logging solutions, satellite positioning technologies, and data communication software.

Fleet management information systems that include GPS and fuel efficiency tracking are vital for minimizing these costs. In addition, real-time data on fuel consumption, driver behaviours, and maintenance reports enable businesses to identify areas for improvement and opportunities for cost savings.

The City of North Battleford uses the Nero system, which is described as a Global Tracking Vehicle & Asset Tracking Management Solution.

Fleet Maintenance Information Systems - the Options

Fleet management information systems (FMIS') are generally available from these three sources:

(1) Fleet Management/Leasing Company Systems. Many major leasing service providers (often called "Fleet Management Companies") offer their clients a fleet maintenance/management system as a value-added, extra-cost service. Some are well-designed fleet maintenance systems that feature work orders, VMRS[19] code tracking, exception reporting, fuel tracking, detailed fleet analysis, reports and more.

In addition to their fleet maintenance information systems (FMIS), most leasing companies offer their clients a range of extra-cost additional services. These include fleet analysis services, telematics, fuel cards, driver license management, specifications development, advisory services, and more. In addition, FMIS systems managed by leasing companies are often connected online to their call centers, which enable on-road assistance for breakdowns and accidents.

FMIS's offered by 3rd party leasing/fleet management companies can be a viable option for clients who do not wish to invest in or manage an in-house fleet maintenance system.

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[19] VMRS, or Vehicle Maintenance and Repair Standards, was developed by and for equipment users under the auspices of American Trucking Associations, in the 1970's. VMRS is a structured coding system, providing the discipline necessary to operate in today's computer-based information age or — where desired — as a completely manual system. Simple in concept, VMRS can be used at any level, from total operating systems down to the individual part level. The level of coding used is entirely up to the user. One can select the level of reporting detail at any time without the need to redesign the coding structure or implement costly new programs. No matter which level the user selects, the data collected can be compared directly to data collected by others at the same or higher VMRS coding level.

(2) Enterprise Resource Planning (ERP) Systems. ERP is the integrated management of main business processes, often in real-time and mediated by software and technology. ERP is usually a category of business management software — typically a suite of integrated applications —that an organization can use to collect, store, manage, and interpret data from these many business activities. ERP provides an integrated and continuously updated view of core business processes using common databases maintained by a database management system.

ERP systems track business resources — cash, raw materials, production capacity — and the status of business commitments: orders, purchase orders, and payroll. The applications that make up the system share data across various departments (purchasing, HR, accounting, etc.) that provide the data. ERP facilitates information flow between all business functions and manages connections to outside stakeholders.

ERP solutions may offer a built-in fleet maintenance component. Like most data systems, ERPs constantly evolve, but the fleet component of these systems – *from our perspective and experience as fleet management consultants* – typically lack functionality and fall short of a fleet manager's needs.

For example, in some ERP systems, preventive maintenance (PM) scheduling functionalities may have been initially designed for managing plant or building assets, for which PM inspections are based on a single parameter such as a time interval (i.e., days, weeks or months or even years) since the last PM. Unfortunately, this approach will not suffice for a fleet since vehicle assets are more dynamic than buildings and physical plant assets. Vehicles require more frequent, more complex, and often more demanding scheduling parameters.

Examples of multi-parameter PM scheduling functionalities are events that are:

- Scheduled for when the vehicle(s) meet the first of a pre-determined limit of kms-travelled, or an hours-operated threshold *in addition* to the time (days, months) elapsed since the last PM

- Based on liters of fuel used between oil changes or the last time the brakes were adjusted

- Timing of annual mandatory SGI commercial vehicle inspections required one calendar year after the last event

- Based on engine, or truck component manufacturer's requirements that have specific and unique scheduled PM requirements and intervals.

For the reasons we've described, our opinion is that the blanket, one-size-fits-all approach used in some ERP systems will not suffice. PM scheduling in an FMIS must allow for customized schedules unit by unit. Therefore, a robust, well-planned, dedicated, purpose-designed FMIS system will enable easily customizable, flexible, multiple-parameter PM scheduling.

3) 'Best of Breed" Dedicated, Fleet Maintenance Software. Several examples of 'best of breed' fleet maintenance information software (FMIS) offerings are available in today's marketplace. Many of these programs are mature technologies developed years/decades ago and have constantly evolved and been finessed since their inception through user feedback, regular upgrades, and enhancements.

Best of breed FMIS providers focus on one thing – providing the best possible software for managing a fleet through automation. Fleet maintenance software developers only focus on providing fleet managers with the best possible software solutions. They are not interested in managing other types of municipal or physical plant assets.

Automotive FMIS' are designed using automotive fleet jargon and terminology meaningful to fleet managers; they feature asset categories and classification protocol unique to vehicles. In addition, their reports are designed to have meaning and purpose relative only to vehicle operations.

FMIS software developers' sole purpose is designing, developing, and supporting the best possible fleet maintenance systems for their fleet clients. That said, among FMIS providers, some systems are superior to others. The key to finding the right FMIS solution is to identify the requirements of the fleet upfront, then systematically analyze all available systems' functionalities.

Desirable attributes for a dedicated best of breed FMIS package include:

- Ease of use for users of all levels of experience
- Data integrity and reliability
- Ability to seamlessly interface with existing (or planned) fuel, accounting, telematics, dispatch, human resource, ERP, EARMS and other corporate systems
- Detailed, searchable vehicle maintenance histories
- Due or overdue PM services or inspections
- PM scheduling with customizable and multiple parameters and triggers
- Shop workflow management
- PM worksheets that set out tasks
- Standard job/task descriptions based on automotive needs
- Work pending lists with issues displayed in priority order
- Parts inventory management (purchases and issuance)
- Fuel system interface to track and reconcile (i.e., bulk fuel-purchased versus fuel-dispensed) and to also track on-road retail or card lock purchases at the unit level
- Backordered parts that need to be reordered
- Repair orders that are open and in progress

- Employee driver licenses, physicals or other admin. items needing attention
- Equipment with licenses, permits or any other scheduled admin. items needing renewal
- Open parts returned to a vendor and awaiting a credit
- Tire management data displaying tires in need of attention
- Monitoring of fuel costs, consumption, and efficiency trends
- Historical data and custom benchmarks
- Exception management, identifying units and drivers with poor fuel efficiency
- Tracking any/all persons associated with fleet operations, from their files, records and photos to ongoing data related to productivity, repair history and costs
- Commercial driver's license (A, D and Z levels) and physician examination renewals, and more.
- Ensuring control of external vendors by tracking all activity and purchase history, as well as their terms and contacts
- Simplifying the tracking and reporting of warranty costs as they are incurred – without the added time and cost of manual entry
- Keeping the fleet in compliance with safety regulations and eliminating fines by automatically scheduling driver license renewals and physicals, tracking mechanic certifications, and more.
- Supporting the full 9-digit VMRS codes for labour and parts on repair orders and external repairs, quotes, authorizations, and repair order import
- Tracking VMRS codes to labour lines on repair orders and quotes for failure analysis on buying decisions (i.e., monitoring cost per km for tire brands, engine or driveline types, make/models of vehicles)
- Operational, management and executive reports, as well as the ability to create customized reporting on any aspect of the fleet
- Ad Hoc reporting: Fleet cost and performance immediately including tracking of costs and performance by category of equipment, fleet tracking reports combining operating and cost data, year-to-date fleet expenses, parts inventory values, life cycle management and personnel productivity, fuel management trends tracked period-over-period or year-over-year, and depreciation, insurance and recurring cost auto-posting, total fleet operating costs and cost-per-km data and more.

Purpose-designed FMIS programs employ automotive fleet industry-specific jargon and specific reporting functionalities required for automotive fleet use. Their developers have focused decades of effort on designing software programs specifically for effective and optimized vehicle fleet management.

For optimal fleet asset management, the need for accurate and accessible fleet operating data – such as obtained from the use of a dedicated and purpose-designed FMIS – cannot be over-stated. An example is the issue of aging fleet vehicles. Older, under-utilized vehicles may show as costing less, when, they may be stranded assets if allowed to continue to be under-utilized until eventual retirement/replacement.

We feel it is advantageous when fleet data is readily available in an easy-to-use fleet management information system that allows management to see and be guided by vehicle usage and cost patterns and trends. This type of information is best accomplished with a purpose-designed vehicle FMIS that features standard fleet management reports targeted on fleet optimization.

Electronic Logging Devices

The ELD mandate, also known as the electronic logbook law, is a federal law. It requires all qualifying commercial motor vehicle drivers to use their electronic logging devices to record driver and vehicle activity. This includes hours of service (HOS) and records of duty status (RODS).

The ELD mandate (sometimes referred to as the e-logs mandate) states that drivers of commercial motor vehicles must use ELDs. This technology has been mandatory in the U.S. since December 18, 2017. Canadian fleets are required to start transitioning to electronic logging devices (ELDs) as the Canadian transport ministry announced new regulations.

The Transport Canada ELD mandate for commercial drivers was aimed at improving road safety and came into effect in June 2021. From that date, e-logs have been required for federally regulated motor carriers in Canada. In May 2021, the Government of Canada announced that a progressive enforcement period would be rolled out for all jurisdictions, ending in June 2022. However, to give the industry, provinces, and territories time to get ready, the progressive enforcement period will be extended until January 1, 2023. From that date onwards, drivers will be penalized for not using a certified ELD when required to do so.

Drivers of commercial buses and trucks in Canada are required to self-report their on-duty, off-duty, and daily driving time, according to the Commercial Vehicle Drivers Hours of Service Regulations. Drivers must keep a daily log of driving records.

Canadian ELDs must meet the Technical Standard for Electronic Logging Devices published by the Canadian Council of Motor Transport Administrators (CCMTA) which outlines the minimum requirements.

Canadian ELD regulations mimic U.S. regulations in that the ELD are required to:

- Synchronize with the engine
- Provide GPS tracking
- Capture drive time automatically
- Use an on-screen display to show inspectors at roadside
- Allow special driving statuses – Yard Move (YM) and Personal Conveyance (PC)
- Have a mechanism to verify logs and agree to edits

Logbook Exemption

Under the Saskatchewan SGI regulation[20], a driver is not required to keep a daily log for the day if:

- On the operator's instructions, a commercial motor vehicle is driven solely within a radius of 160 kilometres of the driver's starting location

The Saskatchewan regulations can be found here:
https://www.sgi.sk.ca/documents/625510/2584690/provincial_hours.pdf/87b0b1de-80bd-40ae-829a-f88930a102cb

Logbook exemption can create confusion when dealing with municipalities within 160 kilometres of the drivers starting location. Many believe this exempts municipalities from tracking hours of service. However, if a driver is not required to keep a daily log, the operator (City of North Battleford) may be obliged to maintain these records for the day.

The exemption from having to keep a logbook does not exempt a driver from being in compliance with the remainder of the Hours of Service (HOS) regulations; it applies only to the requirement of maintaining a logbook. If any of the above conditions that exempt the driver from keeping a logbook end, then the driver must maintain a daily log for each day he/she does not qualify for the exemption.

AVL/GPS Systems and ELD Systems – Decision-Making

Automatic Vehicle Locating (AVL) and Global Positioning System (GPS) systems have been a growth industry since they began to emerge about two decades ago. The commercial fleet industry has seen many AVL/GPS telematics providers come and go through corporate mergers and acquisitions.

ELD systems, being an adjunct to AVL/GPS and relatively new, have already seen their share of providers. Of the industry leaders, deciding which solution is the best fit can be challenging. The key to success in selecting a system is identifying specific business needs and goals, then making objective comparisons between the industry leaders. The City's Fleet and Maintenance Department has selected the Nero system.

Challenges

Maintaining historical digital records of daily trip inspections and hours-of-work data are as critical as the current-day practice of retaining paper-based, hard copies of inspections. Paper-based, hard copy records are virtually permanent and require filing, archiving, and storing the forms in a safe area in readiness in the event they are ever required for audit, or other purpose. Digital records are

[20] Source: http://www.mto.gov.on.ca/english/trucks/commercial-vehicle-operators-registration.shtml

vulnerable, in that data can be deleted unintentionally and backup servers can fail. Therefore, historical data storage is a significant concern that must be addressed.

Recommendations

- The City would benefit greatly from a Fleet Management Information System (FMIS) as we have described in this section.
- A needs-analysis review should be completed regarding City of North Battleford's requirements for an FMIS. Fleet Challenge has developed a FMIS needs-analysis tool for this purpose, and we will make it available to City of North Battleford for the asking.
- We recommend acquiring a purpose-designed, "best of breed" dedicated FMIS. There are many excellent options available (but a needs-analysis approach should be used to make the selection as to which option is best-suited.)
- Prepare interfaces between whichever FMIS is chosen to any other system in use such as fuel dispensing, accounting, and human resource systems.
- Consider expanding GPS based telematics to all units. Telematics data can greatly facilitate key data transfer between vehicles and corporate management system.
- We recommend that City of North Battleford should seek advice from its legal counsel regarding the issue of driver's daily vehicle inspections, hours of service and the use of electronic logging devices. This topic has become controversial as it pertains to municipal operations.
- Whether using ELDs, or paper-based systems, ensure that driver's daily circle checks are in place, that evidence of the fleet mechanics follow ups and corrections are in place if/when defects are reported by drivers, and documentation is maintained/archived in the event of a safety audit.

2.7 Human Resources

In a commercial vehicle fleet operation, the topic of human resources (HR) pertains to a fleet's management, support personnel and fleet maintenance technicians. Our HR review extends to the drivers of fleet vehicles and equipment operators and includes orientation practices, and driver training aspects. Therefore, in this section of our report, we focus on both areas of human resources which have touchpoints to the fleet.

Overview

Fleet Business Structure

The Fleet section has a reporting structure typical of most municipalities and private sector organizations. Management personnel includes:

- A Fleet and Maintenance Manager
- An Equipment Supervisor

Unionized personnel include:

- Two licenced journeymen Mechanics
- One unlicensed Fleet Maintenance person

Fleet management also has a part-time administrative support person.

The Fleet Mechanics are members of CUPE; the next bargaining of the current collective agreement will take place in 2024. Mechanics are expected to provide their own hand tools.

Within the Fleet team, there are clearly defined lines of responsibility, beginning with the shopfloor fleet mechanics and maintenance person. Upward reporting is hierarchically and logically stratified and includes a Fleet Equipment Supervisor and the Fleet and Maintenance Manager.

Mechanics provide their own hand tools, and the City does not subsidize their cost.

Fleet Drivers and Operators

- New equipment training is provided for drivers/operators, but it has not been provided historically for mechanics – Fleet management is doing so now.

- Fleet management orchestrate orientation sessions on new equipment for drivers and mechanics.

- Summer students are not receiving formal driver training.
- Mechanics are open to learning and attending any recommended courses.

Best Management Practices

The Fleet Management Team

For most mid- to large-size municipalities, the fleet is usually one of the top expenses on the corporate balance sheet. For this reason, municipal fleets engage the focused attention of a professional Fleet Manager with responsibilities solely focused on fleet management.

Management Staff – Personal Development

Whether managing a small local fleet or overseeing a large, diverse fleet, specialized skills and knowledge are required to make well-informed business decisions. Therefore, fleet management personnel should continually seek specialized training and personal development opportunities for themselves and their team, to continue to grow their fleet management expertise and knowledge. Options include membership and participation in industry organizations that offer relevant training and education, college and university courses, and a variety of personal skills development classes and networking events.

Although difficult during the present time due to the Covid-19 pandemic, attendance and participation in fleet management networking and information/training events can result in an enthused, focused, refreshed, and motivated fleet management team and potentially result in new take-home best management practices.

The NAFA Fleet Management Association www.nafa.org is one example of an industry organization that offers a Certified Automotive Fleet Manager (CAFM) program. The American/Canadian Public Works Association (www.apwa.net<http://www.apwa.net) offers a Certified Public Fleet Professional (CPFP) program that is oriented toward public sector municipal fleets.

We believe that regular attendance at fleet management conferences should be part of personal development plans for those involved in managing and maintaining the fleet. Examples of annual events are NAFA sessions and the annual Fleet Technology Expo. The knowledge gained from attending these events more than justifies travel and accommodation expenses, and a side benefit may be morale and confidence-boosting. They are rich in content, offer learning and networking opportunities, and have the potential to save money and increase fleet efficiencies that may result in a net benefit to City of North Battleford.

For these reasons, we urge participation in personal development and networking opportunities for those engaged in managing the fleet. Additionally, the staff (technicians and support staff) who are carrying out maintenance and other fleet-related tasks would benefit from personal/career development training or peer networking events.

Fleet Maintenance Technicians

Recruiting qualified vehicle technicians in today's market is a perennial problem. Retaining technicians is also often problematic as some skilled, licenced technicians may be lured away by potentially higher earnings elsewhere. Some vehicle technicians may also be attracted to less physically demanding jobs. Recruiting and retaining suitable new technicians, with the requisite training, skills and endorsements may be challenging.

City of North Battleford now employs two licensed journeymen mechanics. In the future, mechanics will require additional skills-training to service emerging technologies, such as electric vehicles.

Staff Requirements

Calculating Labour Demand

Fleet Challenge completed a fleet maintenance demand study to evaluate the adequacy of current technician staffing levels at City of North Battleford. By calculating the frequency, the estimated labour hours required for PM inspections, and the number of each type of vehicle in the fleet we calculated total preventive maintenance demand (in terms of person/hours).

From this value, knowing from experience and past data that a PM Ratio of .50 delivers a high level of uptime, we calculated reactive repair demand (also in terms of person/hours). By adding PM (and SGI mandatory inspections) demand to reactive repair demand (PM Ratio of .50) we calculated total labour demand for fleet maintenance.

As in all human endeavours, there is variability between each technician's productivity levels. Also, there may be variability between vehicles, even those of the same categories, which can make maintenance less – or more – demanding. For this reason, we calculated total labour demand using low and high estimates of the time required to perform PM and reactive repairs.

The low estimate of total labour demand to service the full City of North Battleford fleet today is 8,538 person/hours and the high estimate is 14,102 person/hours.

Calculating Labour Capacity

We calculated the labour capacity for each full-time equivalent (FTE) Fleet Mechanic/Technician. To do this we began with the total annual, on-duty, direct labour hours for each person. We subtracted statutory holidays, paid vacations, lieu time, breaks, safety (and other) meetings, training, and an allowance for other indirect (unproductive) time such as delivering vehicles, meeting with drivers, reviewing vehicle issues, road tests, completing work orders, etc. The net annual labour capacity (wrench time) per each FTE Fleet Technician is **1,368** hours.

Calculating Fleet Technician Requirements

With lower and upper estimates of maintenance demand established, and net capacity per FTE calculated, we compared total fleet maintenance labour capacity relative to demand. Based on the *lower estimates* of baseline labour demand for attainment of all PM, SGI inspections, and reactive repairs, we determined that **six** technicians are required today to meet the current demand. Based on *upper estimates* of maintenance demand, 10 FTEs would be required. Today, City of North Battleford currently employs **three** FTE Fleet Maintenance Mechanics & Repair persons.

Accounting for Growth

The City of North Battleford estimates a 1% growth rate per year. Albeit a small increase, the increased population may, in all probability, require additional resources in terms of municipal employees. These additional employees will require mobility regarding vehicles and equipment, which may translate to an increased fleet size.

What this means to the Fleet management section is that more vehicles and equipment will increase fleet maintenance labour demand. It may also create additional demand for garage bays to perform maintenance.

For reasons of the expected growth of City of North Battleford, we began by calculating the number of fleet technicians and garage bays required today, as described in *Section 2.3 – Fleet Maintenance*. We then increased demand commensurate with the expected population growth in the next decade. We estimated an increase in fleet size of 43 units by 2032.

Based on the potential of a fleet size increase by 2032, **seven** fleet maintenance technicians at low demand and **eleven** mechanics at peak demand would be required to keep up with additional demand. Please see the *Future Fleet Maintenance Technician Labour Demand* in *Table 5* (below.)

Table 5 - Future Fleet Maintenance Technician Labour Demand

No. of FTE Techs Required for Reactive & PM Demand LOW (baseline yr.)	No. of FTE Techs Required for Reactive & PM Demand HIGH (baseline yr.)	No. of FTE Techs Required for Reactive & PM Demand LOW (+10 yrs.)	No. of FTE Techs Required for Reactive & PM Demand HIGH (+10 yrs.)
6	10	7	11

Recruiting Motor Vehicle Technicians

Recruiting qualified motor vehicle technicians in today's market has been a perennial problem but this was not the case at the beginning of this century. To better understand the downward trend in licensed technicians, we looked at a 2019 study conducted by the Canadian Apprentice Forum (CAF). From 2004 to 2010, the number of registered apprentices increased from 99,500 to 145,300.

In 2014, the number of registrants began to decline due to downward trends in oil and other commodity prices (decrease of 7,100 registrants between 2014-2017.) Ever since, the number of registered apprentices stayed consistent but the demand for qualified candidates has increased steadily. Projections for 2019 and beyond show nearly as much demand as there is supply of apprentices which will put the industry at an even more dramatic deficit for qualified motor vehicle technicians soon.

Recruiting and retaining technicians with multiple licenses is even more difficult and oftentimes organizations will settle with those holding, or apprenticing, for one license type.

To develop and maintain a strong pool of skilled workers, recruitment and retention incentives must be considered and these can be widely various depending on the candidates. In general, studies have shown millennials are incented by much different rewards that their baby boomer counterparts; therefore, recruitment and retention strategies should also be customized, ensuring equality and inclusiveness.

Retaining Motor Vehicle Technicians

Pay Scale

While a competitive pay rate is a benefit for employees, it also benefits employers. Employers offering excellent wages have employees who are more productive and engaged. A major cause of employee turnover is pay rate. If employees feel that they aren't being paid enough and are able to find higher-paid work elsewhere, they'll quit and move on. Employee turnover costs companies' huge amounts of money. The cost of replacing and training new employees exceeds the amount of money saved by offering lower pay.

Today, many Canadian employers are using recruitment firms to find skilled, licensed motor vehicle technicians and some are offering potential candidates attractive sign-on bonuses.

Stability and Predictability

In very general terms, experienced, licensed technicians are often looking for consistent, regular shiftwork (either day, afternoon, or weekend shifts). Rotating shifts, although useful to provide coverage for the company, are often difficult to administer, complicated to adjust for short term disruptions (sick leave, vacation, unforeseen circumstances) and can be unappealing to technicians who require more consistency. This is especially true for young apprentices trying to balance school, work, and appointments or those with young families trying to balance a busy home life.

Work Environment

Employee retention is often incumbent on a good working environment. For Fleet Technicians, work environment extends to their working relationship with fleet management and staff, user-groups, and co-workers. No one likes spending their working hours in a toxic, unhappy environment.

Work environment includes the physical workplace, in this case the fleet garage, and the shop equipment technicians are provided to do their jobs. Work environment extends to garage lighting, noise levels, safety equipment, heating, and ventilation, and more.

Fleet Technicians Survey

To determine the level of satisfaction of the City of North Battleford Fleet Technicians we issued a survey to the group. A full overview and analysis of the survey results is found in *Section 3* of this report. However, in terms of shop practices and workspace, Fleet personnel are, overall, concerned about the current number of staff as well as the availability and adequacy of workspace to serve an increased fleet size.

In the ‘freestyle” section of our Fleet staff survey we received the comments below, when asked for their suggestions on how Fleet department could be improved for its internal customers:

- *“Additional resources to complete work - more staff or more service contract suppliers”*
- *“More technicians to repair more equipment internally rather than hiring 3rd party companies that offer subpar repair service and high shop rate. In house repair allow best quality and potential modifications to address the root cause of failure.”*

- *"I feel that we have great techs with a fantastic level of standard, but where we are very lacking is in the manpower to do the job. Since I started, we have increased the frequency of preventative maintenance, but it's nowhere near enough we lack people"*

The above comments are consistent with Fleet Challenge findings that the current number of fleet maintenance personnel is inadequately matched to fleet size.

Their overall levels of satisfaction or agreement with shop operations and workflow median response rates were as follows:

- Suitability of tools and shop equipment 3.5/4 (a positive response rate)
- Proper maintenance of tools and shop equipment: 3.8/4 (a positive response rate)
- Lack of availability of bays: 4/4 (all agreed as to the lack of availability of bays)
- Work delays experienced due to unavailability of a work bay: 3.5/4 (most agreed delays experienced)
- Cluttering of bay areas due to lack of space: 4/4 (all agreed)
- Adequacy of hoists and/or other vehicle lifts: 3/4 (a positive response rate)
- Adequacy of current staff numbers to service vehicles and equipment: 4/4 (all agreed staff count is inadequate)
- Access to fleet vehicles from shop locations: 4/4 (all agreed good access)
- Adequacy of current shops to serve an increased fleet size: 4/4 (all agreed garage is inadequate to service additional vehicles)

Fleet personnel evidently have concerns about staffing levels and the need for additional workspace.

Recommendations – Fleet Personnel

- Additional fleet maintenance personnel are required to keep up with maintenance demand based on current fleet size

- In the labour time codes of an FMIS (see Section 2.6 on fleet management information systems) monitor Fleet Maintenance Technician job times to confirm delays caused by insufficient personnel, or an inadequate number of garage bays to maintain the fleet.

- We urge participation in personal development and networking opportunities for those engaged in managing the fleet. We recommend fleet educational training courses. The NAFA Fleet Management Association www.nafa.org is one example of an industry organization that offers a Certified Automotive Fleet Manager (CAFM) program. The American/Canadian Public Works Association (www.apwa.net<http://www.apwa.net) offers a Certified Public Fleet Professional (CPFP) program that is oriented toward public sector municipal fleets.

- All staff who are carrying out maintenance and other fleet-related duties would benefit from personal/career development training or peer networking events.

- Consider electric vehicle training and accreditation for Fleet Maintenance Mechanics when such courses and upgrades become more readily available.

- Consider an apprenticeship for the Fleet Maintenance person now employed by the Fleet and Maintenance Department

Commercial Fleet Drivers

Driver Training

In most public sector fleets, the drivers of fleet vehicles are managed by, and the responsibility of, the vehicle user departments. The Fleet Department typically plays a supporting role in providing driver training, and the drivers of fleet vehicles can directly impact the fleet's safety rating.

For reasons of due-diligence, worker and public safety, and skills-enhancement, engaging the services of a fleet driver and equipment trainer is an essential best management practice for municipal fleets. Driver training programs vary between municipal fleets but typically include pre-hire and orientation sessions, on-road training, abstract reviews, remedial one-to-one training for drivers who have had repeat incidents, and refresher training courses.

There are no published standards or guidelines around how frequently driver refresher training should take place. Credible published recommendations or best practices on these matters are not readily available from any known source. In the author's own experience as a former fleet manager responsible for providing driver-training for 1,500 commercial drivers, yearly driver refresher training was determined to be the optimal interval for providing a Professional Driver Improvement Course (PDIC) to all drivers.

Over time, many things can change regarding rules and regulations that affect commercial drivers. As well, physical, and mental changes that may impact the performance of individual drivers can occur; onset of disabilities may be gradual and not immediately detected by the affected individuals or their employer.

There is no single answer to the question of how frequently driver training should take place; it is something that should be determined by trend-analysis. Our recommended approach is to begin by ramping up training in increments, starting with the highest-frequency groups as identified by studying past trends (such as light-duty vehicle drivers versus medium/heavy-duty truck drivers). Continue to monitor the impacts of the additional training and then make course-corrections as required until collisions begin trending downwards.

Driver Guidebook

A driver's guidebook (or handbook) is an invaluable aid for new-hires and existing employees alike. Leading fleet managers ensure that such a document is available and up to date. This ensures consistency in fleet operations.

At minimum, a driver's guidebook should describe standard operating procedures, practices, and policies around vehicle operations. It should include contact information and inform drivers about fueling, emergency and accident procedures, and provide tips about safe and eco-friendly vehicle operations. Preparing a guidebook is an excellent job for a summer student or intern.

Driver Records

In Canada, regulations governing commercial vehicles, drivers, and motor carriers are based on the Canadian National Safety Code (NSC) standards. The NSC is a code of minimum performance standards, applying to all persons responsible for the safe operation of commercial vehicles[21].

In Saskatchewan, every carrier shall maintain a copy of the following for each driver who operates the carrier's commercial vehicles[22]:

> (a) a copy of a valid driver's licence, including all documents deemed to be part of the driver's licence; and
> (b) subject to subsection (2), a copy of the driver's driving record.

A carrier shall ensure that each of its driver's driving records is kept up to date and contains information respecting the driver's driving record for at least the previous 12 months.

Driver's Daily (Pre-Trip) Inspections

The purpose of the driver's daily vehicle inspection is to ensure that problems and defects have been identified before the vehicle is operated on the highway. Inspections prevent the operation of a vehicle with problems that are likely to cause or contribute to the severity of an accident.

HTA Regulation 199/07 contain the requirements for daily (pre-trip or "circle check") inspections that must be completed within 24 hours before driving.

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[21] Source: http://www.cvse.ca/index.htm

[22] Source: The Commercial Vehicle and Drivers (Record-Keeping) Regulations being Chapter H-3.1 Reg 22 (effective March 4, 2004) as amended by Saskatchewan Regulations 4/2005,117/2010,98/2015 and 52/2021.

How Daily Inspections Work

- The vehicle is inspected by the driver before it is driven
- The inspection is conducted with the use of a schedule listing the vehicle components and systems that require inspection
- An inspection report is completed
- The inspection and report are valid for 24 hours
- The driver carries the inspection schedule and report in the vehicle
- The driver records on the report any defects found while enroute and at the end of the trip or day
- The driver reports defects to the operator at the time they are discovered – the operator must repair the defect immediately or before the next dispatch and keep records of repair.

How to Complete a Daily Inspection

An inspection procedure (circle procedure or walk-around) that best suits the vehicle and its location can be chosen. No matter which order of items one chooses, each item on the applicable inspection schedule must be inspected.

Defects must be recorded on the inspection report, and the operator notified about them. Drivers must carry and produce an inspection schedule based on their vehicle, as well as a corresponding valid inspection report. If no defects are found on the vehicle, as defined in the inspection schedule, then "no defect" is recorded, and the inspection is valid for 24 hours.

If a "minor" defect is found on the vehicle, as defined in the inspection schedule, the defect must be recorded and reported to the operator as soon as possible. The operator is required to repair any defects that do not meet the performance standards. The inspection is valid for 24 hours.

If a major defect is found on the vehicle, as defined in the inspection schedule, the vehicle cannot be operated. Drivers must record the defect, report it to the operator immediately, and the vehicle must be repaired prior to being driven.

If a defect as defined in the inspection schedule is identified after the inspection is completed, the defect must also be recorded and reported to the operator. Should the identified defect be a major defect, drivers must stop operating the vehicle until it is repaired.

The National Safety Code program office monitors all carriers, and each is given a safety rating. This rating is determined by their:

- On-road performance, and

- Record-keeping and safety-monitoring performance (if the business has been audited by a Carrier Safety Inspector).

The SGI Carrier Profile

The Carrier Profile system collects data on accidents, convictions, roadside inspections, and facility audit results for Saskatchewan commercially licensed vehicles. This information is recorded in the Carrier Profile system under the NSC number of the appropriate carrier.

The Carrier Profile Program monitors the performance of each carrier. Each infraction is given a point rating based on the severity of the infraction. If the total number of points reaches or exceeds a threshold level, the carrier's file will be moved into the Compliance Review Program (CRP). The carrier may be subjected to a facility audit by SGI – Carrier & Vehicle Safety Services.

Recommendations – Fleet Drivers

- Fleet management should regularly review its SGI Carrier Profile - annually at a minimum; more frequently is better.

- The SGI Carrier Profile should be treated as "sacrosanct," and we recommend considering a third-party mock audit to identify gaps in the City's fleet safety program.

- Obtain and review driver abstracts annually at a minimum or, better, quarterly.

- Consider engaging a driver trainer for regular driver/operator training, whether in-house or from an external service provider.

- Monitor vehicle and equipment collisions and claims. Segment collision data into vehicle categories (light-duty vehicles, medium and heavy trucks). Study collision trends to determine the drivers requiring more focused training.

- Consider posting costs for at-fault vehicle collisions or negligent damages to user departments whose drivers were responsible, thereby potentially incenting departmental managers to take part in and support remedial actions for their drivers.

- Consider requiring Professional Driver Improvement Course (PDIC) training for all vehicle and equipment operators as part of their onboarding.

- Consider remedial PDIC training and testing and for drivers that have been involved in preventable collisions/incidents.

- Consider including fuel-efficient driver eco-training to add to driver safety training.
- FCC highly recommends Natural Resources Canada (NRCan) Smart Driver program. See: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/greening-freight-programs/smartdriver-training-series/21048#city
- Ebnforce an anti-idling policy and monitor vehicles that idle unnecessarily via Nero.

2.8 Fuel Management

The cost of fuel is usually one of the highest controllable costs for most fleets. Therefore, proactive fleet managers will make it one of their top priorities to ensure that their fleet acquires fuel as efficiently and cost-effectively as possible. Reducing fuel cost and use is critical, both fiscally and environmentally.

Best Management Practices

A best management practice aimed at reducing fuel usage is to monitor the fleet's corporate average fuel efficiency (CAFE). We feel that CAFE is one of the most important key performance indicators (KPIs) for cost- and GHG emissions-conscious fleet managers to monitor and take actions for improvement.

CAFE is directly reflective of a fleet's footprint. It is a measure that encompasses many facets of fleet operations ranging from driver behaviours (such as unnecessary idling, harsh driving, and unnecessary trips) to right-sizing of vehicles for their assigned tasks (getting the job done with more fuel-efficient vehicles) to the use of alternate and renewable low-carbon fuels. CAFE is also impacted by a fleet's average age, since older vehicles are less fuel-efficient than modern units and, consequently, cost more to operate and produce more emissions.

Similarly, auto/truck manufacturers are required to measure and report their CAFE to the government as this is reflective of the mix of the vehicles in their lineup and their corporate environmental footprint.

CAFE indicates the fleet's overall performance, and therefore we feel it is a key performance indicator (KPI) to watch closely. Improvements to this KPI are evidence that the fleet is on a healthy trend, and strategies undertaken to improve the fleet's performance are working. Baseline CAFE for the City of North Battleford fleet is included in the Fleet Analytics Review™ (FAR) modelling which FCC will provide separately to the City.

Exception Units – High Fuel Consumption

Frequent reviews of fleet exception units that are driving up fuel costs (and emissions) followed by remedial actions on a case-by-case basis are best management practices that result in reduced fuel usage, cost, and emissions.

The recommended course of action is to: (1) pinpoint the problem units, (2) find the root cause(s), and (3) take corrective actions.

The following are some considerations when managing high fuel exception consumption units:

- Are there mechanical problems in the vehicle(s) (i.e., scan test, check for fault codes in the ECM, or run a five-gas analysis)
- Are the vehicles matched to their job requirements (i.e., are the vehicles too big or too small)?
- Are the vehicles technologically outdated (i.e., modern electronic engine coupled with a programmable electronic transmission vs. outdated engine technologies and a driver-controlled manual transmission)?
- Can operational practices be improved upon (i.e., route planning, trip optimization)?
- Are units idling unnecessarily or driven harshly (i.e., managing driver behaviors)?
- Are there idling reduction technologies that can be employed (i.e., idling stop/start devices, auxiliary cab heaters or battery systems)?
- Are better transportation options available (i.e., mode shift – carpooling, car sharing, or employee-provided vehicles)?
- What are the weather impacts (i.e., was the past winter more severe)?
- Is the fuel posted to units going into the fleet's vehicles? Perhaps it's being used for gas-powered tools, other fleet vehicles – or possibly even being pilfered?

Driver Behaviours – Excess Idling

Engine idling is an unavoidable reality in municipal fleets, however *unnecessary* idling should be managed. Therefore, we recommend vigilance regarding *excessive or unnecessary* idling.

Most drivers wish to "do the right thing" and merely suggesting to them that excessive idling is not acceptable is often enough. For others, old habits are hard to break. All drivers would benefit from driver eco-training around the negative effects (i.e., fuel costs, emissions, health impacts) of idling. Fuel-efficient driving can come in many forms, from hiring an eco-training contractor to setting up an in-house eco-driving trainer or offering online training.

Idling vehicles are bad optics for any organization. The public is keenly aware of this issue, and bad opinions can develop from seeing a fleet's vehicles idling unnecessarily, wasting fuel and money as well as polluting the air. While there are times that idling is unavoidable, socially responsible companies take this matter seriously and do not allow their company drivers to idle unnecessarily.

Fuel System and Supply Management

Fuel usage reconciliation is a link in a chain of best management practices that ensures all fuel purchased by City of North Battleford is accurately accounted for and is used appropriately (i.e., the fuel is being used in the fleet’s vehicles and the potential for pilferage is mitigated). This requires accurate record-keeping of all deliveries and all fuel transferred to vehicles. A fuel spill or leakage into the ground could be catastrophic and mechanisms must be in place to detect fuel leakage. It is essential, for bulk fuel tank owners to monitor and reconcile fuel in all storage tanks.

Monitoring and reconciliation of fuel ensures spill detection and typically requires manual daily dips (level reading) of the fuel tanks and daily recording of the dip readings, or optionally the use of some form of electronic leak detection that provides an audit trail.

Recommendations

- Seek competitive bids for the fuel supply (e.g., via RFP, RFQ).
- Consider fuel hedging strategies or financial hedging of the fleet's fuel budget.
- Review fuel purchasing co-operative options that leverage the combined fuel volumes of the lower tiers and/or neighboring communities.
- For reasons of safety, compliance and accountability all fuel usage must be reconciled routinely and regularly. This means reconciling the bulk purchases versus the amount of fuel dispensed to fleet vehicles and the amount remaining on hand (in storage). Some fleets choose to do so daily while others reconcile each time a delivery of fuel is received.
- We recommend a review of all fuel management and distribution practices, including truck-mounted tanks used to fuel up vehicles.
- Track the fleet's CAFE regularly as a key performance indicator (KPI) aimed at reducing fuel usage. A fleet management information system (FMIS) will be required.
- Monitor the higher-than-average fuel users – which are the fleet exceptions – and take corrective actions. A fleet management information system (FMIS) will be required.

2.9 Green Fleet Facilities

In Canada and around the world, leading companies and all levels of government have developed Green Fleet Plans to set out their short- and long-term carbon reduction targets; some include strategies for air, land, and water pollution reduction.

A Green Fleet Plan may also include green initiatives for fleet maintenance facilities and parking garages. For fleets that outsource maintenance, plans may also define eco-standards for contractors, such as third-party suppliers. This section of our report is around current green fleet facilities and garage activities at City of North Battleford.

Overview

- There is no Green Fleet Plan at City of North Battleford.
- There is no electric vehicle charging infrastructure for future City of North Battleford electric fleet vehicles.
- There are no hybrid-electric vehicles in the City of North Battleford fleet.
- There are no fully electric vehicles in the City of North Battleford fleet.
- There are no alternate fuelled vehicles in the City of North Battleford fleet.
- There are no fleet vehicles powered by renewable fuels.

Best Practices & Recommendations

Eco-Friendly Fleet Maintenance Operations

Whether maintaining vehicles in-house or outsourcing this activity, the following are some eco-friendly procedures:

- Aqueous Parts Cleaners: Aqueous parts washers are a new generation of water-based small parts cleaning equipment that are safe and biodegradable yet have the cleaning power of traditional cleaning solvents. The City uses a green enzyme solvent which is better for hands and supposed to be eco-friendly but has to be warmed and is kept on a timer-auto set to “on” during the day, and “off” after-hours.

- Filter Recycling: Used oil, fuel, coolant, and air filters should be recycled.

- Waste Oil Recycling: Waste oils are picked up by vendors and re-used in the creation of new products from the recycled oils, including the recycling of motor oil and hydraulic oil. Oil recycling benefits the environment and lessens the likelihood of used oil being dumped on lands and in waterways. Service providers will pick up and recycle waste oils.

- Vehicle Washing: Vehicle washing processes can contain contaminants that are released into the groundwater, rivers, lakes, and streams. Preferences should be for re-using wash water and utilizing eco-friendly products. Staff should confirm wash areas are equipped with interceptors.

- Tire Recapping: Quality tire casings can be re-capped, extending their lifecycle and saving money. Ensure that all end-of-cycle scrap tires are disposed of in an environmentally friendly way.

- Synthetic Oils: Most engines today are compatible with synthetic oils. Synthetic oil is used as a substitute for lubricants refined from petroleum when operating in extremes of temperatures because, in general, it provides superior mechanical and chemical properties versus traditional mineral oils. Synthetics typically cost more but may extend oil drain intervals, thereby potentially reducing expense and wasting fewer natural resources.

- Green Technologies: Green vehicle technologies such as idle shutdown devices, battery backup systems for DC loads, auxiliary heaters, and others, will deliver fuel-efficiency increases.

Section 3: Fleet Management Practices Survey

Our organization recognizes the value of stakeholder engagement and user group participation in any go-forward plans under consideration by our fleet clients. With that focus in mind, FCC set out to gain fleet staff perspectives and opinions from City of North Battleford's vehicle drivers, equipment operators and management groups around various best management practices, level of service, and fleet greening.

FCC understands the importance of hearing the opinions of *all* stakeholders, including both management and staff. It was clearly communicated to all survey recipients that their responses were confidential and anonymous; as so, they were encouraged to express their opinions freely.

Surveys are not always the ideal method for collecting opinions and gathering information – person-to-person dialogues is better. It is known in the industry that people are often reluctant to provide their personal opinions in surveys; typically, survey response rates are known to only be in the 10 to 15% range. Knowing that feedback from stakeholders is important for go-forward planning, given Covid-19 preventing in-person meetings, as a workaround we instead conducted web-based online surveys. Online surveys can give participants a sense of freedom to speak candidly and voice their concerns.

Unique surveys were prepared for management personnel, unionized drivers/operators as well as Fleet Maintenance staff to gather views and opinions. Survey responses provided us with valuable feedback, which we will outline and discuss in this section. For select results we provide comments provided by respondents and median scores to key survey questions for each of the participant groups.

Fleet Maintenance Staff Survey

Fleet staff were surveyed, and we received the following comments in response to a general question: How would you suggest that the Fleet Maintenance Department could be improved for your internal customers? What are your ideas?

- *"Modern work order processes/technology. Additional resources to complete work like more staff or more service contract suppliers."*
- *"More technicians to repair more equipment internally rather than hiring 3rd party companies that offer subpar repair service and high shop rate. In house repair allow best quality and potential modifications to address the root cause of failure."*

- *“I feel that we have great techs with a fantastic level of standard, but where we are very lacking is in the manpower to do the job. Since I started, we have increased the frequency of preventative maintenance, but it’s nowhere near enough, we lack people.”*

Fleet staff were asked if the maintenance shop equipment was maintained properly and all agreed it was. Regarding the number of service bays, 75% of Fleet staff reported it is sometimes difficult to find available bays for completing repairs/maintenance. 100% replied that work delays occur due to the unavailability of work bays. These responses are consistent with our garage bay analysis that the number of bays is inadequate at times of peak demand (please see previous section: *Garage Bay Capacity Study*).

Regarding electric vehicles, 75% of Fleet personnel did not agree that electric vehicle (EV) replacements for current internal combustion engine vehicles would be capable of performing driver's job duties; 25% were undecided.

In the freestyle section of the Fleet staff survey, we heard the following about electric vehicles (note: the following are relevant excerpts from full comments)

- *“Anything to do with EVs in Canada is a joke and will never work. There will be more pollution and energy wasted, storing, and trying to recycle spent batteries and mining precious metals needed to build the batteries and electronic parts for EVs”*

- *“We have looked into EVs here, but our infrastructure doesn’t support them. It would mean massive upgrades to electrical services*”

Other Fleet staff comments included:

- *“Shared shop space and lack of technology are two of the biggest challenges. The old equipment needs a lot of attention that we don't have the resources for. The new equipment that we do have isn't getting the preventative maintenance it needs to prevent future problems.”*

- *“The biggest thing I see is that we need more people. We had a poor level of standard a few years ago but with changes in personnel, that has changed. We are striving to put the best product out there possible, but we can’t keep up with the mechanic numbers we have. It has been suggested that we lower our standards, but I don’t see that as a good option.”*

- *“More techs for internal repairs and more technician input on new equipment purchases. Mechanics know best what a good machine or problematic one is!”*

Driver/Operator Group Survey

Survey participants from the driver/operator group were asked about Fleet maintenance personnel's customer service and professionalism. Their mean response rate was 4.5 (out of 5) and the median rating was also 4.5 (out of 5) indicating a high level (of satisfaction). The group was divided but equally positive - half reported fleet maintenance *service and professionalism* were adequate and the other half felt it was excellent.

Regarding the *quality* of preventive maintenance (PM) and repairs, the driver/operator group's median survey rating was 3 (of a possible 4), indicating a high-level of quality.

However, regarding the *frequency* of preventive maintenance, the overall rating was 2.8 (of 4) – 25% of the group felt the frequency was "far too low", while 50% indicated they felt it was "adequate."

When asked about the age of the fleet's vehicles/equipment and if the current age is suitable for the duties they are required to perform, 75% of the group replied that fleet units are too old.

Management Group Survey

The City's management group were surveyed. Of 30 management respondents that started the survey, just 10 persons completed it. We have no way of knowing why only 1/3 of the City's management group responded and we will not speculate as to why. However, it is known there are many reasons why people do not participate in surveys[23]. Common reasons include a lack of interest, a belief that respondent's opinions don't matter, distrust or fear and fear of reprisal. (despite all survey groups being advised their responses are anonymous)

Regardless of the low management group response rate, those who chose to take part in the survey provided good insights. Regarding the Fleet Maintenance Department team's customer service and professionalism, all respondents reported "*good*" or better. 30% of the group responded at the median point, 60% were above median and 10% responded with "*excellent*".

As far as the frequency of preventive maintenance, 40% of the management group felt it was adequate while 40% reported it being inadequate (not enough frequency). 100% of the group believed that an increased number of preventive maintenance checks (i.e., intervals of 80 engine hours) would improve the reliability and safety of their vehicles. 70% of the same group felt that costs to their department were satisfactory.

[23] https://www.psychologytoday.com/ca/blog/the-science-behind-behavior/202106/why-customers-hate-participating-in-surveys

The management group was asked: Are the number of vehicles/equipment suitable for the duties of your area of responsibility? E.g., do you have enough units to get the job done? 90% of the group agreed they have enough vehicles – a full 30% (3 individuals) replied *strongly* in the affirmative, 30% replied above the median point and 30% indicated that the number of vehicles was acceptable. Just one person felt the number of vehicles was inadequate.

The management survey group was asked for their suggestions as to how things might be improved in the fleet. We received the following three responses:

- *"Start replacing vehicles and equipment on a 5 - 10-year cycle*."
- *"Some people should be in cars, smaller trucks, and vans.*"
- *"Having the proper vehicle for the job, a lot of the fleet is over sized and aged.*"

Management respondents were asked questions about driver training at the City. Regarding whether adequate driver training provided for *new-hires*, all respondents replied in the affirmative (yes, adequate new-hire training is provided). When asked about *driver refresher training*, all respondents (100%) felt adequate training was provided.

Regarding equipment operators, when management was asked if adequate *equipment training* was provided for *new-hires*, 60% responded in the affirmative, while 40% felt was inadequate. As far as whether adequate equipment *refresher training* was provided, the group was divided with 50% (5 respondents) agreeing there was sufficient training while 50% did not feel it was adequate.

We asked: "how could driver and equipment training could be improved to better serve your area of responsibility's needs" and "What is needed?". We received these comments:

- *"We need to have semi-annual training so we can schedule in training for our staff. There are times when there is no training for a couple of years on certain things*."
- *"Review the driving of each new hire before letting them use vehicles and equipment."*

We asked a series of questions about fuel usage and emissions reduction methods including fuel-efficient vehicles, less vehicles (e.g., fleet downsizing), right-sizing (e.g., smaller vehicles), alternate and renewable fuels, hybrid (gas/electric) and full-electric vehicles, responses were generally positive.

When asked the management group about switching some vehicles to all-electric (e.g., battery power only), 60% were in favour or strongly agreed while four persons either disagreed or strongly disagreed. When asked about switching new vehicles to hybrid units (gas/electric) 80% (8 of 10 respondents) agreed or strongly agreed. We asked several questions about electric vehicles and work equipment responses were positive.

Last, in a freestyle section of the management survey, we asked for suggestions on how the City of North Battleford can show leadership and join hundreds of other Canadian cities in reducing the greenhouse gases (GHGs) in their fleet and equipment operations. We received the excellent comment (below):

- *"Look carefully at the needs of the operators. Make sure that vehicles are right sized (usually smaller than what people desire). Look at the job, the history and the costs before deciding on new vehicle replacements."*

Section 4: Data Approach and Methodology

Fleet Challenge maintains that fleet asset management plans must be sustainable on three levels: financially, socially, and environmentally. For this reason, FCC's approach to developing our recommendations for City of North Battleford's Equipment and Vehicle Optimization study is based on data-modelling of the current situation, and optimized unit lifecycles considering return-on-investment (ROI) and assessing go-forward solutions. To complete this type of analysis, our team developed Fleet Analytics Review™ (FAR), a software tool designed specifically for complex green fleet planning and evaluation of short- to long-term fuel-reduction strategies, both in terms of cost savings and GHG reductions.

About Fleet Analytics Review™

Fleet Analytics Review™ (FAR) is a user-friendly, interactive decision support tool. FAR was designed to aid our team and fleet managers in developing short- to long-term fleet plans by calculating and simulating the impacts of vehicle replacement and fuel-reduction solutions on operating costs, cost of capital, and emissions. Moreover, it is used for long-term capital planning (LTCP) through an approach that works to balance, or smoothen, annual capital budgets and avoid cost spikes if possible. For a detailed description of FAR, please see *Appendix D*.

The FAR model is dynamic, and users can test future scenarios (such as assessing different vehicle types, fuels, or engine/drivetrain combinations) to see how such decisions impact operating expenses – ahead of their implementation, thereby heading off potentially costly errors. FAR was used by our team to assess the following:

1) **Long-Term Capital Budget Planning.** We data-modelled many long-term capital budget planning approaches. Included were the impacts of the lifecycle analysis (LCA) study we completed for the City, leasing of some units, and budget-balancing options.

2) **Management Practices.** We data-modelled in FAR to assess the cost-benefit, unit-by-unit and fleet-wide, of changes to management practices and operational improvements. These included right-sizing and downsizing the fleet, vehicle specifications enhancements such as improved aerodynamics, reduced rolling resistance, light-weighting, and others.

3) **Fuel Switching.** The cost-benefit and GHG reduction of switching vehicle fuels (e.g., diesel to gas or vice-versa and electrification) for some categories of vehicles

4) **Hybrid-Electric and Battery-Electric Vehicles.** We calculated the potential cost-benefit and GHG reduction, unit-by-unit and fleet-wide, of switching to hybrid-electric vehicles (HEVs), plug-in hybrid-electric vehicles (PHEVs), or battery-electric vehicles (BEVs). Transitioning to BEVs is the ultimate GHG reduction strategy for a fleet. In our analysis, we modeled tailpipe

emissions reduction; therefore, switching to battery-electric reduces fuel consumption by 100% applying this method. However, in terms of life cycle GHG emissions, BEVs are "fuelled" by electricity needed to charge the battery(ies), which can indirectly use fossil fuel depending on the source of electricity.

Variability of Data-Modelling Analysis

Fuel-reduction solutions will have variable rates of success. For example, if a highway trucking fleet opted for aerodynamics packages on their trucks it may takes years to phase them in fully, so full fuel-savings results will accrue over a period of time.

Similar logic applies to best practices based on human behaviour. With driver training, for instance, given that humans all have different rates of learning and information retention, bad driving habits may creep back in over time (or conversely, drivers may improve over time).

Similarly, regarding fuel switching, fuel-reduction potential are dependent on a multitude of factors, including driver training and habits, climates of operation, and maintenance cycles. For switching to EVs, which can be regarded as a fuel switch with the source of "fuel" being the electrical power grid, tailpipe emissions are zero and thus there is no range of fuel-reduction potential at the source (i.e., 100% reduction is achieved at the tailpipe). However, the amount of electricity that is needed to power these units will depend on the same aforementioned factors, influencing operation costs and GHG emissions depending on the source of electricity.

Steps to Producing the City's Equipment and Vehicle Optimization Study

FCC employs a multi-step approach in all fleet reviews and planning. For the City's Equipment and Vehicle Optimization study, the steps included:

1) **Baseline Analysis.** At the outset, it is crucial to confidently know the current fleet baseline in terms of several key performance metrics ranging from cost, service levels (such as utilization and availability rates), and emissions. For this step, we completed a FAR baseline analysis.

   For City of North Battleford, we received baseline data of the 425 in-scope units fleet from fleet management. The dataset provided to our team included a list of units, makes/models/years, asset values and ages, asset descriptions, fuel types, fuel costs, repair costs, and maintenance costs for a one-year review period (2020). Where CNB data was not available we substituted municipal peer fleet average data from our database. We loaded all input data into FAR and completed baseline analysis.

2) **Business-as-Usual Review**. Most fleets have in place standard, business-as-usual (BAU) protocol/policies regarding vehicle replacement, capital budgeting, and fleet modernization

planning. Fleet management generally employs pre-determined vehicle replacement guidelines (such as vehicles that will be replaced every “x” years or “y”-thousand kilometres travelled). We analyzed the long-term outcomes of City of North Battleford's vehicle replacement past practices in terms of impacts on annual capital budgets, operating costs, and GHG emissions.

3) **Lifecycle Analysis.** With FCC’s proprietary lifecycle analysis (LCA) software tool, our team input the fleet's historical data to calculate the optimal economic lifecycles for each vehicle category.

   For City of North Battleford, we completed LCA for select vehicle categories – those with sufficient data provided by the City as well as sufficient data from similar fleets in our municipal fleet database to determine optimal economic lifecycles.

4) **Data-Modelling of Optimized Lifecycles.** With a fleet’s optimal economic lifecycles calculated via LCA modelling, we data-modelled the outcomes in terms of long-term capital planning (LTCP). We modeled a 15-year capital budget plan to assess go-forward operating cost and GHG emission impacts based on optimal economic lifecycles.

5) **Business Case Optimization.** Some end-of-lifecycle vehicles due for replacement will deliver better return-on-investment (ROI) than others when they are to be replaced by new units. One reason is that some vehicles that are due for replacement may have had lighter usage than other similar age units. For vehicles in better condition, service life can be extended to optimize the total cost of ownership (TCO). Lower ROI would result if a vehicle, still in good condition, was replaced prematurely; value will be lost.

   For City of North Battleford, the approach used by FCC’s data analysts was to *defer* replacement of some vehicles to the ensuing capital budget years to ensure full value is received from each unit. Fleet managers everywhere must make tough vehicle replace-or-retain decisions like this each year to optimize and stretch the use of available capital.

   Using our ROI-based approach to deferrals, year-over-year long term capital budgets can be better balanced. Ideally, this step should be completed by Fleet staff based on vehicle condition assessments and to balance go-forward annual capital budgets. Without any knowledge of vehicle condition, for this step our team deferred any units which, based on the data provided, were shown to have lower operating costs (including cost of capital) than if replaced. This step allowed us to balance City of North Battleford’s long-term capital budgets based on optimal ROI.

6) **House-in-Order Actions.** We think it is essential to first get a fleet’s “house in order”. By house-in-order, we are referring to best management practices (BMPs) that should first be put in place, including:

- **Fleet Downsizing.** Reducing the total number of low-utilization vehicles by undertaking a review to determine if some vehicles can be eliminated through early decommissioning

- **Right-Sizing.** Specifying the correctly sized vehicles for the job at hand

Without knowledge of operational needs, it was challenging for our team to model fleet downsizing and vehicle right-sizing. Fleet Maintenance Department management best understands the needs and demands of their specific vehicles. For this reason, we arbitrarily data modelled the results from reducing the fleet size by all units with less than 25% of average utilization than similar category units in the fleet. We do not claim to have any level of understanding of operational needs and our choices for fleet downsizing must be vetted by the City's Fleet Maintenance Department team.

7) **Battery-Electric Vehicle Phase-in Planning.** Although there are numerous advantages of BEVs, few, if any fleets would – or could – replace all their internal combustion engine (ICE) units immediately with BEVs given capital budgets constraints and the fact that BEV offerings are quite limited at this time. This means that BEVs must be phased-in over many years. FCC believes that phasing-in of BEVs should occur based on optimized economic lifecycles and balanced long-term budgets through business case optimization (see Step 5). In other words, the first units to be replaced with BEVs should be those that have been assessed as the optimal candidate vehicles that will deliver the best ROI. These are typically units with higher utilization and fuel consumption.

8) **Electric Vehicle Supply Equipment Planning.** We assessed charging infrastructure needs and long-term capital planning (LTCP), based on Level 2 and 3 charging, battery capacity estimations, and cost estimations of electric vehicle chargers and infrastructure over the modelling period.

FAR Data-Modelling - Summary of Results

Via FAR data-modelling, we completed various cost/benefit and emissions analysis of the aforementioned options (see previous section of this report).

We prepared a chart that is shown in *Table 6 – FAR Data-Modelling Results* (below) which displays our findings.

For select highlights of the results shown in *Table 6*, impacts ranged from:

- Very high capital cost ($8.1m to $8.3m) vehicle and equipment replacement scenarios that would radically reduce the age of the fleet, which were forecasted to *increase* annualized operating costs from ~$23k to ~$34k (FAR data models 1x and 2x).

- A balanced long-term capital plan based on ROI (FAR data model 3x) that would *decrease* annualized operating expenses by ~$43k and GHG emissions by 185 tonnes CO_2e

- A fleet downsizing study (FAR data model 6x) that would reduce annualized operating expenses by ~$19k.

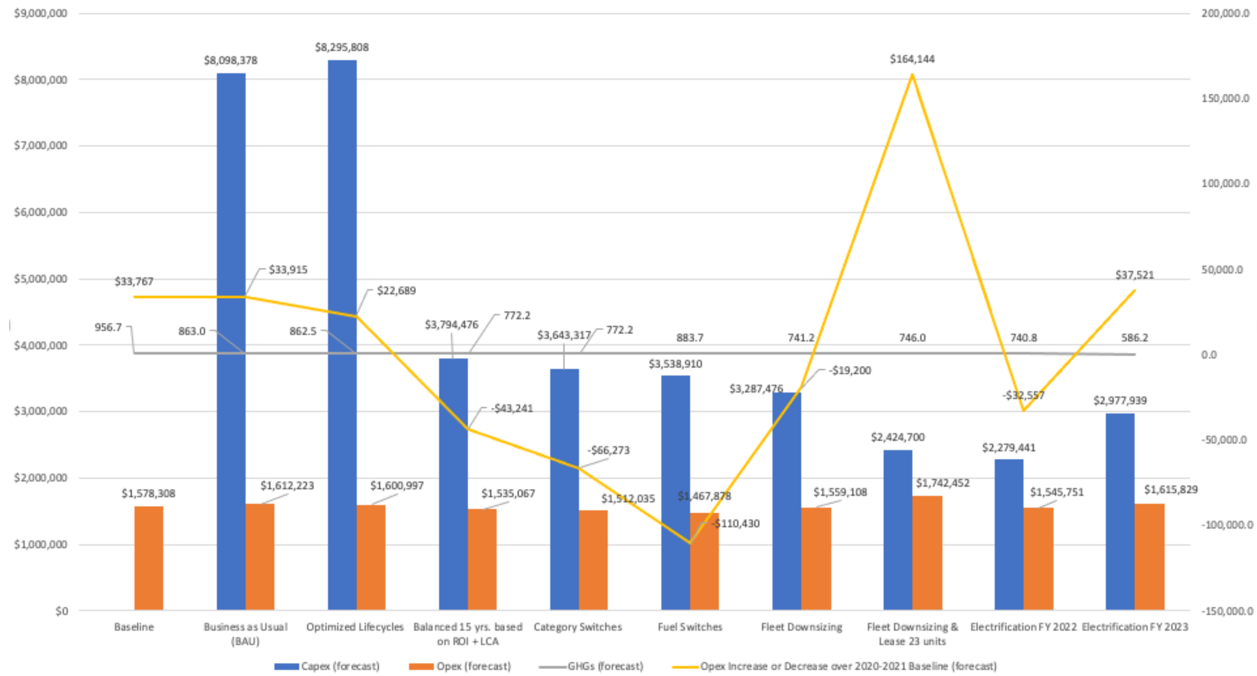
- A fleet downsizing study (as in FAR 6x) combined with leasing 23 units (FAR 6x(a) data model)) which greatly increased annualized operating expenses by an estimated ~$164k.

- Electrification of pickup trucks that are due for replacement beginning in year 2023 when EV pickups are expected to be available for purchase. This data model (FAR 7x) is estimated to decrease annualized operating expenses by ~$33k and GHG emissions by 216 tonnes CO_2e.

As depicted in *Table 6* (below) the results of FAR data-modelling we completed obviously vary greatly in terms of Capex, Opex and GHG emissions. We present the results and our detailed assessment and recommendations within this report.

Armed with this information we expect that the City of North Battleford management will be equipped with sufficient decision supporting information to make its choices regarding the go-forward path it selects for the fleet.

Table 6- FAR Data-Modelling Results



Section 5: Baseline Analysis, Peer Fleet Benchmarking

A fleet baseline analysis provides a starting point for setting targets and measuring progress towards fuel- and GHG-emissions reduction. It is important that a baseline is as accurate as possible, as it provides a snapshot of the current state of a fleet and is the foundation of a fleet management plan. We collected and analyzed vehicle data provided by City of North Battleford for its 425 in-scope fleet assets, and where needed, filled in data gaps.

Fleet Makeup

For our analysis, on-road vehicles were categorized using standard vehicle categorization protocols as shown in *Table 7* (below).

Table 7 – Vehicle Classes

Category	Gross Vehicle Weight	Included Unit Types
Class 1	0–6000 lb. (0–2722 kg)	LD cars, pickups, vans
Class 2	6001–10000 lb. (2722–4536 kg)	LD pickups, vans
Class 3	10001–14000 lb. (4536–6350 kg)	L-MD trucks, HD pickups
Class 4	14001–16000 lb. (6351–7257 kg)	L-MD trucks, buses
Class 5	16001–19500 lb. (7258–8845 kg)	MD trucks
Class 6	19501–26000 lb. (8846–11793 kg)	MD trucks
Class 7	26001–33000 lb. (11794–14969 kg)	HD trucks
Class 8	33000 lb. and up (14969 kg)	HD trucks, fire apparatus

The high-level makeup of the City of Battleford's fleet vehicles and equipment units is shown in *Table 8* (below.)

Table 8 - High-level Fleet Makeup

Fleet Vehicle Type	Number of Units (baseline yr.)
Class 1 (Light-duty Vehicles)	5
Class 2 (Light-duty Vehicles)	53
Class 3 & 4 Light- & Medium-duty Trucks)	21
Class 5 & 6 (Medium-duty Trucks)	7
Class 7 & 8 (Heavy-duty Trucks)	20
Mobile Equipment (heavy equipment, large mowers, ATVs, etc.)	74
Mounted Equipment	31

Fleet Vehicle Type	Number of Units (baseline yr.)
Small Equipment (e.g., weed whackers, chainsaws, etc.)	178
Trailer	36
Total:	425

Fleet Statistical Baseline

To complete the City of North Battleford's fleet equipment and vehicle optimization study we collected baseline data of City of North Battleford's 425 in-scope fleet units from fleet management.

The dataset provided us included a list of units, makes/models/years, asset values and ages, asset descriptions, fuel types, fuel costs, repair costs, and maintenance costs for a one-year review period. Our team loaded the data into FAR and developed a baseline analysis.

Key fleet-wide statistics from the one-year baseline review period are listed below[24]. For a more detailed breakdown of select key performance indicators (KPIs) for each vehicle class, type, and equipment type, please review the FAR 1x(a) baseline data model which we provide separately to the City of North Battleford.

- For the baseline review, there were 425 in-scope City of North Battleford fleet vehicles, trailers, mobile equipment, and small work equipment units
- All units were owned, except three which were leased
- Total kilometres-travelled was 886,992 kilometres
- Original purchase price for the fleet was $11,106,000
- Current-day replacement cost (like-for-like replacements) was $14,628,612
- Market/trade-in value was $2,962,724
- Cost of capital was $125,159
- Cost of preventive maintenance (PM) was $119,139
- Cost of reactive repairs was $455,622
- Cost of fuel was $681,729
- Controllable operating costs[25], including repairs and maintenance, fuel, capital, and downtime combined were $1,578,376
- Fuel used was 356,587 litres

[24] All values are estimated and calculated on data provided by the City. Where data gaps existed proxy data from peer Canadian municipal fleets was used as a workaround.
[25] Controllable operating costs are those which fleet management has direct control including fuel, maintenance, repairs, cost of capital and downtime.

- Tailpipe GHG emissions were 956.7 metric tonnes CO_2e
- Average utilization for on-road units was 5,368 kilometres/year
- Corporate average fuel consumption for all on-road units was 49.5 l/100km
- Average age (on-road vehicles and equipment) was 12.6 years
- Average age of on-road vehicles was 13.9 years

Peer Fleet Comparisons

To put the City's fleet statistical data (above) into perspective and to highlight areas for further review we completed peer municipal fleet comparisons. We prepared *Table 9 – Peer Fleet Comparisons* (below) comparing the City's statistics to benchmark E3 Fleet values (peer fleet averages) based on a review of over 12,000 units of all classes from 62 fleets across British Columbia, Alberta, and Ontario.

Some classes have been combined to align with FCC's E3 Fleet Review categorization.

Table 9 - Peer Fleet Comparisons

KPI	Category	City of North Battleford	Benchmark (Peer Fleet Average)
KM Travelled	Class 1	11,308	15,030
	Class 2	10,464	14,277
	Classes 3, 4	4,392	13,220
	Classes 5-7	3,050	13,022
	Class 8	6,077	13,254
Fuel Consumption (L/100 km)	Class 1	14.0	19.8
	Class 2	19.6	21.7
	Classes 3, 4	30.45	32.2
	Classes 5-7	32.75	51.7
	Class 8	63.6	67.5
GHG Intensity (kg CO2e/km, combustion)	Class 1	0.3	0.46
	Class 2	0.5	0.49
	Classes 3, 4	0.8	0.80
	Classes 5-7	1.23	1.37
	Class 8	1.7	1.97
Cost per KM	Class 1	$ 0.51	$ 0.45
	Class 2	$ 0.74	$ 0.52
	Classes 3, 4	$ 1.84	$ 1.03
	Classes 5-7	$ 3.74	$ 2.05
	Class 8	$ 2.85	$ 3.21

KPI	Category	City of North Battleford	Benchmark (Peer Fleet Average)
Unit Age (years)	Class 1	11.2	5.1
	Class 2	12.1	5.6
	Classes 3, 4	10.9	6.3
	Classes 5-7	22.7	6.9
	Class 8	16.5	6.3
Area Ratio (km^2/no. of units)	All Classes + Equipment + Trailers	0.3[26]	*1.8
Population Ratio (population/no. of units)	All Classes + Equipment + Trailers	131[27]	*1,998

* Average of 12 municipal fleets ranging in size from 19-1,307 units, serving populations ranging from 55,000-645,000 over land areas ranging from 50-4,800 km^2.

We also compared statistical data for the City of North Battleford to a group of 31 urban municipal peer fleets selected from Fleet Challenge's statistical database for comparison purposes.

(1) The City of North Battleford's on-road vehicle fleet average age[28] is 13.9 years -- more than double the average age of the peer group fleets[29] which is 5.8 years.

(2) The City of North Battleford's utilization rate is very low – average utilization is 5,368 kilometres/year[30] which is 1/3 of the average utilization relate of 16,092 km/yr. for the same group of 31 municipal fleets.

(3) At $2.28 per kilometre, North Battleford's average operating cost per kilometre is 34% higher than the peer fleet average cost/km of $1.51

(4) Each of the City's on-road vehicles serves 131 residents compared to the peer fleet group which serves an average of 1,061.

(5) Each of the City's on-road vehicles services 0.3 km^2 of land area compared to the peer fleet group for which each vehicle on average services 4.9 km^2.

The baseline analysis and benchmarking set the foundation for the next stages of the Equipment and Vehicle Optimization study – namely, lifecycle analysis (LCA), long-term capital planning (LTCP),

[26] Land area of City of North Battleford is based on 2016 Census data.
[27] Population of City of North Battleford is based on 2016 Census data.
[28] Average age is for on-road vehicles
[29] As compiled from FCC municipal fleet database
[30] Includes on-road fleet units

and modelling several go-forward solutions for the City of North Battleford's fleet to provide an ambitious, yet feasible, roadmap to reduced costs and improved asset utilization.

Section 6: Lifecycle Analysis

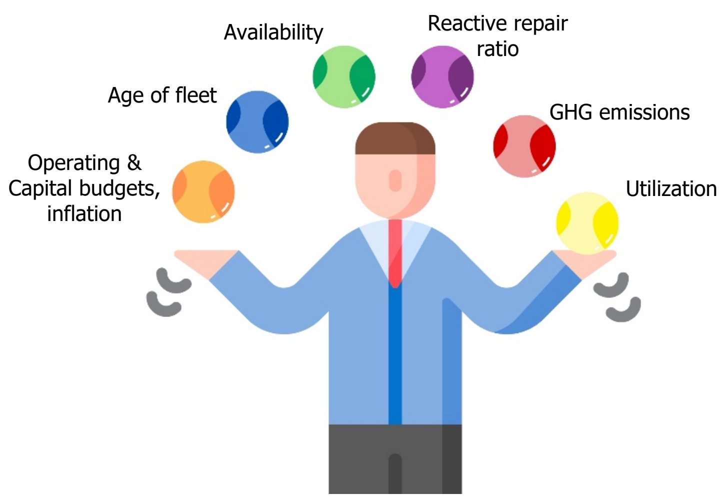
Lifecycle analysis (LCA) is a structured approach to determine the best time to replace vehicles and equipment in terms of age, mileage, or other pertinent factors. LCA provides empirical justification for replacement policies and facilitates the analysis and communication of future replacement costs. LCA identifies capital strategies that will optimize vehicle lifecycles and return-on-investment (ROI). LCA should be the first step in long-term capital budget planning (LTCP).

LCA illustrates the total lifecycle cost of fleet vehicle types/categories. LCA can help determine:

- The age at which units should be considered for replacement; and
- When replacement should occur, ideally before costs rise and reliability/safety is reduced, and before significant capital expenditure or refurbishment is necessary.

As shown in *Illustration 1* (below) fleet management is a complex juggling act. Capital investment, operating expenses, depreciation, preventive maintenance levels, fuel consumption, aging of the fleet, availability, utilization, emissions, and inflation are interconnected issues. Making a change to any one of these critical considerations impacts all of them.

Illustration 1: Fleet Management Juggling Act

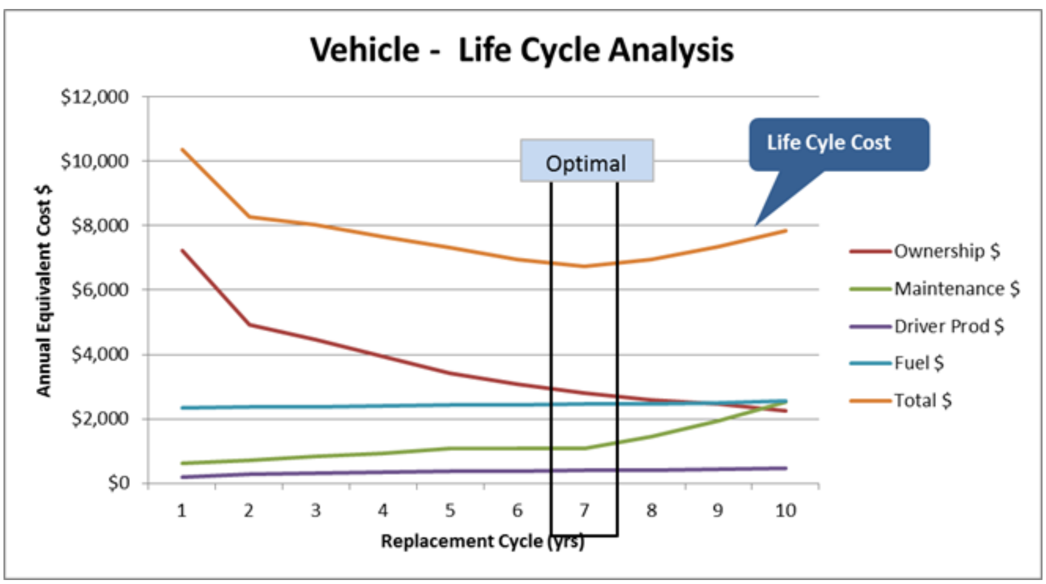


For example, deferred capital spending will result in an aging fleet, in turn resulting in higher reactive repair rates, more downtime, higher fuel consumption, increased operating costs, and, ultimately, a larger overall fleet size to allow for more spare vehicles to compensate for the reduced reliability of primary vehicles. Counter to this, if vehicles are replaced too soon, value may be lost.

FCC believes that the key to success is knowing the optimal economic lifecycle for each type of vehicle in a fleet. With that information, fleet managers can balance their go-forward capital spending to align with service level (uptime) and operating expenses (Opex), and other essential success measures.

Illustration 2 (below) depicts the concept of LCA. As a vehicle's age at retirement increases, ownership costs decrease, and operating costs increase relative to the mileage accumulated. In this example, the operating costs include maintenance, loss of driver productivity caused by reduced vehicle reliability, and fuel consumption. The sum of operating and ownership costs represents the "lifecycle cost curve." The ideal time to replace vehicles is before the rise in operating expenses begins to outweigh the decline in ownership costs.

Illustration 2 - Lifecycle Analysis



The Lifecycle Cost Curve

The lifecycle cost curve and the ideal replacement cycle will be different for various types of vehicles and possibly even for individual vehicles of the same kind. Factors that can cause this variability include differences in vehicle makes/models, model year, equipment design, operating environment, and/or operator habits.

Recommended replacement cycles for a class of vehicles approximates the optimal time to replace most units within that class based on the category-average cost and performance data, by model year.

Replacement cycles should be considered a guideline only, as some vehicles in poor or unsafe condition may require replacement before the criteria are met. Conversely, some vehicles that exceed the criteria may be in good condition and may not warrant replacement. Fleet managers need to exercise judgment and fleet management principles in either advancing replacement or delaying replacement of individual vehicles case by case. A weighted condition assessment of each asset (see *Appendix A*) should be employed to support LCA replacement decisions.

Lifecycles for vehicles are determined by modelling the expected cash flows for owning and operating the vehicle. The approach involves forecasting a stream of costs over a study horizon (future period) for each type of vehicle and determining the replacement cycle that results in the lowest total cost of ownership (TCO).

For City of North Battleford, a discounted cash flow analysis was completed for each vehicle class with sufficient data to complete the LCA. Net present value (NPV) was calculated for outgoing cash flows (vehicle purchase cost, maintenance cost, the impact of downtime on driver productivity cost, improved fuel efficiency of a new vehicle compared to the old vehicle) and incoming cash flows (vehicle residual value) to calculate the total lifecycle cost for various vehicle retention periods.

The NPV amounts for cash flows were converted to annual equivalent cost (AEC) to provide a dollar amount, which is easy to relate to and enables comparison of alternative lifecycle costs. AEC is the fixed annual payment that that would be required to pay back the total of capital and operating costs over the study period. The AEC can be viewed as an average annual cost that considers the time value of money for future cash flows.

Fleet Age and Reliability

Most drivers know from personal experience that older vehicles are less reliable, break down more frequently, cost more to repair, and burn more fuel. Multiply that reality many times over as in a commercial fleet, and the impacts can be significant. In general, as commercial vehicle fleets age, higher operating expenses are incurred due to increased reactive repairs (unplanned repairs and breakdowns). Due to decreased reliability, downtime costs for spare/loaner vehicles increase as does the cost of productivity loss for drivers who are dependent on fleet vehicles to perform their daily work routines.

Downtime costs increase exponentially when more than one person is dependent on a single vehicle to complete their work routines. In addition to the cost of less reliable, aging vehicles and the associated increased downtime are the additional expenses of owning, maintaining, licensing, insuring, and parking spare, back-up vehicles.

Even when downtime is minimized through a rigorous preventive maintenance program, downtime costs are unavoidable and can be substantial for an organization. Ongoing, uninterrupted capital re-investment in modernizing the fleet is critical to any organization that depends on a reliable fleet of vehicles to achieve its objectives and mission, as is the case for all municipalities. The benefits of a newer fleet include better fuel economy, increased vehicle uptime, lower risk of repair, increased safety and, possibly, improved employee morale. Moreover, a more modern and reliable fleet may result in a reduced fleet size since fewer spares will be necessary.

Vehicle Replacement at the Rate of Depreciation

Providing capital to replace units each year with new vehicles is essential for any organization that relies on its fleet to provide its core services to customers. A guideline for fleet replacement is to invest capital at the rate of depreciation. For example, if vehicles are depreciated over ten years, then 10% of the total fleet replacement cost (current NPV) would be required each year to maintain the fleet's average age at the desirable level. However, this guideline is only valid if performance indicators such as uptime and fuel-efficiency are satisfactory. If not, a one-time increase in spending would help bring the fleet's average age and performance up to an acceptable level.

Vehicle Replacement Criteria

Today's vehicles are built better and last longer than ever before. With the right preventive maintenance, operating conditions, and driver behaviours, vehicle service lives can often be extended longer than in the past. The LCA completed for this report optimizes vehicle lifecycle costs based on vehicle age. Vehicle age was determined to be the best replacement criteria for City of North Battleford, given the relatively low average utilization rates in the fleet. Because annual kms-travelled are low, most vehicles will time-out versus mileage-out at retirement.

Vehicles approaching their end-of-lifecycles should be assessed case by case with a thorough ground-up and top-down physical assessment of the vehicle's condition, as this would serve to inform and confirm decisions around extending their lifecycles.

For higher annual mileage vehicles in the fleet, it is recommended that City of North Battleford review the condition of high mileage vehicles at thresholds of 20,000 km/yr for light-duty vehicles (LDVs) and 25,000 km/yr for medium and heavy-duty vehicles (MHDVs) for potential early replacement. The recommended vehicle replacement age can be multiplied by these values to determine mileage thresholds. For example, if the recommended lifecycle is ten years for a vehicle type, the recommended replacement mileage is 10 x 20,000 = 200,000 km.

Environmental Considerations

LCA is used to evaluate whether the increased costs of capital for newer, more modern, and fuel-efficient vehicles will be offset by lower fuel, repair, and downtime costs. For low-mileage units, the amount of fuel saved may be minimal, often resulting in lifecycle extension being the better financial option. However, aging a fleet to extract full value from each unit may counteract the fleet's progress toward modernization and reduced GHG emissions.

When modelling battery-electric vehicle (BEV) replacement, some units do not show return-on-investment (ROI) due to increased cost of capital exacerbated by low utilization for some units. LCA-optimized lifecycles combined with vehicle condition assessments are recommended by our team to extend the lifecycles, wherever possible, of current-day internal combustion engine (ICE) fleet vehicles while awaiting BEV replacements to become available.

Key Parameters and Assumptions

The key LCA parameters and assumptions used for all selected vehicle classes are listed in *Table 10* (below).

Table 10: Key LCA Parameters and Assumptions

Parameter	Value	Description
Net Acquisition Cost	Varies by vehicle class	Based on average vehicle acquisition cost data provided by City of North Battleford
Cost of Capital/ Lease Rate	2.45%	Cost of funds for vehicle acquisition (the prime interest rate at the time of the LCA)
Discount Rate for NPV	1.75%	Rate used to discount cash flows
Tech. Prod Loss Hrs./Touch	3.0	Average loss in driver productivity each time a fleet technician services a vehicle. Work orders are deemed equivalent to "touches"
Tech. Labour Rate $/Hr.	$75	Estimated/typical hourly labour rate
CIF[31] on Maintenance	1.8%	Cost increase factor or inflation on parts and mechanic labour
CIF on Driver Rate	1.5 %	Cost increase factor or inflation on driver loaded labour rate

[31] CIF = Cost Inflation Factor

Parameter	Value	Description
CIF on Vehicle	2.0%	Cost increase factor or inflation on vehicle replacement prices
CIF on Fuel	4.0%	An assumption based on market trends
Annual Vehicle Efficiency Improvement	2.0%	Fuel efficiency improvement factor for new vehicles compared to the vehicles being replaced (estimated by Fleet Challenge)
Average Km/Yr.	Varies by vehicle class	Annual distance travelled under the assumption that the new vehicle will travel the same distance as the old vehicle
Cash Flow Horizon (yrs.)	Varies by vehicle class	Discounted cash flow study period, adjusted based on the vehicle class (up to 20 years) and years of available data

LCA is based on average costs and utilization rates for each category of vehicles and provides a credible guideline to optimal vehicle replacement cycles. However, LCA does have limitations since its outcomes are based on average cost data for each category of vehicles. Some vehicles in poor or unsafe condition may require replacement before the LCA-calculated age criteria are met.

Conversely, some vehicles that exceed the criteria may still be in good condition and not warrant replacement due to low usage or recent refurbishment. Therefore, the LCA-recommended replacement criteria should be used as a guideline and not an absolute rule. The physical condition of each unit should then be assessed case-by-case by trained and knowledgeable staff, who are familiar with each unit's usage and maintenance history before replacement decisions are finalized.

Data Challenges

The discipline of completing fleet LCA is dependent on historical cost data. LCA modelling software was designed and intended to be populated with a fleet's actual historical cost data. Without having cost data and performing LCA, vehicle replacement decisions may be based solely on intuition and personal observations – essentially the sentiments of someone who has a high degree of familiarity with the fleet. Often, we have observed that “guesstimates” made by seasoned fleet managers can have a high degree of accuracy. However, today’s business decisions based on “gut” feelings often do not stand up to scrutiny and must be backed up by analytical data.

For City of North Battleford, our team used an LCA modelling tool developed by FCC in 2013 and refreshed in 2017. Our tool is dependent on actual fleet historical data when available for the model years and vehicle types being studied.

Fleet management provided our team with data for in-scope vehicles. LCA was undertaken for vehicle categories with sufficient historical data over the review period from City of North Battleford, as well as with sufficient peer fleet data to fill data gaps.

Lifecycle Analysis Results Summary

Lifecycle analysis (LCA) was undertaken by FCC to calculate the optimal economic lifecycles for vehicle replacements. LCA was completed for select vehicle categories where sufficient historical data was available from the City of North Battleford. Peer municipal fleet data from our database was used to fill numerous data gaps.

The LCA took into consideration the cost of downtime (as caused by reduced reliability), the year-to-year “rollup” of the cost of capital, inflation, worker cost/hour, salvage and market values, inflation, and average kilometres-driven data.

The results are summarized in *Table 11* (below). In *Appendix D*, we have included LCA charts for each applicable vehicle category in City of North Battleford's fleet.

Table 11 - Lifecycle Analysis - Summary

Category	Current Replacement Cycle (years)	Optimal Economic Lifecyle (years)	Optimal Economic Lifecyle Recommended (total kilometers)	Change (+ or - years)
Pickups - Class 1 & 2	11	11	110,407	no change
Class 3 Trucks	11	10	75,270	-1
Class 4 Bus / Truck	12	12	36,132	no change
Class 8 Trucks w/Mounted Equipment	12	11	81,202	-1

Category	Current Replacement Cycle (years)	Optimal Economic Lifecyle (years)	Optimal Economic Lifecyle Recommended (total kilometers)	Change (+ or - years)
Class 8 - Fire	12	12	47,784	no change

Next Step After LCA: Vehicle Condition Assessments

As we have described, vehicles approaching their end of lifecycle should be assessed case by case. A thorough ground-up and top-down physical assessment of each vehicle's condition (see *Appendix A*), in conjunction with routine shop visits for preventive maintenance inspections, would serve to inform decisions around extending vehicle lifecycles. A weighted point system should be used to determine vehicle condition and qualification for replacement (see *Appendix A*).

Section 7: Long-Term Capital Planning

After completing lifecycle analysis (LCA), the Fleet Analytics Review™ (FAR) software tool enables methodical, well-informed business decisions for long-term capital planning (LTCP) purposes.

Vehicle data provided by City of North Battleford for the baseline year was input into FAR, and the tool calculated capital budgets for the ensuing fifteen years driven by vehicle lifecycles based on fleet management's vehicle retention practices (business-as-usual or BAU) and the optimized economic lifecycles that were calculated by LCA. On a unit-by-unit basis, in FAR we calculated:

(1) whether replacing units due for replacement would save City of North Battleford operating expenses (Opex) or cost additional money; and
(2) the GHG-reduction impacts of vehicle replacements.

The tool also calculated and displayed the costs (operating and capital) and GHG impacts of those decisions for the fleet as a whole.

Fleet management does not usually have unlimited capital budgets; therefore, each year, tough decisions must be made around which vehicles to replace and which to delay replacement. Typically, when a fleet manager uses LTCP for the first time, year one will show a cost spike caused by previously deferred vehicles. Replacement of some of these units can be again delayed because they are still in good serviceable condition, have low mileage, or perhaps have just received a costly refurbishment that will extend the unit's life. Other vehicles may no longer have a purpose in the organization and could potentially be eliminated from the fleet. These decisions can be aided by the FAR LTCP tool by displaying to the user whether cost-savings are possible by replacing a unit.

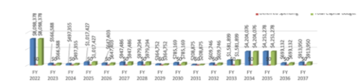
In FAR, replacement of units shown not to provide return-on-investment (ROI) can be deferred to the following year until replacement yields a net decrease in Opex. Following this method, a fleet manager can balance go-forward annual capital expenses (Capex) and avoid year-over-year cost spikes. This approach can keep the average age of the fleet at an acceptable level, provide the lowest cost and highest uptime, and reduce emissions.

While historical data in FAR will demonstrate whether a business case exists for vehicle replacement, the final step in LTCP depends on fleet management personnel's expertise. Therefore, the last step is to combine LCA data with unit-by-unit condition assessments (see *Appendix A*). *No software tool can supplant this final step in capital budget planning.*

For City of North Battleford, we modelled a 15-year budget cycle for (1) business-as-usual (BAU) vehicle replacement practices, (2) optimized economic lifecycles, and (3) balanced Capex and optimized lifecycles (only replacing units with ROI).

A look at the 15-year capital budgeting within FAR is shown in the screen capture below (*Illustration 3*), from the City's FAR 1x data model. The 'thumbnail' view appearing at the top left of the image shows the currently *very* unbalanced 15-year capital budget needs of the City's fleet.

Illustration 3 - FAR Dashboard



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								Fiscal Year 2022									
ers of fuel used in period	Operating Expense Increase or Savings [-]	Unit #	Category	Current Fuel Type	Category of Replacement Unit	Fuel Type of Replacement Unit	Planned Life Cycle (years)	Planned Capital Budget 2022 (includes existing deferrals)	Enter "DEF" to defer unit to next year or "NIX" to nix unit entirely	Deferred Spending for 2022	Total Capital Budget 2022	Opex Increase or -Reduction	Opex Increase or -Reduction from Vehicle Category Switch with Replacement	Opex Increase or -Reduction from Fuel Switch with Replacement	Net CO_2 Reduction from Unit Replacement & Greening Plan	CO_2 Reduction from Vehicle Category Switch	CO_2 Reduction from Fuel Switch
1,725	$76	146	Class 1	G	Class 1	G	11	$0		$0	$0	$76	$0	$0	0.00	0.00	0.00
1,393	$1,260	BY0092	Class 1	G	Class 1	G	11	$0		$0	$0	$1,260	$0	$0	0.00	0.00	0.00
1,572	$626	PW0082	Class 1	G	Class 1	G	11	$41,008		$0	$41,008	-$1,280	$0	$0	0.08	0.00	0.00
1,484	$415	PW0086	Class 1	G	Class 1	G	11	$35,160		$0	$35,160	-$1,232	$0	$0	0.07	0.00	0.00
1,485	$252	PW0088	Class 1	G	Class 1	G	11	$32,381		$0	$32,381	-$1,358	$0	$0	0.07	0.00	0.00
2,214	$109	100	Class 2	G	Class 2	G	11	$37,540		$0	$37,540	-$1,801	$0	$0	0.11	0.00	0.00
2,069	-$330	102	Class 2	G	Class 2	G	11	$41,008		$0	$41,008	-$2,236	$0	$0	0.10	0.00	0.00
1,426	-$338	103	Class 2	G	Class 2	G	11	$47,721		$0	$47,721	-$1,875	$0	$0	0.07	0.00	0.00
1,344	-$564	104	Class 2	G	Class 2	G	11	$37,540		$0	$37,540	-$1,723	$0	$0	0.06	0.00	0.00
2,069	-$73	105	Class 2	G	Class 2	G	11	$38,282		$0	$38,282	-$1,898	$0	$0	0.10	0.00	0.00
2,069	-$298	110	Class 2	G	Class 2	G	11	$41,793		$0	$41,793	-$2,245	$0	$0	0.10	0.00	0.00
2,069	-$303	111	Class 2	G	Class 2	G	11	$37,540		$0	$37,540	-$2,088	$0	$0	0.10	0.00	0.00
2,069	-$298	113	Class 2	G	Class 2	G	11	$41,793		$0	$41,793	-$2,245	$0	$0	0.10	0.00	0.00
2,069	-$200	115	Class 2	G	Class 2	G	11	$44,238		$0	$44,238	-$2,267	$0	$0	0.10	0.00	0.00
1,676	-$754	116	Class 2	G	Class 2	G	11	$35,160		$0	$35,160	-$2,168	$0	$0	0.08	0.00	0.00
2,338	-$481	118	Class 2	G	Class 2	G	11	$29,614		$0	$29,614	-$2,362	$0	$0	0.11	0.00	0.00
2,069	-$512	119	Class 2	G	Class 2	G	11	$0		$0	$0	-$512	$0	$0	0.00	0.00	0.00
2,069	-$598	145	Class 2	G	Class 2	G	11	$0		$0	$0	-$598	$0	$0	0.00	0.00	0.00
1,865	-$749	147	Class 2	G	Class 2	G	11	$0		$0	$0	-$749	$0	$0	-3.48	0.00	0.00
2,409	-$381	150	Class 2	G	Class 2	G	11	$0		$0	$0	-$381	$0	$0	0.00	0.00	0.00
1,429	-$727	1001	Class 2	G	Class 2	G	11	$35,160		$0	$35,160	-$1,932	$0	$0	0.07	0.00	0.00
2,069	$27	1002	Class 2	G	Class 2	G	11	$38,282		$0	$38,282	-$1,798	$0	$0	0.10	0.00	0.00
2,069	-$298	1003	Class 2	G	Class 2	G	11	$41,793		$0	$41,793	-$2,245	$0	$0	0.10	0.00	0.00
2,271	-$159	1005	Class 2	G	Class 2	G	11	$43,408		$0	$43,408	-$2,384	$0	$0	0.11	0.00	0.00

	Fiscal Year 2023								
Unit #	Planned Capital Budget 2023 (includes deferrals from 2022)	Enter "DEF" to defer unit to next year or "NIX" to nix unit entirely	Deferred Spending for 2023	Total Capital Budget 2023	Opex Increase or -Reduction	Opex Increase or -Reduction from Vehicle Category Switch with Replacement	Opex Increase or -Reduction from Fuel Switch with Replacement	Net CO2 Reduction from Vehicle Replacement & Greening Plan	CO2 Reduction from Vehicle Category Switch
146	$0		$0	$0	$78	$0	$0	0.00	0.00
BY0092	$0		$0	$0	$1,284	$0	$0	0.00	0.00
PW0082	$0		$0	$0	$638	$0	$0	0.08	0.00
PW0086	$0		$0	$0	$423	$0	$0	0.07	0.00
PW0088	$0		$0	$0	$256	$0	$0	0.07	0.00
100	$0		$0	$0	$112	$0	$0	0.11	0.00
102	$0		$0	$0	-$336	$0	$0	0.10	0.00
103	$0		$0	$0	-$345	$0	$0	0.07	0.00
104	$0		$0	$0	-$574	$0	$0	0.06	0.00
105	$0		$0	$0	-$74	$0	$0	0.10	0.00
110	$0		$0	$0	-$304	$0	$0	0.10	0.00
111	$0		$0	$0	-$309	$0	$0	0.10	0.00
113	$0		$0	$0	-$304	$0	$0	0.10	0.00
115	$0		$0	$0	-$204	$0	$0	0.10	0.00
116	$0		$0	$0	-$769	$0	$0	0.08	0.00
118	$0		$0	$0	-$490	$0	$0	0.11	0.00
119	$33,840		$0	$33,840	-$1,049	$0	$0	0.10	0.00
145	$0		$0	$0	-$609	$0	$0	0.00	0.00
147	$0		$0	$0	-$763	$0	$0	-3.48	0.00
150	$0		$0	$0	-$388	$0	$0	0.00	0.00
1001	$0		$0	$0	-$740	$0	$0	0.07	0.00
1002	$0		$0	$0	$27	$0	$0	0.10	0.00
1003	$0		$0	$0	-$304	$0	$0	0.10	0.00
1005	$0		$0	$0	-$162	$0	$0	0.11	0.00

Business-as-Usual

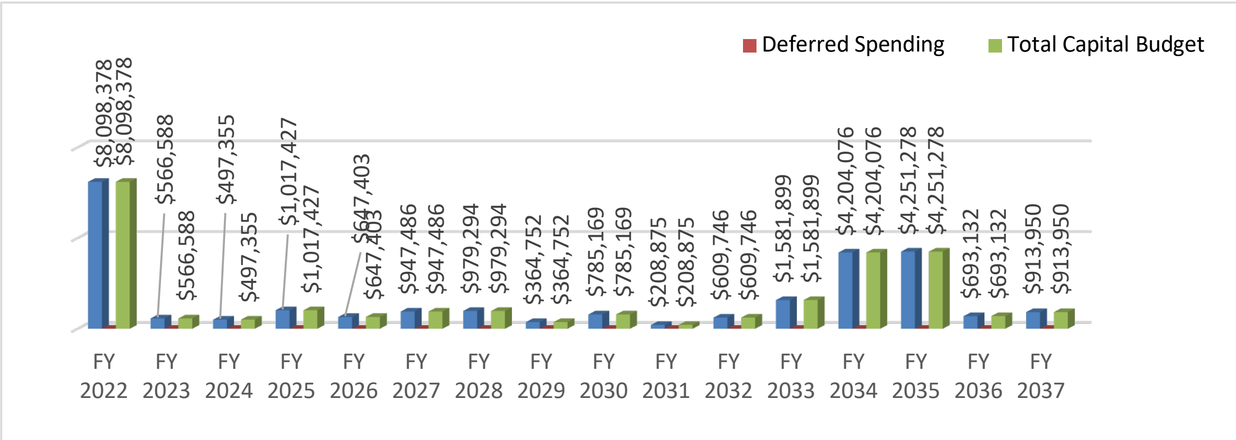
In FAR 1x data model we modelled a 15-year budget cycle based on City of North Battleford's present-day average replacement practices. These BAU outcomes include the impacts of current replacement cycles on Opex, Capex, and GHG emissions for all 425 in-scope fleet vehicles and equipment.

As illustrated in *Figure 2* (below), based on present-day replacement practices, it was estimated that, in 2022, ~$8.1 million would be required to replace all due or past-due units with new like-for-like vehicles. It should be noted that numerous vehicles in the City of North Battleford fleet are well beyond the average age for replacement. *Clearly, significant "catch-up" Capex spending is required to modernize the fleet.*

In the 14 ensuing years, far fewer vehicles require replacement each year, bringing down capital spending to an average of about $1.2 million in the following 14 fiscal years (to year 2037. Clearly, there is uneven capital spend projected in this scenario.

In the hypothetical event that all vehicles due/past-due for replacement in 2022 were indeed replaced, Opex is estimated to increase by ~$34k due to increased cost of capital (note that cost of capital is included under Opex), and GHG emissions are estimated to decrease by 93.4 tonnes CO_2e due to the increased fuel efficiency of newer vehicles.

Figure 2: FAR 1x. Planned capital budget (blue), deferred spending (red), and total capital budget (green) for BAU replacement practices

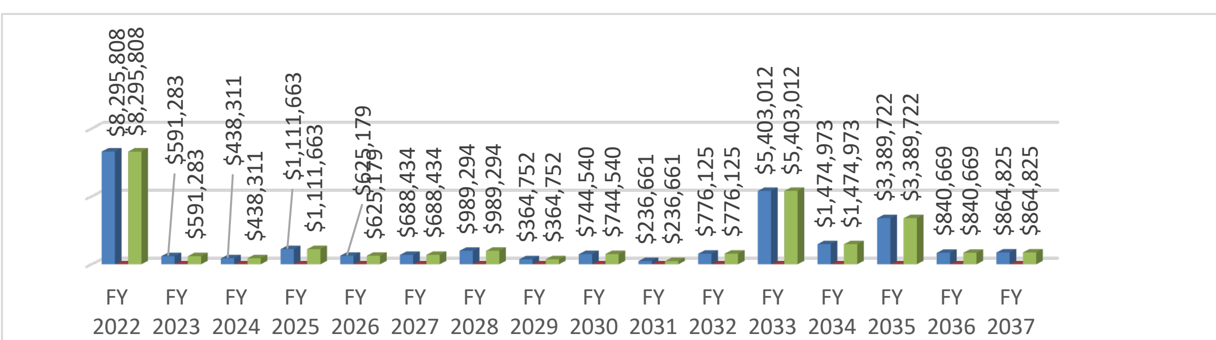


Optimized Economic Lifecycles

In FAR data model 2x we calculated the impacts of LCA-optimized vehicle replacement cycles on Opex, Capex, and GHG emissions over a fifteen-year horizon for vehicle categories with sufficient historical data over the review period from City of North Battleford, as well as with sufficient peer fleet data to fill data gaps.

As illustrated in *Figure 3* (below), based on optimized economic lifecycles it was estimated that, in 2022, ~$8.3 million would be required to replace all due or past-due units with new like-for-like vehicles, which is even more than present-day replacement practices. This increase is because our optimal lifecycles are more aggressive than the City's historical replacement ages – we calculated that even more vehicles should be replaced. Like BAU, there is a very uneven capital spend projected in following years.

Figure 3: FAR 2x. Planned capital budget (blue), deferred spending (red), and total capital budget (green) for optimized economic lifecycles



Balanced Capex and Optimized Economic Lifecycles

Once optimized economic lifecycles were modelled, it became apparent that some vehicles deliver better ROI than others. Some vehicles in the fleet may have received lighter usage than other similar age units, which may have been worked harder. For vehicles in better condition, their service life can be extended to optimize their lifetime total cost of ownership (TCO). Lower ROI would result if a vehicle, still in good condition, was replaced prematurely; value will be lost.

For FAR data model 3x, the approach used by FCC was to defer some vehicles to ensuing capital budget years to ensure full value is received from each unit. In our data-modelling, without knowledge of the physical condition of units due for replacement based on vehicle ages, our analysts instead deferred vehicles showing low/no ROI to following budget years to balance annual year-over-year capital budgets. This step was intended to be a simulation of balancing long-term budgets using optimized lifecycles and ROI. Fleet managers make similar decisions each year based on vehicle condition assessments and other information, such as maintenance history.

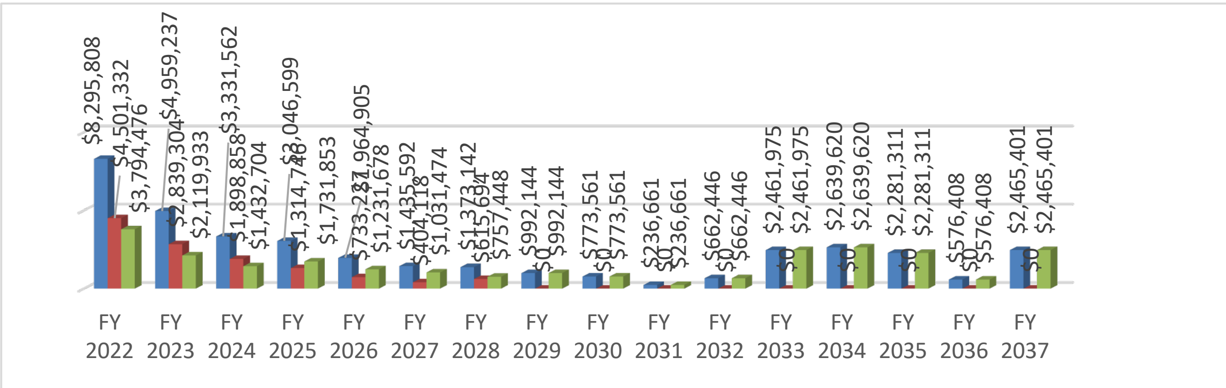
As consultants without access to information regarding vehicle condition, and to reduce and apportion the required capital over a more extended period, we opted to defer using the following criteria:

(1) Units with low/no ROI
(2) Units that have most recently became due for replacement (to ensure past-due units get higher priority for replacement)
(3) Lower-mileage units (to ensure that higher-mileage units are replaced first)

Using this prioritization protocol, we selectively and strategically made deferrals over the 15-year budget cycle to maximize Opex benefits and balance Capex to the best of our ability. As a result, FAR data model 3x has much more balanced Capex over the 15-year budget cycle than FAR 1x and 2x, with overall increasing capital spending towards the end of the period due to compounding inflation.

As illustrated in *Figure 4* (below) the net result was a Capex requirement in 2022 of ~$3.8 million. After that, there is an average annual capital budget ranging of ~$1.4 million over the remaining 14 years of the budget period (to year 2037).

Figure 4: FAR 3x. Planned capital budget (blue), deferred spending (red), and total capital budget (green) for balanced Capex and optimized lifecycles



Recommendations

- Consider adopting FCC's lifecycle analysis (LCA) approach to extract maximum value from each vehicle in conjunction with a weighted point system (see *Appendix A*).
- To balance each year's Capex budgets, defer vehicles that will not provide return on investment, providing their condition is acceptable
- When the fleet's average age and uptime rates are determined to be at acceptable levels, consider re-investing in the fleet at the rate of depreciation.
- Consider – temporarily - although more costly from an operating expense lens, leasing or renting vehicles to bring down the extremely high number of units that are due and past-due for replacement
- Consider a corporate fleet downsizing initiative to reduce overall fleet size.

Section 8: Purchasing vs. Leasing vs. Renting Analysis

Fleet managers have various vehicle acquisition options, including purchasing, leasing, and renting. Deciding which option is best depends on multiple factors specific to the needs and usage of the fleet vehicles and market conditions. The City of North Battleford's fleet vehicle and equipment were purchased, and three units leased.

In this section of our report, we will discuss the features and benefits of each of the three primary options – purchasing, leasing, and renting we will and assess the total cost of ownership (TCO) for each.

Image Credit: Getty Images

Detailed descriptions of various vehicle acquisition options are in *Appendix E.*

Approach and Methodology

To assess the lifecycle total cost of ownership (TCO) impacts, Fleet Challenge completed discounted cash flow analysis. We modeled the costs based on a typical Class 1 sedan for these three options:

(1) Purchasing (i.e., purchasing a sedan and maintaining it in-house)
(2) Leasing (i.e., leasing the sedan and maintaining it in-house)
(3) Renting (i.e., renting the sedan, which includes the costs of maintenance and licensing)

Discounted Cashflow Analysis

Discounted cash flow (DCF) is a valuation method[32] to estimate the value of an investment based on its expected future cash flows. DCF analysis applies to investment decisions of investors in companies or securities, such as acquiring a company, investing in a technology startup, or purchasing a stock, and for business owners and managers looking to make capital budgeting or operating expenditures decisions such as opening a new factory as well as purchasing or leasing new vehicles or equipment. Fleet Challenge completed discounted cash flow analysis to compare the full-lifecycle total cost of ownership (TCO) for each of the three vehicle acquisition options.

Business Assumptions for the Purchase, Lease & Rent Analysis

To complete an analysis[33] for each option, several business assumptions were required. To ensure the accuracy of assumptions, we based the analysis and comparisons of the three options around one vehicle type (Class 1 sedan). We chose this vehicle type since several key assumptions were

[32] Source: https://www.investopedia.com/terms/d/dcf.asp
[33] At no additional cost, Fleet Challenge will provide our DCF analysis data-modeling software tool template to City of North Battleford for its own use, should leasing ever be under consideration in the future.

known, including fuel-used and maintenance expenses. In addition, we used rental rates and contractual conditions for a sedan recently obtained by another Ontario municipality. That municipality had recently issued an RFP in which they received competitive quotes from rental companies.

FCC used the following business assumptions for our study:

- Vehicle type: Class 1 Sedan
- Acquisition cost: $27,130
- Annual days-of-use: 261[34]
- Cash flow horizon: 12 years
- Lease term (Option 2a): six (6) years – two back-to-back 6-year leases
- Lease term (Option 2b): six (6) years - w/ cash purchase for residual value after year six
- Lease interest rate: 7% (includes estimated rates and profit adder)
- Rental rate: Class 1 Sedan: $450 per month
- Projected resale value annual decrease: 2%
- Average fuel consumption: 9.5 liters/100km[35]
- Spare vehicle cost/km[36]: $0.15 ($0.00 for the rental option)
- Oil changes and minor PM inspection intervals: 7,000 km
- Maintenance, repair costs: owner/lessee expense (for purchase & lease options only)
- Miscellaneous lease fees and surcharges: $75 p/mth.
- License costs: owner/lessee expense (for purchase and lease option)

The above-described assumptions were input by our analyst into our DCF analysis MS Excel™ - based software tool as shown below in *Table 12: List of Input Assumptions* (below).

Table 12: List of Input Assumptions

Vehicle Type/Category and Cost Information	
Vehicle Make/Model	Sedan
Vehicle Acquisition Cost (includes upfitting)	$27,130
Projected Resale Value Annual Decrease (2% per year)	2.0%
NPV discount rate	1.75%
Inflation rate	2.45%
Fuel Consumption: (litres or litre equivalent per 100 km)	9.5
Annual Kilometers-Travelled* (kms)	29,870
Planned Replacement Lifecycle (months)	144.0

[34] Analysis based on five days per week, nine statutory holidays per year
[35] Based on Class 1 sedan FAR™ analysis
[36] Acquisition cost of a Class 1 sedan – used for the purchase option DCF analysis

Vehicle Type/Category and Cost Information	
Cost of Capital (%)	2.45%
Cash Flow Horizon (months)	144.0
Lease: Term (months)	72
Lease: Interest Rate (%) (based on market data or per RFP)	6%
Lease: Lease service-provider profit adder (%) (estimated or per RFP)	1%

Operating Costs – Buy and Lease Options

Based on the business assumptions shown in *Table 12* (above), we estimated the annual operating in each year of the 12-year horizon. Please see *Table 13: Annual Operating Expenses* (below).

Note: Operating expenses varied for each of the three options. We adjusted the baseline year costs to account for inflation in each year of the 12-year horizon for increased accuracy.

Table 13: Annual Operating Expenses

Operating Expenses (buy or lease)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Maintenance and repair ($/yr.)	$700	$725	$917	$1,088	$1,130	$1,067	$1,200	$1,163	$1,233	$1,185	$2,459	$2,329
Fuel/electric ($/liter or kWh)	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178
Licence ($/yr.)	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120
Total operating costs:	**$3,998**	**$4,023**	**$4,215**	**$4,386**	**$4,428**	**$4,365**	**$4,498**	**$4,461**	**$4,531**	**$4,483**	**$5,757**	**$5,627**

Option 1: Purchase

With the assumptions described above in *Tables 12* and *13*, we calculated the lifecycle total cost of ownership (TCO) for Option 1: Purchasing.

In this scenario, the analysis was data-modelled for a sedan; it depicts the impacts of purchasing and maintaining a sedan in-house through its entire lifecycle. We calculated the TCO over a 12-year horizon for a single vehicle.

Please see *Table 14: Option 1, Purchase – Sedan* (below). We estimate the average annual TCO for a sedan to be **$7,188**. The TCO over a 12-year lifecycle was estimated to be **$86,257** per unit.

Table 14: Option 1, Purchase – Sedan

Option 1: Purchase	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**
Cost of capital (opportunity cost)	$649	$633	$618	$603	$589	$575	$561	$548	$535	$522	$509	$497
Depreciation	$4,070	$4,070	$4,070	$4,070	$4,070	$4,070	$0	$0	$0	$0	$0	$0
Operating Cost	$3,998	$4,096	$4,196	$4,299	$4,405	$4,513	$4,623	$4,736	$4,852	$4,971	$5,093	$5,218
Cash flow	$4,647	$4,729	$4,815	$4,903	$4,994	$5,087	$5,184	$5,284	$5,387	$5,493	$5,602	$5,715
Total Cost of Ownership	**$8,716**	**$8,799**	**$8,884**	**$8,972**	**$9,063**	**$9,157**	**$5,184**	**$5,284**	**$5,387**	**$5,493**	**$5,602**	**$5,715**

Option 2a: Lease

Fleet Challenge completed analysis for two vehicle leasing scenarios. In the first scenario, Option 2a, the sedan would be leased for six years. At the end of the lease, the vehicle would be replaced with another similar unit which would also be leased for six years, to achieve a 12-year lifecycle comparison (i.e., to the other options).

The costs of two back-to-back six-year sedan leases are shown in *Table 15: Option 2a – Six-Year Lease (x2)* (below). For the lease Option 2a of a Class 1 Sedan, the average annual cost is **$9,862,** and the lifecycle total cost of ownership (TCO) is **$118,350**.

Table 15: Option 2a – Six-Year Lease (x2)

Option 2a: 6-Year Lease (x 2)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Lease payments ($ per month - includes interest rate & profit)	5,204	5,204	5,204	5,204	5,204	5,204	5,204	5,204	5,204	5,204	5,204	5,204
Operating cost (fuel, maintenance, Licence)	3,998	4,096	4,196	4,299	4,405	4,513	4,623	4,736	4,852	4,971	5,093	5,218
Misc. fees and surcharges ($ per month, estimated or per RFP)	75	75	75	75	75	75	75	75	75	75	75	75
Cash flow	9,277	9,375	9,476	9,578	9,684	9,792	9,902	10,015	10,131	10,250	10,372	10,497
Total Cost of Ownership	**9,277**	**9,375**	**9,476**	**9,578**	**9,684**	**9,792**	**9,902**	**10,015**	**10,131**	**10,250**	**10,372**	**10,497**

Option 2b: Lease

In our second lease scenario, Option 2b, we analyzed the cost of leasing a sedan for six years, then purchasing the vehicle for its residual value at the end of the lease. The vehicle would remain in service until the end of its 12-year lifecycle.

The costs of a six-year lease for a sedan with a buyout at the end of the lease, then buying and operating the vehicle for another six years are shown in *Table 16: Option 2b – Six-Year Lease with Buyout* (below).

For lease Option 2b of a Class 1 Sedan, the average annual cost is **$7,474**, and the lifecycle total cost of ownership (TCO) is **$ 89,690**.

Table 16: Option 2b – Six-Year Lease with Buyout

Option 2b: 6- Year Lease with Buyout	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Lease payments ($ per month - includes interest rate & profit)	$5,204	$5,204	$5,204	$5,204	$5,204	$5,204						
Buy & dep. years 7-12							$452	$452	$452	$452	$452	$452
Cost of capital-year 7-12							$0	($11)	($21)	($30)	($39)	($48)
Operating cost (fuel, maintenance, Licence, inflation)	$3,998	$4,096	$4,196	$4,299	$4,405	$4,513	$4,623	$4,736	$4,852	$4,971	$5,093	$5,218
Misc. fees and surcharges ($ per month, estimated or per RFP)	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75
Lease: Cash flow	$9,277	$9,375	$9,476	$9,578	$9,684	$9,792	$5,150	$5,264	$5,380	$5,498	$5,620	$5,745
Total Cost of Ownership	**$9,277**	**$9,375**	**$9,476**	**$9,578**	**$9,684**	**$9,792**	**$5,150**	**$5,253**	**$5,359**	**$5,468**	**$5,581**	**$5,697**

Both leasing options (2a and 2b) were higher-cost options for vehicle acquisition relative to the purchase option. However, for both lease options, several critical assumptions used in the analysis were unknown, and they could potentially shape the outcome of the study. Specifically, these were:

- **Purchase price.** Since vehicle(s) would be purchased by the lessor and leasing companies may be able to buy vehicle for a substantially lower price, this one assumption could be a game-changer.

- **Interest rate.** The interest rate charged to City of North Battleford by a potential lessor is unknown. Typically, this rate is the product of the lessor's costs of the lessee's creditworthiness, both of which are unknown to our analysts. Fleet Challenge used an estimated market-based rate as a workaround, but a firm cost must be determined through competitive bidding.

- **Profit.** It is safe to assume all leasing companies wish to make a profit and that a profit adder would be charged to City of North Battleford on top of interest charges. However, the potential lessor's exact profit margin is unknown. Therefore, Fleet Challenge used a "safe" (low) assumption as a workaround.

- **Service charges.** It is safe to assume that all leasing companies include administrative and other service fees in their lease charges. Exactly which fees and what the costs might be are unknown. Fleet Challenge used a safe (low) rate as a business assumption as a workaround.

- **Reconditioning.** For Option 2a, closed-end leasing, lessors typically charge the lessee to restore the vehicle to a predetermined state at the end of the term. The degree or level of reconditioning should be negotiated with potential lease vendors at the outset – for our analysis, this was an unknown.

- **Lease term.** We used a six-year term; shorter periods are available, impacting the monthly lease charges.

- **Residual value.** The residual value at the end of an open-end lease can be negotiated with lessors. For our analysis, we reduced the vehicle value by 2% annually.

Important note. The many unknown business assumptions (listed above) could alter the outcomes of the leasing cost analysis. It is possible that the cumulative impact of preferential interest rates combined with a reduced cost of vehicle acquisition (and other factors), the lease option could become more favourable. Therefore, Fleet Challenge recommends that, should City of North Battleford ever be considering leasing as an alternative to purchasing or renting, the Municipality should first issue an RFP or RFQ to determine these costs with absolute clarity. Then, with certainty around these key assumptions, lease versus buy DCF analysis should then be recalculated.

Option 3: Rent

Rental Contract Assumptions

For this option, our analysis was based on municipal peer data, and we made the following assumptions for a rental contract:

- Rental units on a full-service plan.
- All scheduled maintenance is included in the cost and performed offsite.
- The rental agency is responsible for replacing a vehicle if downtime exceeds 24 hours for any reason.
- Vehicles are no older than three years.
- City of North Battleford responsible for paying monthly charges only.
- Maintenance and licensing, normal wear and tear costs included.
- The only extra is for damages above normal wear and tear.
- Rentals based on estimated mileage; no over-mileage fees are applicable.

We calculated the costs of Option 3: Renting, and the results are shown in *Table 17: Option 3 – Rent* (below). For the rent option of a Class 1 Sedan, the average annual cost is **$8,653**, and the lifecycle total cost of ownership (TCO) is **$103,838.**

Table 17: Option 3 – Rent

Option 2: Rent	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Rent payments ($ per month) - includes maintenance	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400	$5,400
Operating cost (fuel only)	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178	$3,178
Misc. fees and surcharges ($ per month, estimated or per RFP)	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75
Cash flow	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653	$8,653
Total Cost of Ownership	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**	**$8,653**

Important note. Fleet Challenge recommends that, with more certainty around key data inputs, buy vs. lease vs. rent DCF analysis should be recalculated using the same principles presented in this analysis.

Summary of DCF Analysis

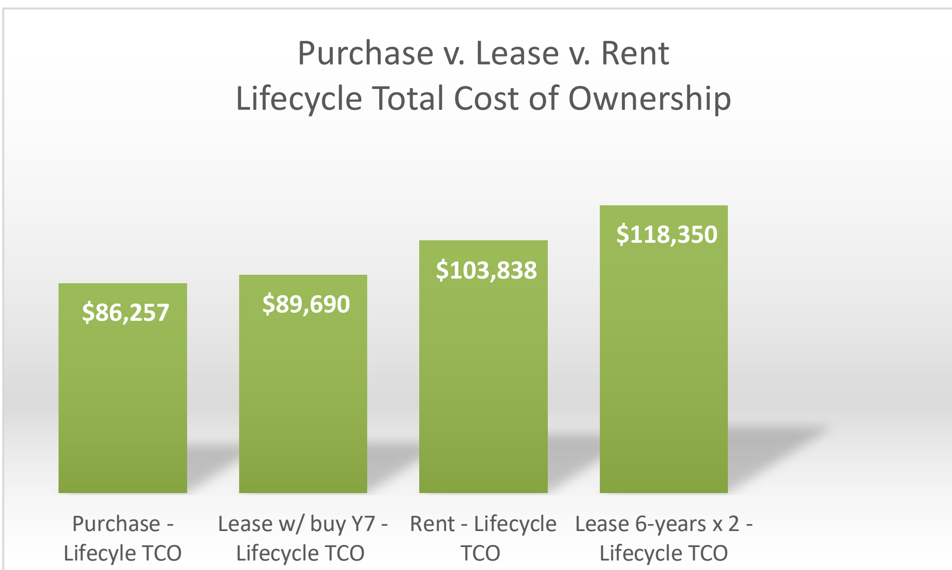
After completing the DCF analysis for purchasing, leasing, and renting options, modelling results showed that Option 1: Purchase would provide the lowest total cost of ownership (TCO) over the 12-year lifecycle. However, with that stated, several key business assumptions for the leasing and rental options are unknown, and these could influence the outcomes as we have described.

Table 18 and *Figure 5* (below) summarize the purchase, lease, and rent analysis. Based on our modelling, the lowest cost option is to purchase vehicles, followed by the 6-year lease with buyback option; the rental option followed. Finally, the highest cost option is the 6-year closed-end lease.

Table 18: Summary of Purchase, Lease & Rent Analysis

Purchase - Lifecyle TCO	Lease w/ buy Y7 - Lifecycle TCO	Rent - Lifecycle TCO	Lease 6-years x 2 - Lifecycle TCO
$ 86,257	$ 89,690	$ 103,838	$ 118,350

Figure 5: Purchase, Lease & Rent Analysis – Lifecyle TCO



Purchase versus Rent – Other Considerations

High-Mileage Applications

As per our cost calculations for the example of a Class 1 Sedan, the rental option would cost $1,465 per year more than purchasing. However, in some high mileage applications, renting can bring more cost certainty and control since the rental agency is obliged to provide new, fresh vehicles.

For example, costly mechanical repairs are almost a certainty in the late years of a 12-year life for vehicles with higher-than-average annual kilometers travelled. To counteract this situation, either the vehicle's lifecycle must be reduced, or the prospects of high repair costs will be almost certain; both will increase the TCO for the purchase option. Therefore, renting may be a cost-effective option in some high mileage applications.

Reduced Administrative Effort

Viewing the vehicle procurement options holistically, renting can mean a reduction in administrative effort for a municipality – it is possible that some responsibilities managed internally may be transferred to the rental (or leasing) agency.

The cost of administrative effort may be high. For example, tasks such as preparing vehicle specifications and preparing, issuing, and awarding RFQs for vehicle purchases every year, managing, scheduling and supervising vehicle maintenance, and maintaining vehicle service histories are routines that incur administrative effort and, hence, cost. The exact value of this cost is unknown, but likely significant.

Although out of scope for this project, the cost impact of reduced administrative effort could be determined by undertaking an activity-based costing[37] (ABC) exercise. Based on this premise, it is possible that a rental agreement could have cost parity with the vehicle purchasing option and provide cost savings in high annual mileage applications.

Purchase, Lease or Rent – Recommendations

- If City of North Battleford is ever considering leasing as an alternative to purchasing or renting, management should first issue an RFP or RFQ to determine these costs with absolute clarity. Then, with certainty around these assumptions, lease versus buy DCF analysis should be recalculated.

- Carefully prepare bid specifications for a vehicle leasing RFP/Q so that *all* cradle-to-grave leasing costs, including all service charges and extra fees, can be identified, and evaluated.

[37] Source: https://www.investopedia.com/terms/a/abc.asp

- In RFP/Qs, consider adding a requirement for potential lease vendors to state their beginning-to-end, total-cost-of-leasing projections, including all fees and surcharges over the entire lease term in their proposals.

- To ensure consistent bid responses in RFP/Qs, employ a standard response format, such as a fillable .pdf template, for bidders to list their charges, rates, additional fees, and surcharges in the same way so competing bidders' responses will be comparable.

- Require vendor proposals to include their proposed fixed or floating interest rate and their proposed percentage of profit "adder" (markup).

- Require vendors to guarantee that all applicable service charges and other fees that may be applied over the leased vehicle's entire lifecycle have been stated.

Section 9: Green Fleet Planning

A primary objective of the Fleet Equipment and Vehicle Optimization Study was to analyze City of North Battleford's in-scope fleet data Propose opportunities to improve environmental sustainability and decrease fuel usage, including:

- Evaluation of the cost and benefits of alternative vehicles or equipment that will decrease fuel consumption or utilize electric or hybrid technology.

- Decreases or increases in departmental vehicles or equipment to improve environmental impacts

FCC prepared the fleet's baseline from data provided by the City for the review period, including capital expenses (Capex), operating expenses (Opex), and fuel consumption for all units. From the baseline, as we describe in previous sections of this report, we modelled a 15-year budget cycle for business-as-usual (BAU) vehicle retention practices, optimized economic lifecycles through lifecycle analysis (LCA), and balanced Capex using optimized economic lifecycles by deferring replacement of due units that would not provide return-on-investment (ROI).

We then modelled several fuel-reduction scenarios categorized into three groups:

(1) Best management practices (BMPs);
(2) Fuel switching; and
(3) Electrification, which includes transitioning to hybrid-electric vehicles (HEVs) battery-electric vehicles (BEVs)

The emphasis of our recommendations is centred on electric vehicle (EV) phase-in, as this is the most effective long-term GHG reduction strategy for a fleet as more electric vehicle models come to market and as battery technology continues to advance. Although lower mileage units are unlikely to deliver ROI if replaced with a BEV based on our modelling due to increased capital costs, our team reasoned that this approach was most appropriate given the objective of the Green Fleet Strategy is to assist City of North Battleford to achieve deep GHG emissions reductions while improving operational efficiency and reducing fuel and maintenance costs.

Overview of Solutions Modelled in FAR

Here, we provide an overview for all solutions modelled in City of North Battleford's Green Fleet Strategy. More details on all solutions that have been researched by FCC, including the ones presented to the City, can be found in *Appendix F*.

Light-Weighting

Lighter vehicles consume less fuel, produce less emissions, and can carry larger payload. However, light-weighting may overstress some vehicles, increasing maintenance demand and lifecycle cost; therefore, fleet managers must exercise caution before choosing which vehicles to proceed with a light-weighting enhancement.

Low-Rolling Resistance Tires

Rolling resistance is the energy lost from drag and friction of a tire rolling over a surface[38]. The phenomenon is complex, and nearly all operating conditions can affect the outcome. For heavy trucks, an estimated 15-30% of fuel consumption is used to overcome rolling resistance.

A 5% reduction in rolling resistance would improve fuel economy by approximately 1.5% for light and heavy-duty vehicles. Installing low-rolling resistance (LRR) tires and/or auto-inflation systems can help fleets reduce fuel costs. It important to ensure proper tire inflation in conjunction with using LRR tires.

Tires and fuel economy represent a significant cost in a fleet's portfolio. In Class 8 trucks, approximately one-third of fuel efficiency comes from the rolling resistance of the tire. The opportunity for fuel savings from LRR tires in these and other vehicle applications is substantial.

According to a North American Council for Freight Efficiency (NACFE) report, the use of LRR tires, in either a dual or a wide-base configuration, is a good investment for managing fuel economy. Generally, the fuel savings pay for the additional cost of the LRR tires. In addition, advancements in tire tread life and traction will reduce the frequency of LRR tire replacement.

Anti-Idling Policy and Technologies

An idling-reduction policy is a way to motivate fleet drivers to limit unnecessary idling. However, for an idling-reduction policy to be successful continuous enforcement such as spot-checks, and fuel use tracking must be present. An idling-reduction policy could be used as an overarching commitment to idle reduction that is carried out through driver training and motivation sessions, rather than an initiative on its own.

There are several idling-reduction technologies available that can aid in idle reduction, including auxiliary power units (APU), stop/start devices, auxiliary cab heaters, battery backup systems, and block heaters/ engine preheaters. Their functionality, potential, and costs vary considerably and are described in *Appendix C* (FAR models a cost of $5,000 for all vehicle categories). To reap the most

[38] Source: https://afdc.energy.gov/conserve/fuel_economy_tires_light.html

benefits of any idling-reduction technology, installation should always be accompanied by behavioural solutions of driver training and motivation.

Driver Eco-Training

Driver training to modify driver behaviours and ongoing motivation to continue good behaviours are crucial components of successful idling-reduction programs. While most drivers understand the vehicle idling issue, many continue their inefficient practice of excessive idling due to lack of knowledge and/or motivation.

Driver training can be used to optimize the use of idle reduction technologies. The technologies can reduce idling, but the drivers have the ability to override the technologies. Proper training can aid in utilizing the technologies to their full potential. Further, driver training can promote good practices while on the road including progressive shifting, anticipating traffic flow, and coasting where possible.

Route Planning/Optimization and Trip Reduction

In addition to enhanced vehicles specifications and improved driver behaviours, fuel consumption and exhaust emissions can be further reduced through route planning/optimization and trip reduction.

Route planning software can be used optimize multi-stop trips. It can also be used for idling reduction initiatives by integrating GPS tracking software to monitor driver activity in real-time. Moreover, reporting and analytics features within route planning software can help with identifying when a fleet vehicle requires maintenance to ensure optimal fuel efficiency and thus minimize cost and emissions.[39]

Google™ Maps recently announced their mapping/guidance systems will soon feature and advise drivers of the lowest GHG-emission routes to their destinations. By embracing this technology where possible/practical, and perhaps combining its use with a corporate policy or directive for employees to minimize their trips where possible, emissions (and costs) could be minimized.

Fuel Switching

E85 Ethanol

Ethanol is a renewable fuel made from various plant materials known as biomass or feedstocks. Corn and wheat are most commonly used to produce ethanol. In most North American jurisdictions, renewable fuel standards require all gasoline sold to be a 5-10% ethanol blend (E5-10). In Ontario,

[39] Source: https://blog.route4me.com/2020/05/carbon-emissions-reduction-route-optimization-helps-cut-tons-carbon-emissions/

the standard is currently an annual average of E10 for all gasoline sold[40]. Ethanol burns cleaner and more completely than gasoline or diesel fuel; blending ethanol with gasoline increases oxygen content in the fuel, thereby reducing air pollution[41].

A higher blend of ethanol, known as E85 (85% ethanol, 15% gas) can lead to significant GHG reductions. The 15% gasoline is needed to assist in engine starting because pure ethanol is difficult to ignite in cold weather[42]. This fuel must be used in dedicated "flex-fuel" vehicles (FFVs), which can run on any combination of gasoline and ethanol blends (up to 85%).

E85 contains about 29% less energy than gasoline per unit volume[43]. Given this energy loss, about 42% more E85 is required to achieve the same amount of work as gasoline. The significant energy losses per unit volume as compared to gasoline means that the lower cost of E85 per unit volume compared to gasoline does not always offset the higher volume required to achieve the same distance travelled, potentially making E85 more expensive than gasoline.

In terms of strictly tailpipe emissions, E85 has a GHG emissions reduction potential of about 30% when compared to the same volume of gasoline[44], but this value is significantly reduced when accounting for energy equivalency. However, using "net vehicle operation" emissions factors from GHGenius Version 5.01a results in an overall operative GHG emissions reduction of over 80% (i.e., the carbon that is sequestered through the biomass growth nearly completely offsets carbon output from combustion).

The U.S. has thousands of stations that offer E85. Canada has four – and they're all in B.C., according to a biofuels industry association. "It's pretty remarkable, but that's it for Canada – just those four stations, as far as I know," said Ian Thomson, president of Advanced Biofuels Canada, an industry association.

Although E85 may not be available at retail fuel stations and it could potentially be delivered to the City of North Battleford from the U.S. In some jurisdictions including Saskatchewan, it will be challenging to find a local supplier of E85 as it is only available through specialized providers. Alternatively, it could be stored and dispensed in bulk from an onsite fuelling station, but this would incur additional implementation costs. Ethanol tanks require a water monitoring system. In addition, a 10-micron filter, signage, and other upgrades are required to ensure the system is compliant.

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[40] Source: https://www.ontario.ca/page/greener-gasoline
[41] Source: https://afdc.energy.gov/fuels/ethanol_fuel_basics.html
[42] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/ethanol/3493
[43] Source: Department of Energy GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) Model, Jan 20, 2011.
[44] Source: http://www.patagoniaalliance.org/wp-content/uploads/2014/08/How-much-carbon-dioxide-is-produced-by-burning-gasoline-and-diesel-fuel-FAQ-U.S.-Energy-Information-Administration-EIA.pdf

E85 – Feasibility Considerations

- E85 can be used in flex-fuel ready gasoline vehicles with no further modifications.
- There are no infrastructure costs associated with E85 use if a fuelling station is attended or if E85 is delivered direct-to-vehicle.
- Alternatively, E85 could be stored and dispensed in bulk from an onsite fuelling station, but this would incur additional implementation costs.
- E85 is a cleaner burning fuel than gasoline, thereby reducing air pollution. This can result in cleaner intake valves and fuel injectors, and reduced knocking and pinging[45].
- E85 can improve vehicle performance (acceleration) because of its higher octane content[46].
- Given the significant energy losses per unit volume as compared to gasoline, the lower cost of E85 per unit volume compared to gasoline does not always offset the higher volume required to achieve the same distance travelled, potentially making E85 more expensive than gasoline. In-fleet pilot testing is recommended.
- E85 cannot be used in small equipment such as most portable generators and other small engines, so a dedicated fuel tank would be required for exclusive use by flex-fuel capable vehicles only.

Biodiesel, Renewable Diesel

Biodiesel is a renewable fuel made from vegetable oil and waste cooking oil, animal fats such as beef tallow and fish oil, and even algae oil[47]. Biodiesel is often referred to as fatty acid methyl ester or FAME[48].

Biodiesel can be blended in a variety of ratios with conventional fossil diesel. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix (e.g., B2 indicates 2% biodiesel and 98% fossil diesel). Biodiesel blends include: B2, B5, B10, B20, blends greater than B20, and B100 (100% biodiesel, also known as "neat" biodiesel).[49]

[45] Source: https://driving.ca/chevrolet/auto-news/news/western-canadas-first-e85-ethanol-gas-station-ready-to-pum p
[46] Source: https://www.canadianmanufacturing.com/regulation/ethanol-market-chasing-us-canadas-fueling-options-flatline-142054/
[47] Source: https://www.nrcan.gc.ca/energy/alternative-fuels/resources/nrddi/3669
[48] Source: https://www.neste.com/what-difference-between-renewable-diesel-and-traditional-biodiesel-if-any
[49] Source: https://www3.epa.gov/region9/waste/biodiesel/questions.html

Canadian regulations require fuel producers and importers to have an average renewable fuel content of at least 2% based on the volume of diesel fuel and heating distillate oil that they produce or import into Canada.

Net vehicle operation GHG emissions reductions are dependent on the biodiesel blend used; for a given unit mass or volume, the higher the blend, the lower the GHG emissions. Moreover, actual emissions reduction potential for the same distance travelled is dependent on both GHG emissions per unit mass/volume and fuel economy. The energy content of pure biodiesel (B100) is close to 8% lower than pure diesel[50]. Taking into account this energy loss, using blends ranging from B5 to B20, the latter of which may be restricted to summer due to gelling in cold weather, requires slightly more fuel than pure diesel and lowers operative GHG emissions by an estimated 10% as a whole. Using biodiesel can also reduce several other tailpipe emissions including particulates and unburned hydrocarbons[51].

In January 2022, in Saskatchewan, Federated Co-operatives Ltd. announced[52] a new renewable diesel fuel and canola-crushing plant. The oil-production business announced that the estimated $2-billion integrated agriculture complex is to be built in north Regina, near the company's co-op refinery, and in partnership with global pulse-processor and supplier AGT Foods.

Once built, the diesel plant is to have a production capacity of 15,000 barrels a day, or about one billion litres annually. The canola facility is expected to produce 450,000 tonnes of oil.

The Saskatchewan government said the diesel plant portion is expected to create more than 2,500 construction jobs and 150 permanent operating jobs. It is scheduled to be completed by 2027.

Biodiesel – Feasibility Considerations

- Blends of B20 and lower can be used in diesel equipment with no modifications, although certain manufacturers do not extend warranty coverage if equipment is damaged by poor quality fuel in these blends (see details in *Appendix C*).

- Since there are no vehicle conversion or infrastructure costs associated with biodiesel use, biodiesel could be immediately introduced to begin reducing fuel-use and emissions.

- Keeping biodiesel to a lower blend (i.e., B5 or B10) will have better cold weather operability properties than a higher blend (i.e., B20 +) due to thickening at low temperatures.

[50] Source: Department of Energy GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) Model, Jan 20, 2011.
[51] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/biodiesel/3509
[52] https://www.cbc.ca/news/canada/saskatchewan/diesel-canola-plant-regina-1.6318248

- Although production is abundant, there are a limited number of biodiesel vendors and distributors.
- Due to thickening at low temperatures, it may be prudent to store biodiesel fuel in a heated building or storage tank, as well as heat the fuel system's fuel lines, filters, and tanks.
- Biodiesel is as safe in handling and storage as petroleum-based diesel fuel.

Natural Gas

Natural gas, a fossil fuel composed of mostly methane, is one of the cleanest burning alternative fuels. It is also thought to be safer than traditional fuels since, in the event of a spill, natural gas is lighter than air and thus disperses quickly when released. Natural gas can be used in the form of compressed natural gas (CNG) or liquefied natural gas (LNG) to fuel cars and trucks.

CNG is used in traditional gasoline internal combustion engine vehicles that have been modified, or in vehicles which were manufactured for CNG use, either alone (dedicated), with a segregated gasoline system to extend range (dual-fuel), or in conjunction with another fuel such as diesel (bi-fuel). CNG is most commonly used in fleet vehicles like buses and heavy-duty trucks because it requires a larger fuel tank than gasoline and diesel fuel[53].

Based on the same work performed, a vehicle powered by CNG has tailpipe GHG emissions about 20-30% less than a comparable diesel vehicle[54,55]. It also emits up to 95% less nitrogen oxides (NO_x) compared to a diesel and gasoline vehicle[56]. Furthermore, a CNG-powered does not emit particulate matter (PM10), a main cause of air pollution[57].

An alternative and direct replacement to fossil CNG is renewable natural gas (RNG), which is a methane biogas – a gaseous product of the decomposition of organic matter obtained through biochemical process such as anaerobic digestion. It is recovered from landfills, wastewater treatment plants, anaerobic digesters at dairies, food processing plants, or waste processing facilities that are cleaned to meet natural gas pipeline standards.[58]

When RNG is used to fuel fleet vehicles, GHG emissions reductions are significant; different sources estimate the lifecycle reduction to be between 75% and 90% compared to diesel. The carbon dioxide

[53] Source: https://consumerenergyalliance.org/2019/04/energy-explorer-cng-vs-lng/#:~:text=The%20reason%20you%20see%20CNG,requires%20a%20larger%20fuel%20tank.&text=Like%20CNG%2C%20LNG%20is%20compressed,state%20into%20a%20liquid%20state
[54] Source: https://brc.it/en/categorie_faq/cng/
[55] Source: https://envoyenergy.ca/cng-benefits/#:~:text=Commercial%20fleets%20all%20over%20the,solution%20for%20fuelling%20their%20fleets
[56] Source: Northwest Gas Association – Natural Gas Facts
[57] Source: https://brc.it/en/categorie_faq/cng/
[58] Source: https://www.mjbradley.com/sites/default/files/MJB%26A_RNG_Final.pdf

that is generated during the production and combustion of RNG is used in the regeneration of new biomass, representing a closed-loop cycle for carbon dioxide that is released[59].

Feasibility Considerations

- The business case for CNG is, in most cases, made on the differential in price between diesel fuel and natural gas – the higher initial investment costs are typically offset by the fuel savings by using CNG over diesel. However, in a low annual mileage municipal fleet, CNG may cost significantly more than diesel and gasoline, making it cost-prohibitive.

- CNG conversions are available for all classes, with costs ranging from less than $10,000 to over $45,000 CAD. CNG-powered trucks could be re-fueled with overnight slow-fill systems which cost much less than fast-fill systems.

- Trucks being considered for CNG conversion must have ample available frame space for CNG tanks and often this is not possible due to the types of add-on equipment and bodies mounted on the trucks.

- In the event of a power interruption, such as during a severe weather event or some other cause, overnight slow re-fuellers would cease to function and CNG powered vehicles would be sidelined, which could negatively affect an municipality's emergency preparedness plan.

- CNG filling station infrastructure costs could run well in excess of $1 million and as much as $3m or more, depending on capacities and complexities.

Hybrid-Electric Vehicles

- Hybrid Electric Vehicles (HEVs) use two or more distinct types of power, such as an internal combustion engine (ICE) and a battery-powered electric motor as the modes of propulsion, albeit with very limited range when in electric mode. When an HEV accelerates using the ICE, a built-in generator creates power which is stored in the battery and used to run the electric motor at other times. This reduces the overall workload of the ICE, significantly reducing fuel consumption and extending range. Examples of HEVs include the Toyota Prius and Ford Fusion Hybrid. [60]

- Plug-In Hybrid Electric Vehicles (PHEVs) use rechargeable batteries, or another energy storage device, that can be recharged by plugging into an external source of electric power. PHEVs can travel considerable distances in electric-only mode, typically more than 25 km and up to 80 km

[59] Source: Closing the Loop. Canadian Biogas Association. 2015.
[60] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/

for some models, due to their much higher battery capacity than HEVs. When the battery power is low (usually ~80% depleted), the gasoline ICE turns on and the vehicle functions as a conventional hybrid. Such vehicles typically have the same range as their gasoline counterparts. Examples of PHEVs include the Chevrolet Volt and Toyota Prius Prime.[61]

Feasibility Considerations

- Given the combination of an internal combustion engine (ICE) and a battery-powered electric motor in HEVs, there is little, or no preparation required ahead of acquiring these vehicles.

- PHEVs may be plugged into a Level 1 or 2 charger (120 V outlet or 240 V outlet, respectively), with the later achieving a much faster charging speed. However, if a charger is not readily available, the ICE will allow the vehicles to act as regular hybrids, eliminating any range anxiety.

Battery-Electric Vehicles

Globally, vehicles are steadily moving away from the internal combustion engine toward zero-emission battery-electric vehicles (BEVs/EVs).

Air quality is a growing concern in many urban environments and has direct health impacts for residents. Tailpipe emissions from internal combustion engines are one of the major sources of harmful pollutants, such as nitrogen oxides and particulates. Diesel engines in particular have very high nitrogen oxide emissions and yet these make up the majority of the global fleet. As the world's urban population continues to grow, identifying sustainable, cost-effective transport options is becoming more critical. BEVs are one of the most promising ways of reducing harmful emissions and improving overall air quality in cities.

Globally, numerous jurisdictions have already legislated the end of the ICE – some as soon as 2030. On January 28, 2021, General Motors pledged to cease building gasoline and diesel cars, vans, and SUVs by 2035. Even more recently, on June 29, 2021, the Canadian government announced a mandatory target for all new light-duty cars and passenger trucks sales to be zero-emission by 2035, accelerating Canada's previous goal of 100 percent sales by 2040[62]. ICE vehicles purchased today for a fleet with a current-day value in the millions of dollars may be nearly worthless when ICEs become obsolete.

Fleet managers who operate BEVs will see savings in maintenance and fuel costs. BEVs have considerably fewer parts than internal combustion engine (ICE) vehicles. A drivetrain in an ICE vehicle contains more than 2,000 moving parts, compared to about 20 parts in an BEV drivetrain. This 99%

[61] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/
[62] Source: https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

reduction in moving parts creates far fewer points of failure, which limits and, in some cases, eliminates traditional vehicle repairs and maintenance requirements, creating immense savings for fleet managers. BEVs do not require oil changes or tune-ups, do not require diesel exhaust fluid (DEF), and their brake lining life is greatly extended over standard vehicles due to regenerative braking. Though each fleet's electrification journey will be different, the transition to electric vehicles offers significant cost reductions over the long term.

In recent years, BEV range has been considerably extended, thereby providing much wider BEV applications and reducing range anxiety. Today, many BEV models have EPA-estimated ranges exceeding 400 km, which provide much greater reliability when travelling longer distances.

The time required to charge BEVs is dependent on charging speed and battery size. For a battery-electric car or SUV, a full charge using a Level 2 charger takes several hours, but charging from a nearly depleted battery to 70% at a fast (Level 3) charging station can take only 30 minutes[63]. However, heavy-duty trucks charged between 50 and 100 kW (equivalent to DC fast charging) would potentially take several hours to charge[64] due to their much larger battery size.

Although recharging a BEV can take significantly longer than refuelling a conventional vehicle, much of the charging in a return-to-base fleet like City of North Battleford can be done overnight in off-peak hours via Level 2 charging. Please see *Section 10* for details on an analysis of City of North Battleford's charging requirements.

Upstream Emissions

From a broader perspective, to minimize lifecycle GHG emissions, the electricity used to recharge the batteries must be generated from renewable or clean sources such as wind, solar, hydroelectric, or nuclear power. In other words, if BEVs are recharged from electricity generated by fossil fuel plants, they cannot truly be considered as zero emission vehicles (ZEVs). Upstream emissions should be considered when evaluating the effectiveness of BEVs in reducing emissions. Generally, when considering upstream emissions from electricity supply, BEVs still emit > 50% less GHG emissions than their gasoline or diesel counterparts[65], and in some cases emit over 80% less in a grid composed of mostly renewable electricity[66]. Therefore, they can still be the most impactful on-road fleet transportation choice in terms of lifecycle emissions reductions. This level of emissions reduction is what cities need in order to collectively achieve the "deep decarbonization" necessary to mitigate the most serious impacts of climate change.

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[63] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/
[64] Source: https://www.plugincanada.ca/electric-bus-faq/
[65] Source: https://www.eei.org/issuesandpolicy/electrictransportation/Pages/default.aspx
[66] Source: https://blog.ucsusa.org/rachael-nealer/gasoline-vs-electric-global-warming-emissions-953

Battery-Electric Light-Duty Vehicles

There are multiple light-duty cars and SUVs currently on the market; current examples include the Nissan Leaf, Chevrolet Bolt, Kia Soul, and the Tesla Model 3. All with sufficient range for fulfilling daily duties, these vehicles have demonstrated that electrification is not only possible, but also convenient and within an acceptable and affordable price range, particularly when considering fuel and maintenance cost savings over the vehicle's lifetime.

The "workhorse" of municipal fleets, including City of North Battleford, is the pickup truck. Of all the fleet vehicles in FCC's 50,000 vehicle Canadian municipal fleet database, 46% are pickup trucks. Therefore, BEV options in the pickup category have the potential to make a significant impact on the City's fleet GHG emissions reduction, as well as fuel and maintenance cost savings. At this time, there are limited BEV pickups available for purchase, but recently the legacy OEMs General Motors and Ford have both launched BEV pickups; Ford's F-150 Lightning will be shipped in large quantities in the first half of 2022[67], and the 2024 Chevrolet Silverado EV is expected to go on sale in 2023[68].

Battery-Electric Trucks

We expect that battery-electric models for Class 5-8 trucks will come to market soon – likely by 2024 – as almost all truck manufacturers have announced plans to launch battery-electric trucks in these classes. Several are taking orders now, including Lion Electric, Tesla, and Navistar.

A new study[69] quantified what commercial EV-makers have been saying for years: electric trucks are a triple win. They save money for fleet operators and reduce both local air pollution and GHG emissions. The study, which was commissioned by the National Resources Defense Council (NRDC) and the California Electric Transportation Coalition, and conducted by the international research firm ICF, looked at the value proposition for fleet operators of battery-electric trucks and buses (and apparently invented a new acronym: BETs).

Today, BETs have a significant upfront price premium compared to legacy diesel trucks and buses. However, the costs of battery packs and other components are rapidly falling, and the study found that, by 2030 or earlier, electric vehicles will offer a lower total cost of ownership (TCO) for nearly all truck and bus classes, even without incentives.

Like all BEVs, BETs offer a multitude of benefits with some additional ones given their size and load, including:

- Less noise pollution

[67] Source: https://www.theverge.com/2022/1/4/22865664/ford-f150-lightning-double-production-150000-annual
[68] Source: https://www.caranddriver.com/news/a38594208/2024-chevrolet-silverado-ev-revealed /
[69] Source: Posted January 2, 2020 by Charles Morris (https://chargedevs.com/author/charles-morris/) & filed under Newswire (https://chargedevs.com/category/newswire/), The Vehicles (https://chargedevs.com/category/newswire/the-vehicles/)

- Zero tailpipe GHG emissions
- Oil-free operation with very few moving parts
- Simple, low-maintenance electric powertrain with few components
- Longer lasting brakes due to regenerative braking system
- Potential to significantly extend range due to high regenerative braking from carrying heavy loads[70]. The heavier the truck load, the greater the energy produced from regenerative braking.
- Overnight recharging when the vehicle is not in operation and when demand for electricity is lower, which reduces energy costs
- Massive savings potential in total energy costs and service costs
- Competitive lifecycle costs over a 10-year operating life and are better suited over gasoline, diesel, or CNG when accounting for future economic trends

Expected Timelines

Table 19 (below) shows the expected timeline of BEV types and examples of original equipment manufacturers (OEMs) currently producing or expected to produce these vehicles.

Table 19: Expected timeline of BEV types and examples of OEMs

BEV Type	Expected Availability	Example OEMs
Car/SUV	Currently available	Chevrolet, Kia, Tesla
Pickup	2022-2024	General Motors, Ford, Rivian, Lordstown, Tesla
*Refuse Truck	Currently available	BYD, Lion Electric, Mack, Volvo
Passenger Bus	Currently available	Lion Electric
*Transit Bus	Currently available	New Flyer, Nova Bus
Medium- and Heavy-Duty Truck	2024	Daimler, Lion Electric, Navistar, Tesla, Workhorse

*Refuse trucks and transit buses are out of scope for the Equipment and Vehicle Optimization study.

[70] Source: https://www.firstpost.com/tech/science/worlds-largest-electric-vehicle-is-a-110-tonne-dump-truck-that-needs-no-charging-7190131.html

Feasibility Considerations

- Caution must be exercised to ensure longer charging times do not create operational challenges. However, much of the charging in a return-to-base fleet like City of North Battleford can be done overnight in off-peak hours via Level 1 and 2 charging. Please see *Section 10* for an analysis of City of North Battleford's charging requirements.

- Heavy-duty trucks charged in a garage between 50 and 100 kW (equivalent to DC fast charging) would potentially take several hours to charge[71]. DC fast charging installation requires a commercial electrician[72] and costs an estimated $50,000 - $200,000 for equipment and installation[73]. Please see *Section 10* for an analysis of City of North Battleford's charging requirements.

- Extreme cold temperatures can significantly reduce range in BEVs due to heating of the cabin and heating of the battery itself[74]. Therefore, it is important account for this when purchasing BEVs to ensure sufficient range is provided to cover a day's worth of routes in the heart of winter. However, in a return-to-base fleet like City of North Battleford this would likely not pose an operational issue for many units. Please see *Section 10* for an analysis of City of North Battleford's charging requirements.

- Power grid failure or local failure at a site/garage could pose a significant risk to operations. To mitigate this risk, backup generators can deal with short power outages. For longer outages, larger generators would be needed, but this would come at a very expensive cost.[75]

Fuel-Cell Electric Vehicles

Hydrogen fuel cells can produce electricity for motive power with zero tailpipe emissions and, therefore, in theory they can offer enormous environmental and sustainable energy benefits. Fuel cells are flexible in size, power density, and application. There are differing opinions as to whether the next phase zero-emission vehicle (ZEV) batteries will be recharged with onboard hydrogen fuel cells.

While hydrogen fuel-cell vehicles (FCEVs) are included under the umbrella term of emerging electric technologies, this technology is unlikely to become cost-competitive soon – if ever for most vehicle applications. Moreover, most of the hydrogen fuel produced today comes from fossil-fuel sources,

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[71] Source: https://www.plugincanada.ca/electric-bus-faq/
[72] Source: https://calevip.org/electric-vehicle-charging-101
[73] Source: https://www.toronto.ca/wp-content/uploads/2020/02/8c46-City-of-Toronto-Electric-Vehicle-Strategy.pdf
[74] Source: https://www.geotab.com/blog/ev-range/
[75] Source: https://www.plugincanada.ca/electric-bus-faq/

thereby deeming the technology highly ineffective at reducing overall lifecycle greenhouse gas (GHG) emissions.

FCEVs are like electric vehicles in that they use an electric motor to power the drive wheels and have no smog-related or greenhouse gas tailpipe emissions. Rather than being plugged in to charge a battery, these vehicles use onboard fuel cells to generate electricity.

Feasibility Considerations

- In the zero-emissions transportation area, fuel cells have benefits over purely battery-electric vehicle (BEV) technology, namely they can easily meet the extended range requirements and offer rapid refuelling to satisfy driver and consumer interests. However, the effectiveness of BEVs in converting chemical to kinetic energy (also known as the fuel-to-wheel efficiency factor) is still superior to FCEVs. Moreover, the cost of electricity is much cheaper than the cost of hydrogen fuel.

- One of the main issues with the development of hydrogen transportation has been the shortage of hydrogen fuelling stations. Manufacturers are not willing to produce vehicles that customers cannot fuel, while developers are reluctant to build hydrogen stations (costing up to $2,000,000 or more) due to lack of demand.

Synopsis

Transitioning to battery-electric vehicles (BEVs) is the most effective long-term GHG-reduction solution for City of North Battleford's fleet, in consideration of both emissions and operating costs.

Important note. Although we expect the cost of BEVs to come down with time, and eventually reach price parity with ICE vehicles, we did not make this assumption in our modelling; rather, our FAR analysis used current, real data and estimations based on current market conditions and not speculative future market conditions.

Green Fleet Strategy Recommendations

Here, we provide our recommendations for the solutions modelled in the Green Fleet Strategy as well as for monitoring and reporting progress.

Best Management Practices

- As a first step to reducing fuel consumption and GHG emissions, consider implementing fleet-wide driver eco-training and anti-idling policy/technologies, as these solutions are shown to have the greatest fuel- and GHG-reduction potential and the lowest impact on Opex, if fully implemented.

Fuel Switching

- As an interim GHG-reduction solution, consider using B5 biodiesel in winter and B20 in the summer and shoulder months (B10 annualized) for diesel vehicles and, if appropriate, equipment units.

- Consider a pilot project with several units switched to higher-blend biodiesel (B20); if successful, switch other appropriate units – particularly those with several years of useful life remaining (i.e., ones that will not be replaced with a BEV in the short- to mid-term).

- Although compressed natural gas (CNG) conversion is a solution that can potentially deliver significant fuel cost savings, the high cost of natural gas vehicle conversions and installing fast-fuelling stations results in overall higher operating costs, makes it prohibitive based on our modelling.

- Given that vehicles, including those in the medium- and heavy-duty segments, will most likely shift away from the internal combustion engine and towards battery-electric technology, a commitment to CNG does not appear to be a prudent choice for the long-term.

- Renewable natural gas (RNG) offers tremendous GHG-reduction potential (the greatest of all fuel-switching options) and, therefore, is a possible path to deep decarbonization of City of North Battleford's fleet; however, unless there is a local supplier of this fuel, investment in costly fast-fuelling stations (same as what would be used for CNG) is required, making this solution cost-prohibitive based on our modelling.

Hybrid-Electric Vehicles

- Consider purchasing plug-in hybrid vehicles (PHEVs) for lower-mileage units which would be able to fulfil daily duties on battery-power only and recharge overnight – essentially functioning like pure battery-electric vehicles.

- As battery-electric vehicle (BEV) options increase – with light-duty trucks (pickups) on the horizon and the market availability of medium- and heavy-duty trucks forecasted by the mid-2020s – we recommend that City of North Battleford focus on allocating more capital towards BEVs than HEVs or PHEVs, except for high-usage applications that may currently and in the near-term require hybrids due to range limitations. This approach makes technological sense as charging infrastructure expands and vehicles with internal combustion engines become outdated in coming years. Importantly, it will also empower the City to reduce its GHG emissions significantly; achieving deep decarbonization will not be possible unless there is a shift towards purchasing fully electric vehicles.

- Strictly through a lens of fiscal planning, prioritize replacement of ICE units with BEVs *only if they would deliver ROI* – typically ones that have relatively high annual mileage and less demanding duty cycles.

- Conduct a pilot project for several BEVs when they become available (e.g., pickups) to track range capabilities and cost savings and assess the units' performance for all seasons and varying weather conditions.

- If the pilot project is successful, acquire BEVs in bulk to replace units that would provide the greatest ROI.

- Closely monitor the acquisition costs for BEVs and re-evaluate the business case (cost-benefit) for individual units as prices change/ come down.

Monitoring & Reporting Progress

We recommend that City of North Battleford establish key performance indicators (KPIs) and develop associated data collection, analysis, and reporting protocols to measure and report performance annually or biennially, with a focus on the following actions:

- Include fuel consumption (L/100 km), or corporate average fuel economy (CAFE), as a KPI, or as part of benchmark and monitoring reports, to set goals and measure progress towards targets for improved fuel efficiency and reduced GHG emissions.

- Include GHG intensity (kg CO_2e/km) as a KPI, or as part of benchmark and monitoring reports, to measure success in reducing GHG emissions while considering the potential growth of the fleet due to a growing population.

Risk/Change Management Approaches

- Develop BEV educational and outreach materials for employees and operators summarizing the reasons and benefits of transitioning to BEVs, in terms of the environment (improved air quality and greatly reduced lifecycle GHG emissions), reduced fuel and maintenance expenses (the business case), improved performance (e.g., instant torque, little noise, regenerative breaking), greater reliability due to fewer moving parts than internal combustion engine (ICE) vehicles, and continuously expanding charging infrastructure.

- Since operator feedback and employee engagement are essential, invite frontline employees to take BEV test drives to familiarize them with fully electric vehicles and charging, as well as to give them first-hand experience of improved performance (e.g., instant torque, little noise, regenerative breaking).

- Provide operators with a BEV orientation before releasing new models into the fleet to enable to become familiar with the different driving experience (e.g., instant torque, little noise, regenerative breaking) and charging, as well as to alleviate/eliminate any apprehension or uncertainties such as range anxiety.

- As is recommended for the phasing in of BEVs, we recommend a pilot project for several BEVs as they become available (e.g., pickups) to track range capabilities and cost savings and assess the units' performance for all seasons (one year) in varying weather conditions.

Additional Considerations

Battery Replacement, Energy Storage, and Battery Disposal

Global lithium-ion battery demand has risen dramatically over the last ten years, and this is expected to only be the "tip of the iceberg" as we are only at the beginning of the electric vehicle revolution.

Most, if not all, battery-electric vehicle (BEV) manufacturers have an eight-year or 100,000-mile (160,000 km) warranty on their batteries – whichever one (i.e., vehicle age or distance travelled) comes first[76]. However, the current prediction is that a BEV battery will last from 10-20 years, depending on usage, before it needs to be replaced[77].

Consumer Reports estimates that the average BEV battery pack's lifespan is around 200,000 miles (320,000 km), which is nearly 17 years of use if driven 12,000 miles (19,200 km) per year. As a comparison, the average annual mileage for all in-scope City of North Battleford fleet units is ~5,000 km. Therefore, in most cases, BEVs will likely reach their end-of-life before there is a need for battery replacement.

When battery capacity falls below 80%, drivers may start to see a decline in range[78] – which would most likely occur at or after the typical vehicle replacement age because battery degradation is a very gradual process[79]. Once the BEV battery capacity becomes undesirable for powering a vehicle, it can be used to power a building by contributing to a battery storage system, which stores energy

[76] Source: https://www.myev.com/research/ev-101/how-long-should-an-electric-cars-battery-last
[77] Source: https://www.edfenergy.com/electric-cars/batteries
[78] Source: https://www.edfenergy.com/electric-cars/batteries
[79] Source: https://www.myev.com/research/ev-101/how-long-should-an-electric-cars-battery-last

from a battery that can be used later[80]. For example, if a building is powered by renewable energy such as wind or solar, an "old" BEV battery can be used to store energy produced while the wind is blowing or the sun is shining, and then release the stored energy during low-wind periods or at night. This method of generating electricity has multiple benefits, including:

- An effective way of continuing the life of an old BEV battery
- Reducing energy used from the grid, thereby reducing energy costs
- Increasing energy security when using renewables, which have variable energy outputs, by releasing stored energy during off-peak times

When batteries do reach the end of their working life, they can be recycled, which typically involves separating out valuable materials such as cobalt and lithium salts, stainless steel, copper, aluminium, and plastic. Currently, about half of the materials in a BEV battery pack are recycled, but with BEVs expected to undergo an explosion in popularity over the next decade or so, car manufacturers are looking to improve this.[81] Moreover, battery recycling companies have emerged with the growing need for electric vehicle battery recycling, as well as due to the shortage of domestic critical raw materials including lithium, cobalt, and nickel[82].

End-of-lifecycle lithium-ion batteries are first brought to facilities, known as "spokes," which physically separate materials (e.g., shredded metals, mixed plastics, etc.) – much like municipal material recycling facilities (MRFs). These separated materials are then brought to centralized locations, known as "hubs," where battery-grade end products, i.e., the original raw materials (metals) are produced. In May 2020, the lithium-ion battery recycling company Li-Cycle opened a "spoke" facility in Kingston, Ontario with a capacity to process 5,000 tonnes of lithium-ion batteries per year. [83]

[80] Source: https://www.edfenergy.com/electric-cars/batteries
[81] Source: https://www.edfenergy.com/electric-cars/batteries
[82] Source: Li-Cycle Corporate Presentation, July 21 [non-confidential]
[83] Source: Li-Cycle Corporate Presentation, July 21 [non-confidential]

Section 10: Electric Vehicles – Planning

Electric pickups will be available from GM and Ford starting in 2023. Electric pickups are an excellent application of electric vehicle technology for the City. GM and Ford EV pickups will have far more range than required to meet the average daily range requirements of the City. They will also have more than adequatel personnel and load carrying capacity and trailer towing ability.

The City of North Battleford currently owns 45 Class 1 and 2 pickups that could be candidates for replacement with EV models starting 2023, when EV pickups are to become available. In FAR 7x data model, we calculated the cost and emission impacts that would result if these vehicles were switched to EV models as they became due for replacement, starting in 2023 and until 2037. In FAR 7x data model, we determined that, if conventional pickups were replaced by EV pickups starting in 2023 when they become available, annualized operating expenses[84] would decrease by $32,557 and CO_2e emissions would decrease by 215.9 tonnes.

EVSE Charging Analysis Tool

Our team developed an Electric Vehicle Supply Equipment (EVSSE) (charging) analysis tool that is user-friendly and includes programmable and automated formulas for determining charging requirements on a unit-by-unit basis. The tool:

- Is based on estimated daily kms-travelled by each unit, derived from kms-travelled during the review period divided by the number of working days in a year.
- Is based on each unit having access to a charger every night during off-peak hours (7pm-7am).
- Allows programmable upper and lower estimates of range that can be adjusted up or down for data-modelling purposes, in consideration of heating/cooling in cold- or hot-weather conditions as well as on-board accessory electrical DC loads such as lights, laptops, etc., that may diminish available driving range.
- Calculates the daily charging time required to return to near-full charge for vehicles of all classes by allowing for programmable estimates of BEV battery capacity, charger current, and charger voltage.
- Calculates the nightly electrical demand in kWh and cost, assuming all units will charge each night during off-peak hours.

[84] Assumes a full year of operation

- Allows programmable acquisition costs for chargers (or chargers plus infrastructure) for each unit.

The Fleet Challenge EVSE tool simplifies charging rate (kms of range added per hour) by estimating it to be constant for all battery charge levels. This is, strictly speaking, not entirely reflective of reality; charging rate slowly diminishes as battery levels approach 100%. However, applying a constant charging rate does provide a very reasonable approximation, especially considering that we have modelled daily charging requirements based on 90% maximum battery charge levels – as a best practice for optimizing battery life.

Charging rate is dependent on the battery capacity of a vehicle and varies significantly with different vehicle types and battery sizes. The tool allows the user to change the battery size on a unit-by-unit basis if needed (i.e., by comparing a make/model of BEV that is equipped with larger/smaller battery size than another make/model), which makes the calculator even more accurate.

Estimations

The inputs chosen in the EVSE tool are based on several estimations in terms of charging level and battery capacity for different unit types. These can be easily modified by the user according to the specific charging infrastructure installed as well as actual specifications for BEV replacement units. We have included the following estimations in our EVSE modelling:

- Battery size/capacity estimates were based on class/ vehicle type, including:
  - 60 kWh for cars
  - 80 kWh for SUVs
  - 100 kWh for Class 2 pickups and vans
  - 150 kWh for MDVs (Class 3-6 units)
  - 300 kWh for HDVs (Class 7-8 units)

- Upper range estimates (i.e., *actual* driving distance, not advertised range) were based on class/ vehicle type, including:
  - 320 km for cars and SUVs
  - 300 km for Class 2 pickups and vans
  - 280 km for MDVs (Class 3-6 units)
  - 250 km for HDVs (Class 7-8 units)

- Lower range estimates were based on a 50% reduction of upper range estimates for all units.

- Charger current and voltage estimates were based on lower-power Level 2 charging with amperage (current) on the lower end of that allowed by most BEVs[85], as follows:
  - Current: 32 amps
  - Voltage: 240 volts

- A comparative charging analysis was done for Level 3 direct-current (DC) fast charging, with the following estimations:
  - Current: 100 amps
  - Voltage: 480 volts

- The charging rate (kms range added per hour) was estimated by dividing *actual* driving range by the time for full charge. The time for full charge (i.e., 0 to 100%) was estimated by dividing battery capacity by charging power (calculated from current and voltage) and adding a 10% inefficiency[86] [87].

- Return-to-base battery levels are based on a starting charge of 90%, as a best practice for optimizing battery life.

- The time available for overnight charging was estimated as 12 hours during off-peak hours (7pm-7am).

Using our EVSE tool, we determined the charging needs for the City's on-road vehicles through a Level 2 and 3 charging analysis. Being a return-to-base fleet, almost all the City's 45 light-duty (Class 1 & 2) pickups have more than ample overnight time to recharge during off-peak electricity hours using Level 2 chargers. In fact, from our EVSE analyses, we learned that only four units of the 66 pickups will would likely require higher power charging. For these four units, Level 3 (240 V) chargers *may* be required at times, depending on their daily kms-travelled and other considerations such as weather, driver behaviours and onboard DC power loads. We based our calculations on this.

To determine the number of chargers required to be installed annually over the modelling period for a smooth transition of the entire City of North Battleford fleet to BEVs, our approach/method and estimations were as follows:

- A fleet should not be keeping up with the demand for EVSE based on the number of new BEVs added; rather, EVSE installation should be *outpacing* demand to allow for a smooth and seamless transition. Therefore, we have estimated the number of chargers required to

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[85] Source: (https://www.chargepoint.com/en-ca/resources/how-choose-home-ev-charger/#:~:text=Most%20EVs%20can%20take%20in,of%20range%20in%20an%20hour.)
[86] Source: https://www.caranddriver.com/shopping-advice/a32600212/ev-charging-time/
[87] Source: https://www.inchcalculator.com/widgets/?calculator=electric_car_charging_time

outpace the influx of new BEVs into the fleet by taking acquisition years based on optimal economic lifecycles.

- The installation of charging infrastructure ahead of the addition of BEVs also makes use of the delay in purchasing BEV pickups, vans, and medium- and heavy-duty (MHD) vehicles based on availability and procurement timelines – to optimize the use of capital investment in EVSE to ensure ample capacity for charging down the road.

- EVSE is based on the current size of City of North Battleford's fleet.

Our charger data modelling was built on the premise that each EV charger would service two EVs at a time. The estimate charger unit costing which we used for data modelling was $7,500 for a Level 2 charger and $30k for a Level 3 unit. Based on charging demand of 45 units[88], we calculated that 26 Level 2 and two (2) Level 3 chargers would be needed, on a phased-in basis, as EV pickups were acquired by the City each year until 2037.

Before committing to installing Level 3 chargers, it is important to take a strategic approach and consider that many of the EV pickups would likely be adequately charged with a level of charging *between* low-power Level 2 (30 amps, 240 volts) and Level 3 (100+ amps, 480+ volts), if they each have access to a charger every night. Furthermore, it is very possible that range capability and charging speed will continue to improve, reducing some of the need for costly Level 3 charging infrastructure.

Over the next 10-15 years, we recommend allocating capital towards charging infrastructure required for the transition to BEVs for all vehicle categories, with a focus on lighter-duty units (pickups) in the short-term. Much of the additional capital costs associated with electric vehicle supply equipment (EVSE) may be offset through lower operating costs (fuel and maintenance savings). We estimate the total cost of EV chargers between 2023 and 2037 is $360,000.

Based on an approach in which EVSE installation outpaces the demand for EVs to ensure adequate charging capacity, City of North Battleford's pickup truck fleet could be 100% EV by 2037 for the current size and mileage of the pickup truck fleet. Spread out over the entire modelling period, this translates to an average annual charging infrastructure cost of about $24,000 per year for the next 15 years. Allowing for expected rate of inflation, the average costs rise to $27,452 on average each year.

Importantly, existing electrical capacity at facilities may require substantial upgrades to power charging stations for multiple vehicles, which may significantly add to the estimated costs presented

[88] Note: 26 chargers exceed the number of pickups that would be replaced starting in 2023 as it includes units that were already past-due for replacement in 2023.

in our analysis. A qualified electrical professional should be consulted to assess the situation and make recommendations.

Please refer to *Table 20 – EVSE Outlook* (below) for EVSE (charger) costs estimates by each year between 2023 and 2037.

Table 20-EVSE Outlook

Year # of BEV Phase-in Plan	Year of BEV Phase-in	Number of L2 Chargers Added to Fleet (per EVSE phase-in plan)	Number of L3 Chargers Added to Fleet (per EVSE phase-in plan)	Estimated Cost per L2 Charger plus Infrastructure (including inflation)	Estimated Cost per L3 Charger plus Infrastructure (including inflation)	Annual Cost of Chargers plus Infrastructure
1	2022	2	0	$7,500	$30,000	$15,000
2	2023	5	0	$7,650	$30,600	$38,250
3	2024	0	0	$7,803	$31,212	$0
4	2025	4	1	$7,959	$31,836	$63,672
5	2026	2	0	$8,118	$32,473	$16,236
6	2027	4	2	$8,281	$33,122	$99,367
7	2028	4	3	$8,446	$33,785	$135,139
8	2029	2	0	$8,615	$34,461	$17,230
9	2030	0	0	$8,787	$35,150	$0
10	2031	3	0	$8,963	$35,853	$26,890
11	2032	0	0	$9,142	$36,570	$0
12	2033	0	0	$9,325	$37,301	$0
13	2034	0	0	$9,512	$38,047	$0
14	2035	0	0	$9,702	$38,808	$0
15	2036	0	0	$9,896	$39,584	$0
Average (with inflation)		1.7	0.4	$8,647	$34,587	$27,452
Total (with inflation)		26	6			$411,786

Preparing for a Battery-Electric Vehicle Future

Significant among our recommendations in the Equipment and Vehicle Optimization study is a temporary pause on replacing City of North Battleford's end-of-lifecycle internal combustion engine (ICE) vehicles (when appropriate) until equivalent battery-electric vehicle (BEV) models become available in the market.

Vehicle investments are long-term; units purchased today will remain in service for up to a decade or longer. ICE vehicles are quickly becoming outdated as BEVs rapidly take over. Globally, numerous jurisdictions have already legislated the end of the ICE – some as soon as 2030. On January 28, 2021, General Motors pledged to cease building gasoline and diesel cars, vans, and SUVs by 2035. Even more recently, on June 29, 2021, the Canadian government announced a mandatory target for all new light-duty cars and passenger trucks sales to be zero-emission by 2035, accelerating Canada's previous goal of 100 percent sales by 2040[89]. ICE vehicles purchased today for a fleet with a current-day value in the millions of dollars may be nearly worthless when ICEs become obsolete.

BEVs have a fraction of the moving parts of an ICE vehicle, cost far less to maintain, offer better performance, and can have a much lower total cost of ownership (TCO). For these reasons, if the condition of currently owned City of North Battleford fleet ICE vehicles will allow it, we suggest prolonging their lifecycles until BEV replacements are available.

Today, only light-duty (cars, SUVs), transit buses, and a handful of medium- and heavy-duty (MHD) truck BEV models are available. However, by the mid 2020s the types of vehicles that comprise a major portion of the City of North Battleford fleet, including pickup trucks, will be available as BEVs. Therefore, the time is now to **begin preparing for the transition to BEVs** by investing in electric vehicle supply equipment (EVSE) while awaiting suitable BEVs to become readily available.

EVSE & Asset Management

FCC maintains that EVSE should be a capital asset paid for, owned, and managed from the budget of the corporate facilities/properties department. Therefore, the capital cost of charging equipment should not be directly posted to the fleet department; rather, EVSE is an asset (an attribute/enhancement) that increases the market value of the facility/property where fleet vehicles are parked. Moreover, EVSE costs should be a capital expense for the facility's corporate "owner" (usually this is a facilities/properties department), not the vehicle's corporate "owner" (which is usually a fleet department). This is different than in the non-corporate world where the battery-electric vehicle (BEV) owner is often the same owner as the property owner, such as is the case for personal cars and homes. The benefit of this concept is that, unlike vehicles that depreciate quickly, facilities assets

[89] Source: https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

are generally depreciated over far longer periods – sometimes up to 20, 30 or more years. Long depreciation periods translate to lower annual costs, thereby making a better business case for electric vehicles.

Today, there is a lot of focus on asset management best practices for corporations, including the public sector. It is a contemporary asset management best practice that property-related costs, including capital and operating expenses, should be expense items managed by the responsibility centre that manages the asset, in this case the corporate facilities/properties department. The facilities/properties department can then apportion and transfer these costs to their internal users of each property, such as a fleet department.

In a "full cost recovery" business model as we espouse, the facilities/properties department must recover sufficient revenue to fully offset the costs of owning and managing the property, including the installation, use, and maintenance of EVSE.

Regarding the electricity needed to charge BEVs, we have included the cost of electricity as a "fuel" cost under operating expenses in FAR (see *Section 8*). However, the same asset management principles can be applied. Usually, the local power provider bills the facilities/properties department for all electricity used by each property. In an ideal full cost recovery business model, the facilities/properties department would transfer the power costs to its user departments for the amount used in each period. The EVSE would meter the amount of electricity used by each BEV – just like the amount of gas or diesel used by each internal combustion engine (ICE) is tracked vehicle today with fuel pump meters.

NRCan's Zero Emission Vehicle Infrastructure Program

The Government of Canada is committed to helping accelerate the decarbonization and electrification of our transportation sector, and charging infrastructure is a key component to achieving this. Natural Resources Canada (NRCan) has pledged to invest $130 million from 2019-2024 to further expand the country's charging network, particularly Level 2 and Level 3 charging stations, through its Zero Emission Vehicle Infrastructure Program (ZEVIP).

The funding is being delivered through cost-sharing contribution agreements for eligible projects, including:

- BEV charging infrastructure in parking areas intended for public use (e.g., service stations, restaurants, libraries, etc.);
- On-street charging infrastructure;
- Workplace charging infrastructure;

- On-road light-duty vehicle fleet (including municipal fleets);
- On-road medium- or heavy-duty vehicle fleets (including refuse trucks and public utility vehicles);
- Charging infrastructure for multi-unit residential buildings (MURBs); and
- Public transit charging infrastructure.

The application window for ZEVIP is currently closed. However, the program plans to launch another RFP targeting all streams in early 2022. NRCan's contribution through this program will be limited to 50% of total project costs up to a maximum of $5M per project. The maximum funding and approximate costs for each type of charging infrastructure is shown in *Table 21* (directly taken from NRCan's website[90]).

Table 21: Specifications for NRCan's Zero Emission Vehicle Infrastructure Program plus approximate total costs

Type of Infrastructure	Output	Maximum NRCan Funding	Total Costs (Equipment + Installation)
AC Level 2 (208/240V) Connectors	3.3 kW – 19.2 kW	Up to 50% of total project cost, to a maximum of $5,000 per connector	$5,000 - $10,000
DC Fast Charger	20 kW – 49 kW	Up to 50% of total project cost, to a maximum of $15,000 per charger	-
DC Fast Charger	50 kW – 99 kW	Up to 50% of total project cost, to a maximum of $50,000 per charger	$50,000 - $200,000
DC Fast Charger	100 kW and above	Up to 50% of total project cost, to a maximum of $75,000 per charger	$50,000 - $200,000

[90] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876

EVSE Recommendations

- With BEV options increasing and light-duty trucks (pickups and vans) expected to be on the horizon within two years and medium- and heavy-duty trucks in several years, we recommend that City of North Battleford begin addressing charging infrastructure requirements soon to meet the demand in the mid-to-long-term.

- Over the next 10-15 years, allocate capital towards charging infrastructure required for the transition to BEVs for all vehicle categories, with a focus on lighter-duty units in the short-term. Much of the additional capital costs associated with electric vehicle supply equipment (EVSE) may be offset through lower operating costs (fuel and maintenance savings), as can be seen in the BEV Transition Plan shown in *Section 9*.

- Ensure that EVSE installation is *outpacing* the number of new BEVs added to City of North Battleford's fleet to allow for a smooth and seamless transition. The installation of charging infrastructure ahead of the addition of BEVs also makes use of the delay in purchasing BEV pickups, vans, and medium- and heavy-duty (MHD) vehicles based on availability and procurement timelines – to optimize the use of capital investment in EVSE to ensure ample capacity for charging down the road.

- Identify the vehicles in greatest need of Level 3 charging on a unit-by-unit basis, in conjunction with the charging analysis tool provided by our team. These include:
  - Units that may not always rely on overnight charging only;
  - Units with higher mileage than the average in their type (sub-fleet);
  - Units with more demanding duty cycles (less time parked than we allocated); and
  - Heavy-duty BEVs with much larger battery sizes than lighter-duty units.

- Out of fiscal prudence and planning, conduct a re-assessment of charging needs after completion of pilots with a plan to expand the number of Level 3 chargers and/or split/divide the power provided to units for overnight charging. This is because many of the lighter-duty vehicles would likely be adequately charged with a level of charging *between* low-power Level 2 (30 amps, 240 volts) and Level 3 (100+ amps, 480+ volts), provided that they each have access to a charger every night. Also, it is very possible that range capability and charging speed will continue to improve, reducing some of the need for costly Level 3 charging infrastructure.

- Assess existing electrical capacity at facilities to determine whether substantial upgrades for charging multiple vehicles are required, as well as standby generator capacities (outside the scope of this report). A qualified electrical professional should be consulted to assess the situation and make recommendations.

- Explore supplying power to each site on two separate feeds from the grid to reduce the risk of local failure taking power away from the whole site[91].

- To mitigate the risk of power grid failure or local failure at a site/garage, ensure backup generators have sufficient capacity to deal with short power outages, and assess the need for higher-capacity generators for longer outages.

- Explore solar energy technology options to supply energy for EV charging to reduce GHG emissions that may be produced from the electricity supply used for charging. Our recommendation is to pursue rooftop (vs. canopy) solar energy systems, as this provides renewable energy for the entire building/facility as opposed to charging stations only – which more holistically achieves GHG emissions reductions and allows for additional benefits such as vehicle-to-grid (V2G) technology and battery energy storage.

- Monitor upcoming funding opportunities from NRCan's Zero Emission Vehicle Infrastructure Program (ZEVIP), which may greatly offset the capital costs required to install charging infrastructure.

  The application window for the Zero Emission Vehicle Infrastructure Program by NRCan is currently closed. However, the Program plans to launch another RFP targeting all streams in early 2022. See https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876. The Government of Canada announced, through Budget 2019, $130 million over five years (2019-2024) to deploy a network of zero-emission vehicle charging (Level 2 and higher) stations focusing on public places, on-street, multi-unit residential buildings, workplaces, and light-duty vehicle fleets. Support is also available for strategic projects for an electric vehicle or hydrogen infrastructure for corporate fleets, last-mile delivery fleets, and mass transit. This funding will be delivered through cost-sharing contribution agreements for eligible projects to help meet the growing charging and refuelling demand.

- Provide high-voltage training for technicians and closely monitor the launch of new BEV training programs. A pilot for a new EV Maintenance Training Program for automotive technicians was successfully completed at BCIT and is available to the public[92]. There is also an Electric Vehicle Technology Certificate Program offered by SkillCommons, managed by the California State University and its MERLOT program, which offers free and open learning materials electric vehicle development, maintenance, alternative/renewable energy, and energy storage[93].

[91] Source: https://www.plugincanada.ca/electric-bus-faq/
[92] Source: https://commons.bcit.ca/news/2019/12/ev-maintenance-training/
[93] Source: http://support.skillscommons.org/showcases/open-courseware/energy/e-vehicle-tech-cert/

Fleet Challenge
Driving Change

Appendix A: Weighted Points System (example)

COUNTY VEHICLES
WEIGHTED POINTS SYSTEM

April 2019

Vehicle No.	Age	Kl.	Type	Reliability	M & R	Condition	Total Points	Rating
001-13 Ram ½ ton	8	28	3	3	3	3	48	III
002-15 GM ½ ton	6	35	1	3	3	3	51	IV
003-18 Ram 3/4 ton	3	11	3	1	1	2	21	I
004-17 Gm ½ ton	4	27	3	2	2	3	41	III
005-19 Ram ½ ton	3	8	1	1	1	1	15	I
006-11 Ram ½ ton	10	31	3	3	3	4	54	IV
006-20 GM ½ ton	1	4	1	1	1	1	9	I
007-14 Ram ½ ton	7	37	3	3	3	3	56	IV
008-14 Ram ½ ton	7	46	3	3	3	3	65	IV
009-20 GM ½ ton	1	2	1	1	1	1	7	I
010-18 Ram ¾ ton	3	11	3	1	1	2	21	I
011-18 Ram ½ ton	3	5	1	1	1	1	12	I
012-17 GM ½ ton	4	20	3	2	2	2	33	II
013-16 GM ½ ton	5	31	3	2	3	3	47	III
014-13 Ram ½ ton	8	30	3	3	2	3	49	III
015-14 Ram ½ ton	7	22	3	2	3	3	40	III
016-15 GM ½ ton	6	33	3	2	3	3	50	IV
017-12 GM ¾ ton	9	18	3	3	3	3	39	III
018-16 Gm ½ ton	5	35	3	1	2	2	48	III
019-19 Ram ½ ton	2	11	1	1	1	1	17	I
022-20 GM ½ ton	1	1	1	1	1	1	6	I
101-14 Ram 1 ton	7	14	3	2	2	2	40	III
102-09 GM 1 ton	13	7	3	1	2	3	29	II
103-09 GM 5 Ton	12	7	3	1	2	3	28	II
104-15 Int. 5 ton (BC)	6	6	3	1	1	2	19	I
105-15 GM 1 ton	6	14	3	1	2	2	28	II
106-15 GM 1 ton	6	13	3	1	2	2	27	II
107-09 GM 5 ton	12	7	3	1	2	3	28	II
108-12 GM 1 ton (BC)	9	13	5	2	2	2	33	II
109-14 Ram 1 ton	7	14	3	2	2	2	30	II
111-09 GM 5 ton	12	6	6	1	2	3	30	II
112-10 GM Amb. (BC)	11	35	3	3	3	4	59	IV
201-20 Freight Tandem	2	4	5	2	1	1	15	I
202-20 FreieghtTandem	2	4	5	2	1	1	15	I
203-21 Int. Tandem	1	1	5	1	1	1	10	I
204-08 Volvo Tandem	13	38	5	5	4	4	69	IV
204-21 Int. Tandem	1	2	5	1	1	1	11	I
205-09 Volvo Tandem	10	35	5	5	3	4	56	IV
206-19 W Star Tandem	2	8	5	1	1	1	18	I
207-12 Int. Tandem	9	27	5	3	3	3	50	IV
208-12 Frei. Tandem	9	25	5	5	4	3	51	IV
209-13 Volvo Tandem	8	24	5	3	2	3	45	III
210-14 Inter. Tandem	7	18	5	2	1	2	35	II
211-14 Inter. Tandem	7	17	5	2	1	2	36	III

I	1 to 25	Excellent Condition
II	26 to35	Good Condition
III	36 to 50	Qualifies for Replacement
IV	50 & up	Needs Immediate Consideration

Appendix B: Guide to Preparation of Vehicle Specifications

General

The following notes were prepared to establish basic principles, guidelines, and best practices for preparing vehicle and equipment specifications suitable for inclusion in RFQs, RFPs, and tenders.

Overview of Principles

- Fair Competition: In the interest of fair and open competition, specifications should be written so that more than one supplier can satisfy the requirement. Doing so will increase competition and therefore achieve better value for money. It is essential to comply with corporate requirements for fair competition.

- Clarity: Straightforward, easy-to-understand specifications will yield the best bidder responses. It is imperative to develop adequately detailed specifications since this forms the basis of vendor bidding.

  Unclear, unnecessarily detailed, and biased specifications will decrease the number of suppliers participating in the RFP/RFQ/tender and reduce the overall quality. Vague specifications will confuse bidders, which may cause rejection of bids or make the bid responses challenging to rate. Proposals that cannot be rated properly may require rejecting all submissions and rescheduling of the bid request with consequent time delays.

- Avoid Over Complication. Overly complicated bid specifications may discourage responses from perfectly suitable bidders. Within reason, try to keep technical bids to the point and concise using plain language wherever possible.

- Restrictive Specifications: The specifications should be definitive, not restrictive. The objective of writing technical specifications is to explain to the suppliers what is required. Even a simple item such as a chair requires technical specifications. Bidders need to know what the material of the item will be (plastic, wood, metal, etc.), the material used, if it has feature "x," if it has feature "y," if it has feature "z," etc.

  If we don't give enough detail, the bidder may be confused and will probably offer the cheapest available option (since, usually, selection criteria and Purchasing/Procurement policies require buying the lowest cost item that meets technical specifications).

  At the same time, the specifications should not be too detailed to restrict the bidders unnecessarily as many bids as possible must be received to improve competition and increase the chances of purchasing equipment that meets the requirements at the best possible price.

- Specifications must be detailed enough to leave no question about what is required in the bidder's mind. Still, they should be generic enough to attract offers from multiple manufacturers and vendors.

Guidelines for Specifications

The following are some suggestions for preparing specifications:

1. Key attributes should be grouped in order of importance. For example, the first order of importance might be the vehicle (i.e., 202x model-year Class 8, diesel-powered, tandem axle, day-cab and chassis), followed by the key attributes of the engine (i.e., H.P./torque, etc.), driveline (i.e., transmission, axles, etc.), and, lastly, a list of options and additions.

2. Specifications should start with the essential characteristics of the vehicle, equipment, or item being tendered.

3. Employ a point weighting system. The "must-haves" in the specifications should be weighted higher and the "nice to haves" weighted lower.

4. Allow for alternate solutions. Vendors may surprise you with bid responses that may provide a better value than you anticipated.

5. Lines/rows in the spec should be spaced 10 (or more) apart to insert new items as the spec begins to take shape. Then, when finished, all items should be renumbered.

6. Format: Preparing specifications in Excel format and asking bidders to respond in Excel format enables auto-scoring (using weightings as in point #3 above) for those assessing the bids, thereby facilitating and streamlining the process.

7. Each key section should be sequentially numbered, starting from section 1.0.

8. Each sub-section should be numbered sequentially (i.e., 1.1, 1.2, and so on). An example is shown in *Figure 6: Example of a Technical Spec* (below):

Figure 6: Example of a Technical Spec

Section 1.0 Engine

1. Engine shall be minimum of 300 H.P. and xxx ft./lbs. torque at flywheel, and capable of moving the vehicle from a standing stop to road speed on a 5% upgrade at fully loaded capacity of the vehicle.

   1.1. Engine shall be equipped with electronic engine controls

   1.2. Engine shall be capable of operating on ultra-low sulfur diesel (ULSD) and biodiesel (please state biodiesel blend)

9. Avoid Unnecessary Details: Only the key characteristics should be specified. Each key aspect listed should be required for evaluation. For example, there is no need to specify anything that is not a factor in deciding to purchase.

10. Language: Request that bids must be written in English. Bidder responses should be requested in English.

11. Units of Measurement: One of U.S. imperial or metric units must be specified depending on your location.

12. Use of Vendor's Technical Literature: It is usually not possible or, in some cases, risky to write specifications without using technical literature from manufacturers. Therefore, it is acceptable to use technical literature from manufacturers, but the following should be kept in mind:

    a) Use literature only as a reference. Using the literature, avoid preparing locked specifications that favor one supplier over others. Instead, check that the specification you have written is general enough to be met by typical suppliers dealing with such products.

    b) Do not include every specification listed in the literature. Only list the important key characteristics.

    c) Do not be too specific with the specifications when referring to catalogs. Unless they are standards, do not take measures literally. For example, if engine power is stated as 235 HP in the vendor's literature, you may say 'minimum 235 HP' in the specification.

    d) Be careful when referring to specifications from different vendors. Avoid mixing then and writing specifications that no manufacturer can meet.

e) Remember that technical literature was prepared to sell vehicles. Therefore, language should be revised to reflect the required technical characteristics.

f) Avoid subjective statements such as "high quality," "easy to use," etc. The equipment specifications must be objective and actual. Such statements are open for interpretation and are impossible to evaluate. Be aware that 'high grade' may simply indicate more features.

13. Dimensions or Weight: In some cases, dimensions and weight may be part of the specifications. For example, you need to specify the maximum weight for a vehicle lift, and for a truck body you must specify dimensions.

14. Model and Manufacturer: If compatibility is an issue and fleet standardization is an objective, then the model and manufacturer can be specified. This practice is usually acceptable but check with the Purchasing/Procurement department to confirm corporate policies.

15. Accessories: All standard and optional accessories required should be listed at the end of the specifications. It is not acceptable to state full optional accessories required as different manufacturers have a different set of optional accessories, which can prevent fair evaluation.

Need further information or assistance in preparing technical specifications for your next vehicle or equipment purchase? Fleet Challenge specializes in preparing vehicle and equipment specifications for our clients. We have almost 40 spec templates available in our database. Contact Fleet Challenge any time for details: info@fleetchallenge.com or visit our website: www.fleetchallenge.com.

Appendix C: Fleet Analytics Review™

Fleet Analytics Review™ (FAR) is a user-friendly, interactive decision support tool designed to aid our team and fleet managers in developing short- to long-term green fleet plans by calculating the impacts of vehicle replacement and fuel-reduction solutions on operating costs, cost of capital, and GHG emissions. Moreover, it is used for long-term capital planning (LTCP) through an approach that works to balance, or smoothen, annual capital budgets and avoid cost spikes if possible.

FAR is a complex, sophisticated MS Excel software developed by the FCC team in 2016. Since its inception, FAR has been used by our team as the foundational analysis platform for our work in helping fleets with green fleet planning and the transition to low-carbon fuels/technologies.

Purpose

The core functionality of the FAR software is to calculate the financial and GHG reduction impacts of vehicle replacements, operational improvements, and low-carbon fuels/technologies for a fleet.

In the context of assessing fleet modernization, FAR is especially useful in calculating the operating expense (Opex) impacts of vehicles being retained in the fleet beyond their viable age and with diminishing salvage values. Aged, older-technology vehicles consume more fuel, produce more GHGs, usually cost more to operate, are less reliable, and may also present a safety risk. FAR automatically calculates and quantifies these impacts in a defensible business case format.

For fuel-reduction solutions under consideration by fleet management as a means of saving fuel costs and avoiding GHGs, including best management practices (BMPs), alternate or renewable fuels (natural gas, propane, biodiesel, etc.), and EVs (battery-electric, plug-in hybrid, or hybrid), FAR calculates the cost-benefit of the investment in vehicle upgrades, vehicle conversion costs, fuelling infrastructure, or EV charging infrastructure, i.e., whether these solutions would yield a net operating cost reduction, unit-by-unit and fleet-wide.

Approach

The FAR software tool employs a holistic approach – all relevant factors and controllable expenses are considered in its analysis. The data points in our approach include energy equivalency factors of each alternative fuel type (compared to a fossil diesel fuel baseline), vehicle upgrade costs, alternately fuelled vehicle acquisition (or vehicle retrofit) capital costs, vehicle maintenance considerations (higher or lower maintenance demand), fuel system/charging infrastructure capital costs, and any additional expenses for storage, handling & dispensing the fuel(s). All these factors are modelled within the context of planned vehicle lifecycles – a total cost of ownership (TCO) approach.

The FAR process uses historical cost metrics and vehicle operating data (i.e., miles/km-driven, fuel usage, repair and maintenance costs, unit age, cost of capital, downtime, residual value, etc.) to establish not only the fleet's fuel usage and GHG emissions baseline, but also financial and service levels (i.e., utilization, availability/uptime) performance.

FAR highlights "exception" units, vehicles that are performing in a sub-standard way in terms of cost and performance, thus potentially enabling management to identify the reason(s) and take appropriate action(s).

Go-Forward Fuel-Reduction Solutions

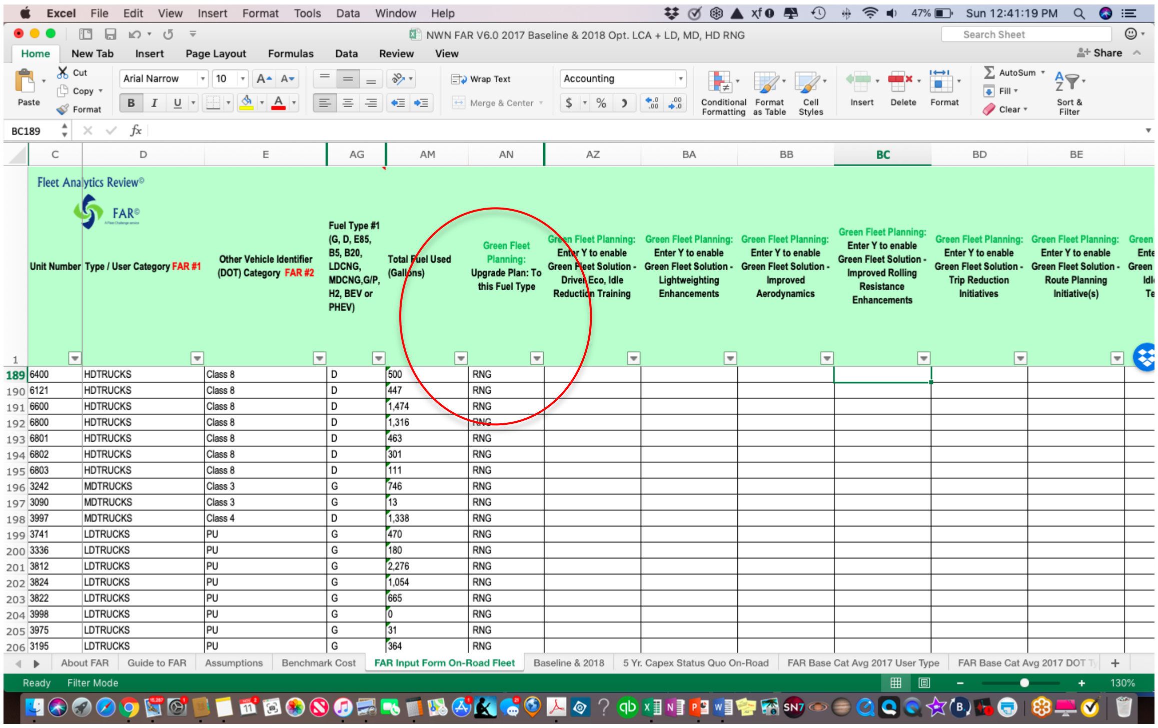
With the FAR baseline established, the software is used to analyze go-forward fuel-reduction solutions. FAR takes into consideration the Opex implications and determines whether Opex reductions will offset any capital expenses (Capex) including vehicle upgrades, vehicle conversions, "up-charges" for premium vehicles (e.g., EVs), and investment in infrastructure.

The FAR analysis includes, but is not limited to:

- The fuel usage and cost differential (+ or -) for the fuel type selected vs the current type (if applicable)
- The energy-efficiency difference
- The unit cost of upgrade for the fuel-saving technology
- The unit cost of conversion to the selected fuel type
- The cost of fueling infrastructure for the selected fuel type apportioned evenly to the chosen vehicles for the fuel-switch
- The cost of charging infrastructure for EVs apportioned evenly to the chosen vehicles to be replaced
- The cost of capital for vehicle replacement for the selected fuel type

FAR then calculates whether a cost-savings or return-on-investment (ROI) would result within the remaining lifecycle for each of the vehicles selected for the vehicle upgrade or fuel switch. *Figure 7* (below) shows a sample screen capture from FAR demonstrating the FAR fuel-switching capabilities. In this example, the user is switching several light-, medium-, and heavy-duty trucks from their current fuel source to renewable natural gas (RNG), and this is accomplished simply by selecting the vehicle(s) to be evaluated and then choosing (in this example) RNG from a drop-down list.

Figure 7: Sample Screen Capture of FAR Showing Fuel-Switching Options



FAR is user-friendly and intuitive; it is based on standard off-the-shelf MS Excel. It is dynamic, and users can run future scenarios (such as assessing different vehicle types, fuels, or engine/drivetrain combinations) to see how such decisions impact Opex ahead of their implementation, thereby mitigating risk and heading off potentially costly errors.

Recent Enhancements and Upgrades to FAR™

FAR V30.5 (beta) features upgrades and enhancements to the functionalities of the FAR tool. These include:

Fuel-Efficient Green Fleet Planning Tools – Fuel Switching. FAR now includes several powerful "Green Fleet Planning" tools. One of these tools is used to estimate the financial and GHG impacts of switching vehicle fuels from fossil-based (gas or diesel) to alternate or renewable fuels or BEVs.

In the Input Form, FAR analysts may make choices as to fuel-switching (for example, changing all gas or diesel-powered vehicles in specific categories to E85, B5-B100 biodiesel, hybrid, plug-in hybrid, battery-electric, CNG, or even hydrogen fuel cells). FAR calculates the net cost and GHG reduction of the fuel-switch being considered, taking into consideration not just the fuel/electricity costs, but the change in fuel efficiency, as well infrastructure costs such as installing a CNG fueling station, electric vehicle chargers, etc.

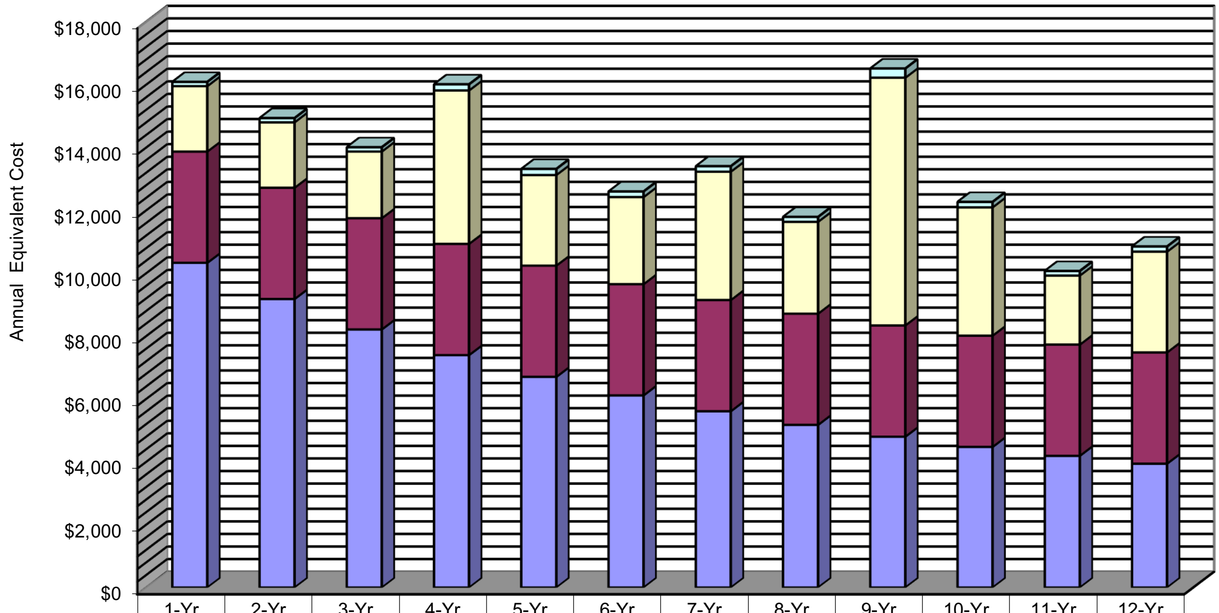
Enhanced Vehicle Replacement Cost-Benefit Analysis. Comparisons and analysis regarding either (a) aging a vehicle (or vehicles) that are now due for replacement for another year or (b) going ahead and replacing the vehicle(s) is now based on the actual average historical peer fleet cost data from our proprietary municipal fleet database.

In FAR, when a vehicle is due for replacement, it calculates the annual cost for a new replacement vehicle (including the capital, fuel, repairs, PM, and downtime) and then compares that amount to the actual average cost for a similar vehicle —that is one-year older (from our peer fleet database). FAR now displays the cost-benefit of replacing each unit that is due for replacement in the 5+ year Capex plan tab – in blue font each vehicle that will save Opex if it is replaced, and red font if it will incur more Opex. This marks a significant change in FAR and eliminates all guesswork or sketchy assumptions and supplants it with real peer fleet operating cost data by model year and vehicle categories we have collected since 2006.

Fuel-Usage and GHG Reduction for New Vehicles. For each vehicle that is due for replacement, FAR now shows the potential fuel-usage and GHG reduction.

Appendix D: Lifecycle Analysis Charts

CNB Lifecycle Cost Analysis - Class 1&2 Pickups



	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Downtime	$134	$134	$136	$193	$193	$175	$173	$156	$291	$173	$146	$163
Repairs	$2,082	$2,082	$2,121	$4,882	$2,882	$2,771	$4,082	$2,921	$7,882	$4,082	$2,196	$3,207
Fuel	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539	$3,539
Fixed Costs	$10,330	$9,178	$8,210	$7,394	$6,702	$6,112	$5,607	$5,173	$4,798	$4,473	$4,189	$3,940

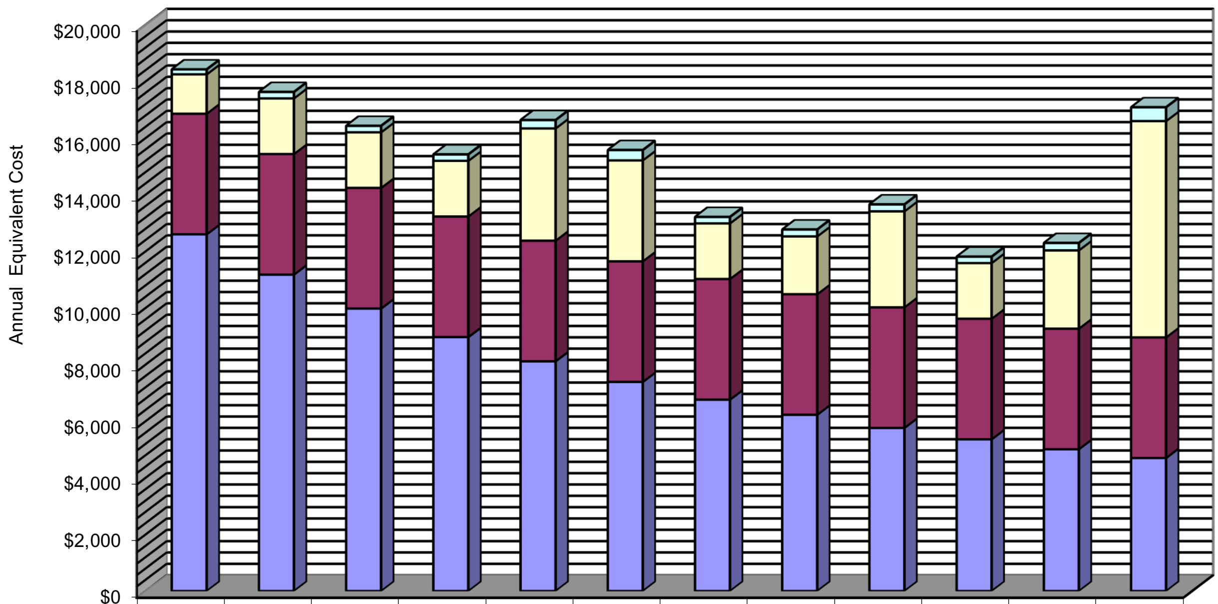
Annual Cost Summary Table for CNB Class 1&2 Pickups (Used in Bar Graph)

	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Fixed Costs	$ 10,330	$ 9,178	$ 8,210	$ 7,394	$ 6,702	$ 6,112	$ 5,607	$ 5,173	$ 4,798	$ 4,473	$ 4,189	$ 3,940
Fuel	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539	$ 3,539
Repair s	$ 2,082	$ 2,082	$ 2,121	$ 4,882	$ 2,882	$ 2,771	$ 4,082	$ 2,921	$ 7,882	$ 4,082	$ 2,196	$ 3,207
Downti me	$ 134	$ 134	$ 136	$ 193	$ 193	$ 175	$ 173	$ 156	$ 291	$ 173	$ 146	$ 163
Total	$ 16,085	$ 14,933	$ 14,006	$ 16,008	$ 13,316	$ 12,597	$ 13,402	$ 11,789	$ 16,511	$ 12,267	$ 10,070	$ 10,849

Optimal Replacement Years: 11

Kilometre at Optimal Replacement: 110,407

CNB Lifecycle Cost Analysis - Class 3 Trucks



	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Downtime	$174	$226	$226	$226	$295	$365	$226	$243	$243	$226	$261	$486
Repairs	$1,390	$1,965	$1,965	$1,965	$3,965	$3,565	$1,965	$2,040	$3,390	$1,965	$2,765	$7,640
Fuel	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260	$4,260
Fixed Costs	$12,598	$11,174	$9,978	$8,968	$8,113	$7,384	$6,760	$6,223	$5,760	$5,357	$5,006	$4,698

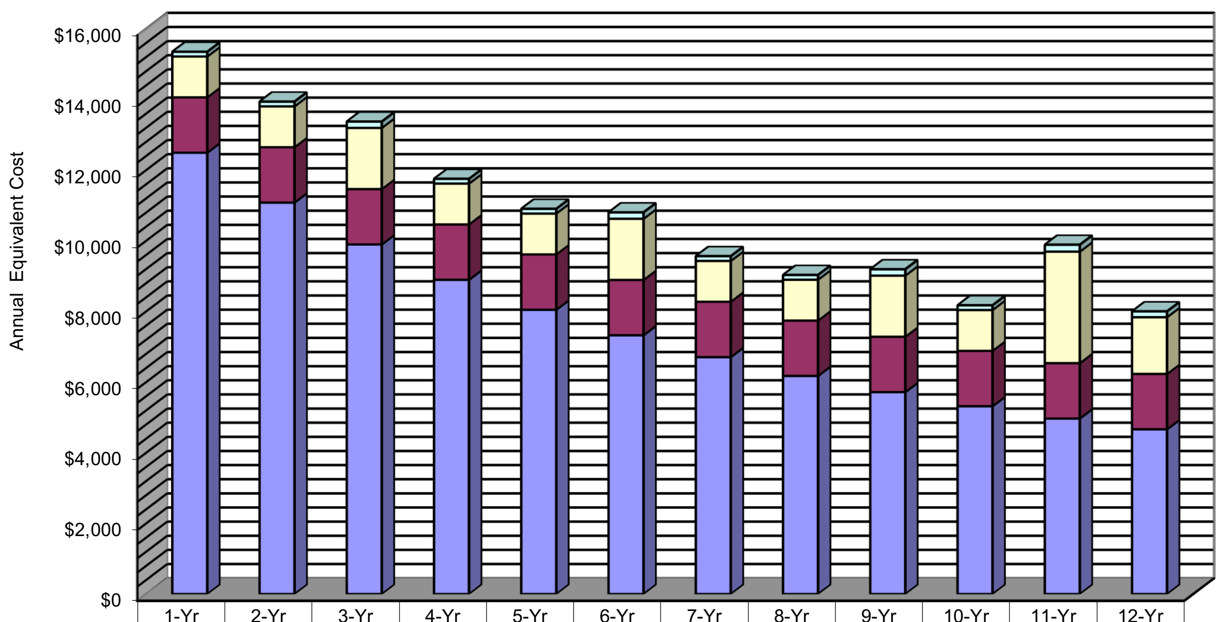
Annual Cost Summary Table for CNB Class 3 Trucks (Used in Bar Graph)

	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Fixed Costs	$ 12,598	$ 11,174	$ 9,978	$ 8,968	$ 8,113	$ 7,384	$ 6,760	$ 6,223	$ 5,760	$ 5,357	$ 5,006	$ 4,698
Fuel	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260	$ 4,260
Repairs	$ 1,390	$ 1,965	$ 1,965	$ 1,965	$ 3,965	$ 3,565	$ 1,965	$ 2,040	$ 3,390	$ 1,965	$ 2,765	$ 7,640
Downtime	$ 174	$ 226	$ 226	$ 226	$ 295	$ 365	$ 226	$ 243	$ 243	$ 226	$ 261	$ 486
Total	**$ 18,422**	**$ 17,625**	**$ 16,429**	**$ 15,419**	**$ 16,633**	**$ 15,574**	**$ 13,211**	**$ 12,767**	**$ 13,653**	**$ 11,808**	**$ 12,292**	**$ 17,084**

Optimal Replacement Years: 10

Kilometre at Optimal Replacement: 75,270

CNB Class 4 Lifecycle Cost Analysis



	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Downtime	$134	$134	$179	$134	$134	$179	$134	$134	$179	$134	$194	$164
Repairs	$1,156	$1,156	$1,731	$1,156	$1,156	$1,731	$1,156	$1,156	$1,731	$1,156	$3,156	$1,606
Fuel	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567	$1,567
Fixed Costs	$12,490	$11,079	$9,893	$8,893	$8,045	$7,323	$6,705	$6,173	$5,714	$5,315	$4,967	$4,662

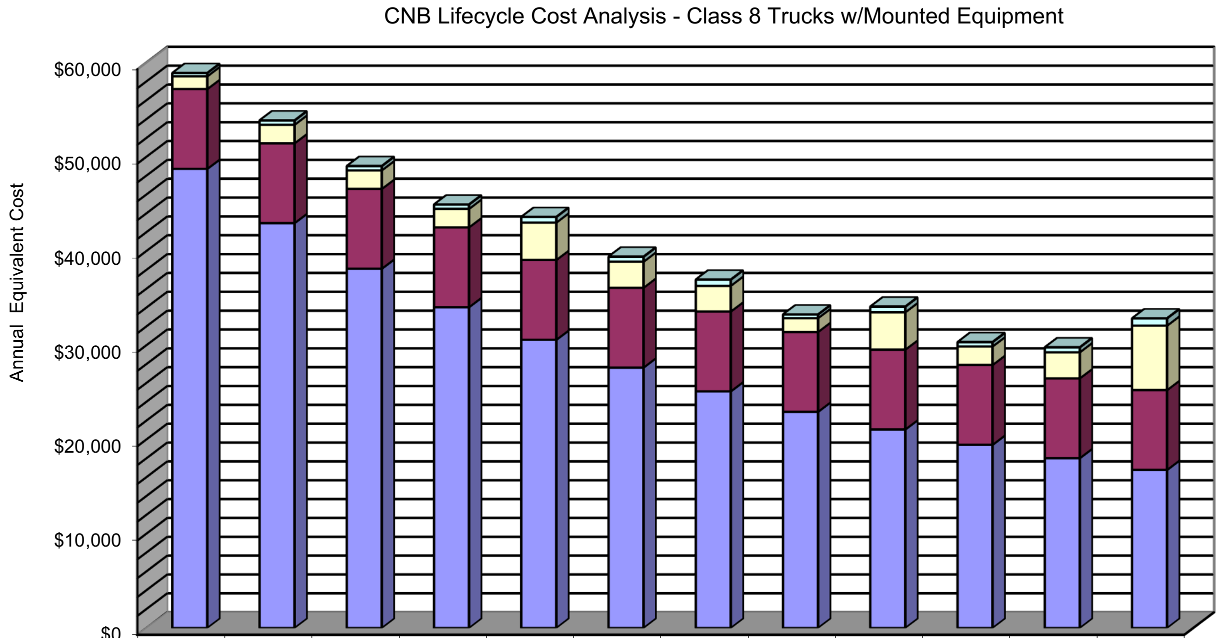
Annual Cost Summary Table for CNB Class 4 & Bus (Used in Bar Graph)

	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Fixed Costs	$ 12,490	$ 11,079	$ 9,893	$ 8,893	$ 8,045	$ 7,323	$ 6,705	$ 6,173	$ 5,714	$ 5,315	$ 4,967	$ 4,662
Fuel	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567	$ 1,567
Repairs	$ 1,156	$ 1,156	$ 1,731	$ 1,156	$ 1,156	$ 1,731	$ 1,156	$ 1,156	$ 1,731	$ 1,156	$ 3,156	$ 1,606
Downtime	$ 134	$ 134	$ 179	$ 134	$ 134	$ 179	$ 134	$ 134	$ 179	$ 134	$ 194	$ 164
Total	$ 15,347	$ 13,935	$ 13,371	$ 11,750	$ 10,902	$ 10,800	$ 9,561	$ 9,030	$ 9,191	$ 8,172	$ 9,884	$ 7,999

Optimal Replacement Years: 12

Kilometre at Optimal Replacement: 36,132

Figure 3: LCA for Class 8 Truck w/Mounted Equipment



	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Downtime	$342	$454	$454	$454	$594	$524	$657	$384	$594	$454	$524	$768
Repairs	$1,351	$1,965	$1,965	$1,965	$3,965	$2,765	$2,726	$1,465	$3,965	$1,965	$2,765	$6,840
Fuel	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473	$8,473
Fixed Costs	$48,730	$42,970	$38,132	$34,049	$30,588	$27,640	$25,117	$22,947	$21,072	$19,444	$18,023	$16,778

Annual Cost Summary Table for CNB Class Trucks w/ Mounted Eq. (Used in Bar Graph)

	1-Yr	2-Yr	3-Yr	4-Yr	5-Yr	6-Yr	7-Yr	8-Yr	9-Yr	10-Yr	11-Yr	12-Yr
Fixed Costs	$ 48,730	$ 42,970	$ 38,132	$ 34,049	$ 30,588	$ 27,640	$ 25,117	$ 22,947	$ 21,072	$ 19,444	$ 18,023	$ 16,778
Fuel	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473	$ 8,473
Repairs	$ 1,351	$ 1,965	$ 1,965	$ 1,965	$ 3,965	$ 2,765	$ 2,726	$ 1,465	$ 3,965	$ 1,965	$ 2,765	$ 6,840
Downtime	$ 342	$ 454	$ 454	$ 454	$ 594	$ 524	$ 657	$ 384	$ 594	$ 454	$ 524	$ 768
Total	$ 58,896	$ 53,862	$ 49,024	$ 44,941	$ 43,620	$ 39,402	$ 36,973	$ 33,270	$ 34,104	$ 30,336	$ 29,786	$ 32,859

Optimal Replacement Years: 11

Kilometre at Optimal Replacement: 81,202

Appendix E: Details on Purchasing vs. Leasing vs. Renting

A fleet has various vehicle acquisition options – including purchasing, leasing, and renting – and the optimal decision is dependent on multiple factors specific to the needs and usage of the fleet vehicles as well as market conditions. Here, we provide details on the various vehicle acquisition options.

Vehicle Acquisition Methods and Definitions

There are many available options for fleets to acquire new vehicles. In the list below, we identify the most common methods of vehicle acquisition.

1) **Rent** – Vehicles are rented from a vendor, typically to fill short-term, seasonal or temporary requirements.

2) **Purchase (Cash)** – Vehicles are purchased with cash.

3) **Purchase (Loan)** – Vehicles are purchased with debt financing.

4) **FMV (Closed-End) Lease** – Vehicles are leased with Fair Market Value lease structure and are not purchased at the end of lease term.

5) **FMV (Closed-End) Lease w/ Cash Purchase** – Vehicles are leased with Fair Market Value lease structure and are purchased at the end of the lease term with cash.

6) **FMV (Closed-End) Lease w/ Loan Purchase** – Vehicles are leased with Fair Market Value lease structure and are purchased at the end of the lease term with debt financing.

7) **TRAC (Open-End) Lease** – Vehicles are leased with Terminal Rental Adjustment Clause lease structure and are not purchased at the end of lease term.

8) **TRAC (Open-End) Lease w/ Cash Purchase** – Vehicles are leased with Terminal Rental Adjustment Clause lease structure and are purchased at the end of the lease term with cash.

9) **TRAC (Open-End) Lease w/ Loan Purchase** – Vehicles are leased with Terminal Rental Adjustment Clause lease structure and are purchased at the end of the lease term with debt financing.

Of the methods outlined (above), purchasing, leasing, or renting are the three primary methods for private and public sector commercial fleets to acquire vehicles.

On the surface, the purchase *v.* lease *v.* rent decision may seem obvious; one may assume that if a fleet uses another party's capital to purchase its vehicles, as opposed to using its own funds, the lender/lessor will most certainly wish to make a profit for the use of their funds, and therefore it will cost more. However, there are several complexities that may influence the “big-picture” view and the total cost of ownership (TCO) for each option for vehicle acquisition.

Next, we explore the three primary options for vehicle acquisition and discuss the features and benefits of each.

Option 1: Purchasing Fleet Vehicles

Years ago, purchasing vehicles was the only option for vehicle acquisition. Purchasing vehicles required either cash or credit. But over the past several decades, fleet management has seen a steady evolution from a relatively straightforward task of managing owned vehicle assets to a complex discipline requiring fleet managers and their organization's leadership to adapt to a changing financial landscape[94].

A vehicle fleet of any size can require a massive capital outlay. Such an outlay may constrain a company's primary business in the private sector. In the public sector, the cost for rolling stock and the ongoing capital for annual fleet modernization may impede the community's ability to fund other capital expenses and programs such as new facilities or infrastructure improvements.

Advantages of Purchasing Fleet Vehicles

Purchasing vehicles may be more expensive – at least initially – and require keeping assets longer than leasing, but there are many advantages. For example:

- **No Mileage Restrictions.** Vehicle owners are not subject to mileage or wear and tear limitations as with leases. The distance the fleet travels annually is solely up to the owner.

- **More Flexibility.** Unlike leases, owners are not restricted to keep vehicles for a specific period. Fleet managers can remove a vehicle(s) from the fleet at any time and without penalties.

- **Pricing Leverage**. Fleets can usually attract price concessions (discounts) from vehicle original equipment manufacturers' (OEMs) seeking their business. If a fleet continues to purchase vehicles from a particular dealer or company, it may negotiate lower vehicle prices for future business. Fleets purchasing vehicles from large national fleet dealers may be eligible to receive enterprise fleet pricing.

- **Tax Benefits.** While not applicable to tax-exempt entities, including municipalities, the depreciation benefits of purchased vehicles reside with the owner. The value of fleet vehicles depreciates over time, and the deductions can be used to help offset profits. In leasing, the depreciation benefit remains with the owner – the lessor.

[94] Source: Mapping the Changing Funding Environment of Fleet Management

- **Depreciation.** Depreciation of vehicles' value is one of the highest fleet costs. Vehicle owners have more control over this number. Leasing companies resell their vehicles in large volumes, sometimes for discounted prices, but owners can sell or trade in their vehicles individually, potentially resulting in lower net depreciation and reduced lifecycle total cost of ownership (TCO).

- **Equity.** Vehicles will gain equity over time. If funds for purchasing are borrowed, ideally, the owner will gain positive equity meaning the amount the fleet owes for its vehicles is less than it is worth. The owner can then reinvest that positive equity back into the company. With leasing, earned equity remains with the lessor.

Cost of Capital and Interest Rates

Timing is crucial for any organization looking to fund its fleet, whether the choice is to borrow capital to purchase its vehicles or to lease them. Market conditions change, sometimes drastically, and interest rates follow these changes. For example, before 1977, rates remained relatively stable, with 3% or 4% fluctuations over several years considered exceptional. In 1977, rates skyrocketed, almost tripling through 1981. A steady decline followed through the 1990s, with a recovery in the 2000s. The global financial meltdown of 2008 caused rates to plummet to historic lows. In 30 years, rates (in the U.S.) were more than 16% in 1981 and as low as 0.1% by 2011. In Canada, interest rates averaged 5.82 % from 1990 until 2021, reaching an all-time high of 16% in February of 1991 and a record low of 0.25% in April of 2009[95]. Fast-forwarding to 2021, while interest rates have been stable and low for a considerable time, we know from history that this reality can change. Fleets that borrow or lease vehicles based on floating interest rates can be vulnerable to swings in their cost of capital, which ultimately affects their costs of conducting business.

Option 2: Leasing Fleet Vehicles

Leasing fleet vehicles may offer advantages over purchasing. For example, fleet leasing companies, often referred to as "Fleet Management Companies" (FMCs), through their tremendous volume purchasing, may offer lower vehicle costs to a fleet client that does not have the same buying power.

Leasing may enable cash-strapped organizations to have a more modern and reliable fleet without significant capital investment. However, leasing vehicles can be a complex process, requiring fleet managers to make increasingly difficult decisions about the type of lease, method of financing and the fleet lessor or FMC they should choose.

Today, leasing is the most common way private sector fleets finance their vehicles. From a tax standpoint, private sector businesses can deduct the business percentage of their lease payments.

95 Source: https://tradingeconomics.com/canada/interest-rate

While tax deductions may be advantageous to the private sector, the same does not apply to tax-exempt municipalities—one of the primary reasons that, in the public sector, most municipalities purchase their fleet vehicles.

Advantages of Leasing Fleet Vehicles

Leasing is similar to renting a vehicle[96], but it's for at least a year instead of using the vehicle for a few days. Leasing and renting are like *paying for the use of a vehicle* instead of paying for the asset itself.

Some advantages are:

- **Preserving Capital**. Leasing (or renting) preserves capital compared to owning vehicles. By leasing, an entity can get newer fleet vehicles without a capital budget line item for rolling stock and potentially apply that capital to other business requirements and priorities.

- **Less Maintenance and Fuel Costs**. Since leased vehicles are typically newer models, they require fewer reactive repairs and, hence, overall maintenance costs (aside from preventative maintenance) and better fuel economy. As a result, the fleet can benefit from more uptime, lower maintenance expenses and lower fuel costs than older fleet vehicles. Some lease agreements may include maintenance options.

- **Off-Balance Sheet Treatment**. Purchasing vehicles is a significant capital expense that impacts the debt-to-equity ratio, potentially making an organization appear less attractive to lenders or investors. Leasing is not as substantial an expense and can potentially be treated off the balance sheet.

- **Flexibility.** Lease terms are generally shorter than ownership lifecycles, which may translate to a more modern fleet.

- **Less Administration**. With a vehicle lease may come fewer administrative tasks. Since the lessor owns the vehicle(s), the lessee's name is not on the registration. Tasks like license renewal are up to the leasing company. Preparing specifications, obtaining competitive bids, and other administrative tasks are the lessor's responsibility.

Open-Ended Leasing

The open-ended lease is the most flexible and popular fleet leasing option. In an open-ended lease, an amortization rate is agreed on at the time the lease begins. When vehicles are sold after being removed from service, the lessee receives or pays additional funds based on whether the sale price is greater or less than the unamortized balance.

[96] Source: https://www.fleetio.com/blog/lease-or-purchase-your-fleet-vehicles

Leases are billed monthly, and the lease rate factor (including the funding cost component) is applied to the average annual outstanding (unamortized) vehicle asset balance. Because the annual average balance is used for the first six months of any year, the lessee underpays the actual funding cost and overpays for the last six.

According to research completed by Deloitte[97], North American customers favour open-end lease contracts over closed-end (90 percent/10 percent). In an open-end lease, the lessee bears the residual risk but is more flexible in terms of contract length and does not have restrictions on usage or kms-travelled. If the market value exceeds the agreed residual value at the end of the lease, the lessee is rewarded by the lessor and can purchase the vehicle for the agreed residual value. If the actual market value is below the agreed residual value, the customer must pay the difference to the lessor.

Closed-Ended Leasing

Another leasing option is the closed-end lease, which has a fixed rate and term. In a closed-end lease, the lessor is the party responsible for resale gains and losses, the depreciation factor, and price-setting for the lessee.

In a closed-end lease, the lessor bears the risk of overestimated residual values. Closed-end leases come with more restrictions in terms of vehicle usage. Usually, the mileage is limited to ~19,000 to 25,000 kilometres per year. Additional mileage and excessive wear and tear will be charged at the end of the lease. However, the lessee can hand in the vehicle without being concerned about the actual market value. The closed-end contract is therefore often called a "walkaway" lease.

Tax Treatment of Leases in Canada

For tax purposes, there is no distinction between a capital lease and an operating lease[98]. A capitalized lease is both an asset and a liability at the same time. If the lease allows the lessee to own the asset at the end of the lease, perhaps for a nominal amount (bargain purchase option), it must be capitalized; the lessee must turn the lease into an asset with an associated liability. However, if a lease has a 10% buyout at the end of the lease, this does not constitute a bargain purchase option. The lease can then be treated as an operating lease and capitalize the asset if purchased at the end of the lease. It is not classified as a capital lease as it does not meet all the criteria of a capital lease[99].

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[97] Source: Fleet leasing and management in North America | A key enabler of future mobility. Deloitte
[98] Source: https://www.bookkeeping-essentials.com/capital-lease.html
[99] Source: Theme: Loans vs. Leases by John W. Day www.reallifeaccounting.com

Service Charges and Other Fees

Both open- and closed-ended lease types will contain an administrative fee and a funding cost component. The funding cost component is applied to the declining balance of the asset — since the monthly amortization is deducted from the capital cost. When any particular lease is terminated, the lessor sometimes bills the fleet for the cumulative difference between the average and the actual balance, which is also known as the "deficit interest" adjustment.

From FCC's professional experience, we have observed numerous additional costs that lessors may apply to a lessee's lease charges. Examples of such surcharges may range from lease initiation fees to environmental charges, licensing, disposal, termination or various other expenses. Service fees and surcharges can substantially increase the lessee's monthly costs per leased vehicle, and in some cases, potentially place any anticipated cost-benefit advantage of the lease at risk.

Often, surcharges and fees are levied by lessors in ways that are very difficult to evaluate when comparing one lessor to another, such as during the competitive bidding process (i.e., RFPs or RFQs). For example, some lessors may apply a specific service fee monthly/annually or apply other surcharge(s) at the end of the contract. At the same time, another lessor may apply costs based on kilometres-travelled thresholds or in some other creative way. The methods of applying these surcharges may vary widely from lessor-to-lessor, and for this reason it becomes incredibly challenging to compare these extra costs from one vendor to another.

End-of-Lease Considerations

In closed-end leases, vehicle reconditioning charges at the end of the lease can be substantial. In a recent example, FCC's fleet client returned a leased sedan after a three-year lease. Knowing the lease requirements regarding end-of-lease vehicle condition, pro-actively, the lessee had the front tires replaced just one day before the vehicle was returned. Despite the vehicle being returned with new tires and tires with an acceptable level of wear on the rear tires, the lessor charged the costs of two new tires to the lessee, stating that the new front tires installed by the lessee were not suitable because they were "not the same make/model as the factory-installed original tires" – *even though the lessee could not possibly purchase the factory-installed tires since they were not available for purchase by the public.*

In another example, a Fleet Challenge client operating a large fleet of highway tractors and trailers returned several (17) end-of-lease tandem-axle trucks to its lessor. Unbeknownst to our client, the fine print in the truck's leases entitled the lessor to be compensated for these mechanical conditions:

- The tread depth for all ten tires on each tandem-axle truck had to meet the lessors' requirements; if not, the cost of new tires for each truck would be charged to the lessee.

Even though the tires on the 17 trucks met provincial safety standards, the tread depth was less than the lessor's requirements and considerable costs were incurred.

- Each truck was equipped with three (or four) wet cell starting batteries. According to the lease agreement, every battery was to have a specific gravity reading acceptable to the lessor; if not, significant charges would be, and were, levied to the lessee.

- Each brake lining and all brake drums were to be measured at the end of the lease; if any were out of the lessor's threshold for wear, additional costs would be charged to the lessee.

In the examples above, in addition to the fees levied, the garage labour costs for making all of the above assessments were to be paid by the lessee – an amount that was substantial by itself.

Such examples of end-of-lease costs will add significantly to the total cost of each vehicle's lifecycle total cost of ownership (TCO). Therefore, fleets considering a new lease vendor should take extreme care to ensure that all language in proposed vehicle lease contracts is carefully reviewed and fully understood before committing.

Interest Rates

Lease interest rates can be fixed or floating. Historically with a fixed rate lease, the rate is set at the lease's inception and fixed at the prime lending rate plus one. Fixed rates were the only funding option available until recently when some lessors began to offer the same rate basis, but with the lease rate floating as the prime rate changed. For example, if the fleet manager or the company's financial leadership believed that the prime rate would fall, they'd likely choose a floating rate to fund their leases.

Choosing the Right Lease Option

The evolution of leases and funding options, in addition to purchasing vehicles outright, has given fleet managers and their companies' financial leadership more control but requires considering several factors to determine the correct option(s). There is no one-size-fits-all solution. Every organization must consider their own needs, comfort level with risk, and anticipated return-on-investment (ROI).

The factors that come into play when considering funding options include:

- Rate: This is the most fundamental funding factor to consider. Lessees seek the lowest rate available at the inception of the lease transaction. Historically, borrowing rates on many of the available options have been volatile, and if the timing is wrong, it can be costly.

- **Consistency**: Some funding rates are more volatile than others. Consistent, predictable rates are preferable.
- **Availability**: Not all funding types are available at all times.
- **Matching**: Funding should match the life of the asset as closely as possible.
- **Fees and Surcharges**: What are the total costs of leasing, including hidden charges?

Option 3: Renting Fleet Vehicles

In both the private and public sectors, fleets may choose to rent additional vehicles for short-term, seasonal or temporary requirements, and some fleets will opt to rent for longer-term needs.

Advantages of Renting Vehicles

In many ways, like leasing (see Option 2), renting vehicles may offer several advantages. Rental agreements will vary from vendor to vendor, but given the right set of circumstances, the benefits may include:

- A way to expand the fleet to meet a defined business need or to modernize the fleet by replacing aging fleet units without capital investment;
- No upfront costs;
- Covered maintenance and repair costs;
- Replacement vehicles at no additional cost when primary rental units are out of service for repairs or maintenance; and
- Little, and possibly no, downtime and associated costs.

Renting fleet vehicles for long-term needs has become more prevalent in recent years. There are several players in the fleet rental market space, including Somerville www.somervilleauto.com and Enterprise https://www.efleets.com/en/locations/toronto.html.

The leading fleet rental service providers are huge-volume purchasers of vehicles, often purchasing tens of thousands of units each year. They have access to vehicle concessions (discounts) that are not available to smaller fleets that buy a much smaller number of units. Some creditworthy rental vehicle service providers may also benefit from long-term, preferential low-interest rates for vehicle acquisition, which can mean a lower cost of capital for vehicle purchases than some private and public sector entities.

Rental companies are expert at knowing precisely how long units should be kept in service. They take a very studied approach to their end of lifecycle disposal practices to ensure the maximum end of lifecycle resale values.

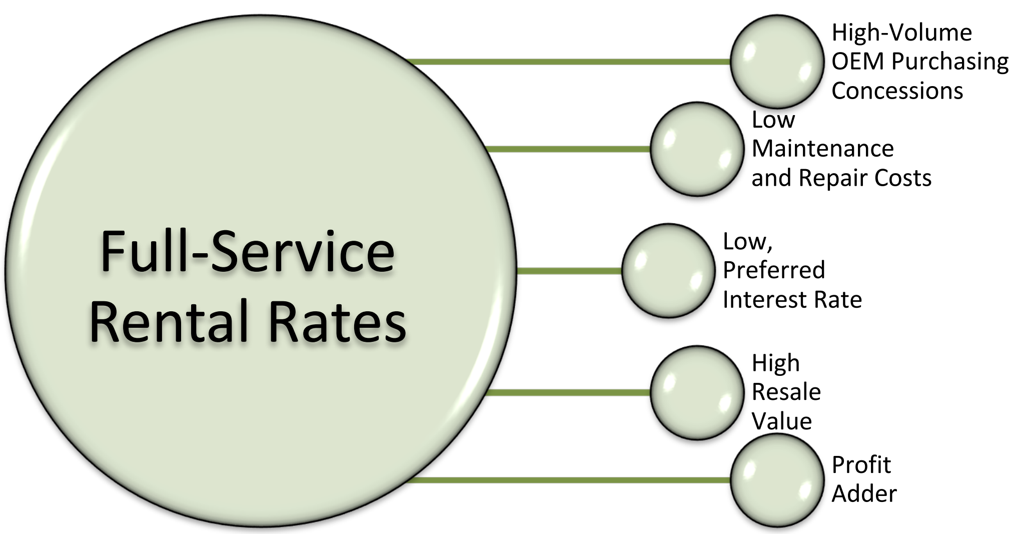
Rental firms may operate their own maintenance facilities, and they will likely purchase replacement and service parts at wholesale prices. In-house labour costs for their fleet maintenance technicians may be less, all of which means low maintenance costs.

The effects of low initial purchase price, low-interest rates, maximum resale prices for end of lifecycle units, combined with low maintenance costs, all result in a very low lifecycle total cost of vehicle ownership (TCO).

Rental providers must add a profit margin to their retail fleet rental rates to be profitable. Their skill is adding just sufficient profit margin for their needs while ensuring their rental rates are competitive. Despite the profit adder, by having a low TCO, rental service providers can offer competitive rental rates to fleet customers, potentially making fleet vehicle rentals an attractive alternative to traditional ownership or leasing.

Please see *Illustration 4: Full-Service Rental Rates* (below). The combined effects of large purchasing volumes, preferential interest rates, high resale value, low maintenance costs and a profit margin are depicted.

Illustration 4: Full-Service Rental Rates



Appendix F: Details on Fuel-Reduction Solutions

There are several vehicle specifications that can aid in fuel-use and emissions reductions. *Table 21* lists sample vehicle specifications and their respective impacts.

Table 22: Strengths and Weaknesses of Enhanced Vehicle Specifications

Specification	Strengths	Weaknesses
Smaller Vehicles	Consume less fuel and thus have reduced emissions	Might not always be suitable for the job
Lighter Vehicles	Consume less fuel, produce less emissions, and can carry larger payload (e.g., if a truck is lighter by "x" pounds/kg, it can carry a commensurately increased payload), which increases efficiency	Light weighting may overstress some vehicles, increasing maintenance demand and lifecycle cost
Aerodynamically Designed Vehicles	Reduces fuel consumption and emissions	Minimal effectiveness in urban setting, high cost, increased maintenance demand for some solutions
Low Rolling Resistance (LRR) Tires and Wide-base Tires	Reduces fuel consumption and emissions, reduce frequency of tire replacement	Potential for on-road service issues, axle loading restrictions in some jurisdictions with wide-base tires
Electronically Controlled, Programmable Diesel Engines	Allow tailoring/minimizing power and torque needs, road speed, and idle time limits therefore reducing fuel consumption and emissions	Seldom give problems, however when they do, often require specialized and costly diagnostic skills (might need to be outsourced) with potentially protracted downtime

Specification	Strengths	Weaknesses
Idling-Reduction Devices	Reduces idle time and therefore lowers fuel use and emissions	Actual idling reduction benefits are dependent on the use of technologies by drivers, some who resent intervention by such devices; some may feel devices could cause a safety concern

Fleet Downsizing

Getting a fleet's "house in order" should include shedding any under-utilized vehicles, so that stranded capital tied up in low-usage units can be re-applied to fleet modernization and new electric vehicles (EVs). When exception data demonstrates that a vehicle's usage has been less than the organization's acceptable minimum threshold, the vehicle is incurring cost without serving a purpose. Hence, the vehicle is a liability, unless it has some redeeming value, i.e., a special-purpose or backup vehicle for emergencies, or a unit reserved for peak periods.

Low-usage units should be routinely and regularly reviewed to determine if there are more cost-effective ways of accomplishing the corporate end-goal. If a specific vehicle is used infrequently, management should be empowered to consider creative solutions for a less costly travel mode, e.g., an inter-departmental vehicle sharing arrangement, a 3rd party service-provider, video conferencing, use of employee's vehicles, etc.

A fleet's first step in cost reduction is to reduce the total number of low-utilization vehicles. Management should undertake a review to determine if some vehicles can be eliminated through early decommissioning.

Right-Sizing

In days past, some fleet managers subscribed to the adage "identify the size of truck you really need for the job — and then buy one bigger." Today, we know this is anachronistic thinking that led to fleets with oversized vehicles, poorer fuel economy, and higher operating costs and GHG emissions.

Instead, savvy fleet managers are leaving the old approach behind and employing the correct and most efficient approach, which is to right-size fleet vehicles – that is, correctly specify the size of vehicle for the job at hand, which leads to lower overall operating costs.

Job Suitability

The types of vehicles and the equipment staff members are fitted should be aligned with the vocational and load requirements. For example, a passenger sedan would be completely unsuitable for plowing snow or carrying loads of anything other than people. Rather, fleet vehicles types are matched specifically to the tasks at hand; in this case, a light-duty truck would be required for snow removal in, for example, parking lots.

Choose the Size Down When Appropriate

Downsizing is a recommended best management practice which results in a lower total cost of ownership (TCO). An example is acquiring light-duty (Class 2a) vans and pick-ups as opposed to heavier-duty units (Class 2b), which have higher acquisition and maintenance costs.

Another example is with heavy-duty units; selecting a single-axle plow-dump unit, which has inherently lower operating costs than a tandem-axle unit, is recommended when appropriate (i.e., when the specific task at hand, or job suitability, is fulfilled by either unit).

Accounting for Limited Space

Limited space for roads, as a result of urban development and densification, may lead to an increased number of traffic roundabouts. Roundabouts pose unique problems for snowplows as well as refuse and recycling trucks because of tight turning movements and lack of adequate space to maneuver. Single axle units are shorter in overall length and, therefore, turn in a smaller radius than tandem or tridem axle units. They also cost less to acquire and maintain. The disadvantages are that single axle trucks may have less traction/control in slippery conditions and have less load-carrying capacities, such as salt/sand or waste (less productivity). However, in urban, low-speed, traffic-congested environments with limited space, such as roundabouts, single axle plows or refuse/recycling trucks will have an advantage over multi-axle units. In this example, it is important to weigh the pros and cons for different sized vehicles; when space is tight, it is often recommended to go smaller when it is safe (i.e., at low speeds) and productivity is acceptable.

Right-Sizing Summary

In summary, it is important for a fleet to consider the following in regard to rightsizing:

- Ensure that fleet vehicles are matched specifically to the tasks at hand (i.e., are job suitable) in terms of both vocation and load requirements.
- When multiple sized units fulfil a task equally well, choose the size down.
- When space is limited, it is often best to choose smaller units, given that it is safe to do so and that the productivity level is acceptable.

Low-Rolling Resistance Tires

Rolling resistance is the energy lost from drag and friction of a tire rolling over a surface[100]. The phenomenon is complex, and nearly all operating conditions can affect the final outcome. Except for all-electric vehicles, it is estimated that 4%–11% of light-duty vehicle fuel consumption is used to overcome rolling resistance. All-electric passenger vehicles can use approximately 23% of their energy for this purpose. For heavy trucks, this can be as high as 15%–30%.

A 5% reduction in rolling resistance would improve fuel economy by approximately 1.5% for light and heavy-duty vehicles. Installing low-rolling resistance (LRR) tires can help fleets reduce fuel costs. It is also important to ensure proper tire inflation (see sections below).

Tires and fuel economy represent a significant cost in a fleet's portfolio. In Class 8 trucks, approximately one-third of fuel efficiency comes from the rolling resistance of the tire. The opportunity for fuel savings from LRR tires in these and other vehicle applications is substantial.

According to a North American Council for Freight Efficiency (NACFE) report, the use of LRR tires, in either a dual or a wide-base configuration, is a good investment for managing fuel economy. Generally, the fuel savings pay for the additional cost of the LRR tires. In addition, advancements in tire tread life and traction will reduce the frequency of LRR tire replacement.

Automatic Tire Inflation Systems

Proper tire inflation pressure is critical to the optimal operation of a commercial vehicle. Underinflated tires result in decreased fuel efficiency and increased tire wear[101]. A 0.5-1.0% increase in fuel consumption is seen in vehicles running with tires underinflated by 10 psi. Appropriate pressure reduces tire wear, increases fuel efficiency, and leads to fewer roadside breakdowns due to tire failures. An example of an automatic tire inflation system (ATIS) is shown in *Illustration 4*.

Illustration 5: Automatic Tire Inflation System (courtesy NACFE)

[100] Source: https://afdc.energy.gov/conserve/fuel_economy_tires_light.html
[101] Source: https://nacfe.org

In the U.S., a large truckload carrier with 5,000 tractors and 15,000 trailers averaging 124,000 miles a year on tractors and 41,000 miles on trailers, conducted a fuel economy test with 60 trucks pulling trailers without tire inflation systems and 75 trucks matched with trailers with the systems installed. The results of the test showed a 1.5% improvement in fuel consumption for trucks with ATIS.

Tire Inflation with Nitrogen

Nitrogen is said to permeate tire walls up to four times slower than air. Tires will lose one to two psi over one month versus the six months it takes a nitrogen-filled tire to lose that same amount of pressure. As a result, the time spent adjusting the tire pressure is reduced.

Supporters of nitrogen for tire inflation claim better tire pressure retention. This is believed to result in:

- A smoother ride
- Improved steering and braking
- Reduced risk of blowouts by as much as 50 percent[102]
- Increased tires tread life by up to 30 percent, improving the tire's life and its grip to the road[103]
- Reduced fuel consumption by up to 6%[104]

It must be noted that it is not the nitrogen itself that improves the fuel efficiency, but rather the enhanced retention of inflation pressure over time[105]. Reduced tire pressure leads to increased fuel consumption. Therefore, if vehicle tire pressure is well monitored, there might not be a fuel consumption benefit of using nitrogen.

Idling Reduction

Idling reduction is an important concern for all leading fleets that are looking to optimize costs and reduce the environmental impact. Municipal fleet vehicles left idling for no apparent reason are seen by the public as being wasteful and polluting. These negative messages are potentially damaging to the reputation of any organization.

Fuel consumption from idling of heavy-duty vehicles is significant. While we acknowledge there are times when idling is simply unavoidable, the U.S. Department of Energy estimates that unnecessarily idling heavy-duty vehicles wastes from half to one U.S. gallon (1.89 to 3.79 liters) or more per hour.

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[102] Source: http://www.gonitrotire.com
[103] Source: http://www.gonitrotire.com
[104] The fuel consumption reduction estimates vary considerably. Enviro-fleets, A guide to helpful resources, June 2010, report an improvement of up to 10%, but the industry standard is between 3% and 6%.
[105] Source: NHTSA Report, 2009: https://one.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/.../2009/811094.pdf

Some fleets idle 30 to 50% or more of their operating time[106]. These are several main approaches to idling reduction, including:

- Idling-reduction policy
- Driver training and motivation
- Idling-reduction awareness and fact-based training
- Incentive programs
- Ongoing driver education
- The use of idling reduction devices, including:
    - Auxiliary power units (APU)
    - Stop/start devices
    - Auxiliary cab heaters
    - Battery backup systems
    - Block heaters / engine preheaters

Idling-Reduction Policy

An idling-reduction policy is a way to motivate fleet drivers to limit unnecessary idling. However, for an idling-reduction policy to be successful continuous enforcement such as spot-checks and fuel use tracking must be present. An idling-reduction policy could be used as an overarching commitment to idling reduction that is carried out though driver training and motivation sessions, rather than an initiative on its own.

When Engine Idling is Unavoidable

There are times when idling is unavoidable. These include:

- Cab heating/ventilation and air conditioning (HVAC)
- Power for critical equipment (such as the use of a PTO for ancillary equipment)
- Maintaining brake air pressure (MD and HD trucks)

It is important to differentiate between *unnecessary* idling and idling that is *unavoidable* due to operational requirements. The focus of all idling-reduction initiatives should be to reduce and, ideally, eliminate *unnecessary* idling and to explore alternatives of how to limit idling for operational purposes with solutions that do not impede with operations, but offer environmental and economic benefits.

Idling Reduction Devices

There are several idling-reduction technologies available that can aid in idle reduction. Their functionality, potential, and costs vary considerably and are described in *Table 23* (below). To reap the most benefits any idling-reduction technology, installation should always be accompanied by behavioural solutions of driver training and motivation.

[106] Source: Fleet Challenge Municipal Best Practices Manual 2008

Table 23: Idling Reduction Devices and Their Associated Costs

Technology	Description	Cost Estimates
Auxiliary Power Units (APU)	An APU consists of a small engine that provides power to heat and cool the cab, as well as to power accessories, heat the engine, and charge the start battery. DC-powered APU systems are also available.	APUs can cost anywhere from ~$8,500 to ~$10,000. Annual maintenance cost is estimated as high as $500.
Stop/Start Devices (Idle-Stop systems)	A stop/start system automatically shuts down and restarts the internal combustion engine to reduce the amount of time the engine spends idling. This technology is particularly useful for vehicles that spend significant amounts of time waiting at traffic lights or frequently come to a stop in traffic jams.	Stop/start devices typically are part of OEM hybrid vehicle systems, but more recently has also been introduced in regular combustion engine vehicles to reduce fuel consumption. Such devices can also be purchased separately (offered by companies like Bosch that also manufacturers OEM devices) and their costs average at about $300-$350.
Auxiliary Cab Heaters	There are two types: (1) Gas- or diesel-fired auxiliary air heater: In most cases, it is fitted in the cab, drawing in cab air through a blower and heating it. (2) Gas- or diesel-fired auxiliary coolant heater: It is installed in a vehicle's engine compartment and enables the vehicle's own coolant circuit to work without the use of the entire engine. Such water-based auxiliary heaters use small amounts of fuel to heat up the liquid in the air-exchange system and provide warm air in the cabin. Compared to air-based auxiliary heaters, the advantage of water-based auxiliary heaters is that they also warm	~$1,250 +

Technology	Description	Cost Estimates
	the engine in the process (similarly to block heaters), thus enhancing starting performance. Auxiliary coolant heaters are manufactured by companies like Webasto and Espar.	
Battery Backup Systems	A battery backup system powers electric devices (emergency lights, etc.) without drawing power from the primary battery. The system consists of adding an isolator and an additional battery to a vehicle's electric system. When the vehicle is off, the isolator prevents power being drawn from the primary battery and instead uses the alternate battery to power any electronic systems. When the vehicle is running, both batteries are recharged; charging to the start battery is prioritized and it is charged first.	The system costs between \$400-\$600 plus the price of a battery which varies based on the required capacity.
Block Heater / Engine Preheater	Engine block heaters use power from electrical outlets in corporate facilities, where vehicles are parked overnight to heat the engine block. The block heater on timer can be set to switch-on a few hours before the vehicle is used to warm up the engine block. This decreases required warm-up idling time. This is a very low-cost option, and a necessity in Canadian winters; however, it is limited to reducing warm-up idling only.	Block heaters cost between \$70 and \$150 and have a negligible annual maintenance cost.

Emissions Reduction Potential

Despite the wide selection of idling reduction solutions, when it comes to internal combustion engines, there is no technology that completely eliminates CO_2 and other emissions. Only battery-electric and hydrogen fuel cell vehicle technologies can eliminate tailpipe emissions. Idling-reduction initiatives can be helpful in reducing unnecessary idling in the short and medium term, and as a segue to gradual transition to electric trucks and, potentially, hydrogen fuel cells in the long-run.

Driver Training and Motivation

Idling-Reduction Training and Incentives

Driver training to modify driver behaviours and ongoing motivation to continue good behaviours are crucial components of successful idling-reduction programs. While most drivers understand the vehicle idling issue, many continue their inefficient practice of excessive idling due to lack of knowledge and/or motivation.

Driver training can be used to optimize the use of idle reduction technologies. The technologies can reduce idling but the drivers have the ability to override the technologies. Proper training can aid in utilizing the technologies to their full potential.

In addition to establishing corporate idling reduction policies, behaviour-based approaches for idling reduction include:

- Idling-reduction training for drivers; and
- Incentive programs to encourage drivers to limit idling.

For best results, these approaches should be used in conjunction. Regardless of the approach, the greatest impact pledges of idling-reduction should be made in a public forum. Moreover, idling-reduction targets should be customized as various fleet vehicles may have different operating requirements and will benefit from targets that accurately reflect their work environment. Beginning from a measured starting point, progress should be evaluated at regular intervals to modify and adapt the approach if progress is not occurring.

Driver Eco-Training

Driver eco-training should be fact-based and aimed at increased awareness and promotion of good practices. Typically, eco-training courses address the following areas:

- Progressive shifting (or use of automated transmissions)
- Starting out in a gear that doesn’t require using the throttle when releasing the clutch
- Shifting up at very low RPM
- Block shifting where possible (e.g., shifting from third to fifth gear)
- Maintaining a steady speed while driving
- Using cruise control where appropriate
- Anticipating traffic flow
- Coasting where possible
- Braking and accelerating smoothly and gradually
- Avoiding unnecessary idling

Driver eco-training programs vary considerably. They can be organized as short (typically an hour long) information sessions/workshops or can be considerably longer and involve more hands-on activities. Extended training can vary in length from a half to a full day or can also be scheduled into shorter sessions over a period of time.

Online Training

Online training courses are gaining popularity thanks to their flexibility. This trend has accelerated due to the Covid-19 pandemic and the need for social distancing measures. It is strongly recommended that discussion sessions among the drivers be organized to review training topics to deepen their understanding and provide a forum for questions and concerns. The individual responsible for the idling reduction incentives program could facilitate such sessions.

In-Person Training

In-person driver eco-training courses vary greatly in length, depth, and format. These courses offer a more personalized approach, facilitate immediate discussion, and typically allow for practical application. For best results, eco-training could be combined with professional driver improvement training.

NRCan SmartDriver Training Series

SmartDriver provides free, practical training to help Canada's commercial and institutional fleets lower their fuel consumption, operating costs, and harmful vehicle emissions. Fleet energy-management training that helps truckers, transit operators, school bus driver, and other professional drivers is claimed by NRCan to improve fuel efficiency by up to 35 percent. FCC highly recommends NRCan's SmartDriver training: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/greening-freight-programs/smartdriver-training-series/21048

Continuous Motivation

Studies have demonstrated that driver training benefits, although significant, are likely to diminish over time. Ongoing feedback and motivation is recommended as a preventive measure. This can include:

(1) Tracking Idling to Provide Feedback to Drivers

- Monitoring the progress of any initiative is crucial not only to determine the impact, but to also provide feedback to the drivers to provide them the opportunity to modify their behaviour.

- Practices that track and report fuel consumption establish a valuable monitoring basis. Knowledge and comprehensive factual information can help build a stronger business case and “buy-in” for idling reduction.

- Telematics technologies help managers and drivers track idling and provide measurable data to manage goals. Such technologies, however, can be expensive as they typically use GPS systems and OBD monitoring devices.

(2) Implementing a Corporate Idling Reduction Policy

- It is our opinion that in most cases drivers want to “do the right things.” By ramping up communications about excessive idling and instituting a clear idling policy, a reduction of unnecessary idling will likely result.

(3) Ongoing Information Campaigns and Reminders

- In general, information campaigns are low-cost, easy to manage, and lead to a more knowledgeable and receptive public. To raise awareness of the issues these can be initiated even before driver training commences. Numerous resources that address idling awareness issues are available free of charge and ready to implement.

(4) Non-Monetary Incentives Programs

- There are a few approaches that can aid in motivating drivers to continue to apply the skills gained during eco-training. Competition among departments/teams to reduce idling can be an effective approach. Periodic recognition of high-performers can be either public or private. An example of a non-monetary reward might be the donation to a charity in the amount of the lowest idling department’s fuel cost savings.

Summary and Potential Impact

Driver training is an initiative that attempts to change an individual’s behaviour and thus the results are hard to predict and the variance is large. A multitude of aspects, such as the current level of driver education and driving practices, the level of idling, corporate culture and policy, and individual receptiveness and willingness to change will influence results. It is estimated that driver training has a potential to reduce vehicle fuel consumption by anywhere from 3% to 35%, with the typical results between 5% and 10%.

Route Planning and Optimization

In addition to vehicle upgrades, proper maintenance, driver training, and continuous motivation to maintain good driving habits, a fleet can further minimize fuel consumption and exhaust emissions through route planning and optimization. Route planning software can be used optimize multi-stop trips. There are different software available for categories in both public and private fleets (e.g., service dispatch software, courier software, trucking software, etc.) [107].

Route planning software used for delivery services ensures the minimum driving time for multi-stop trips by using advanced algorithms to arrive at the optimal route that provides the highest collective reduction in total driving time and, consequently, fuel consumption. This can also mean fewer vehicles and less traffic on the road at one time.[108]

Route planning software can also be used for idling reduction initiatives by integrating GPS tracking software to monitor driver activity in real-time. Moreover, reporting and analytics features within route planning software can help with identifying when a fleet vehicle requires maintenance to ensure optimal fuel efficiency and thus minimize cost and emissions.[109]

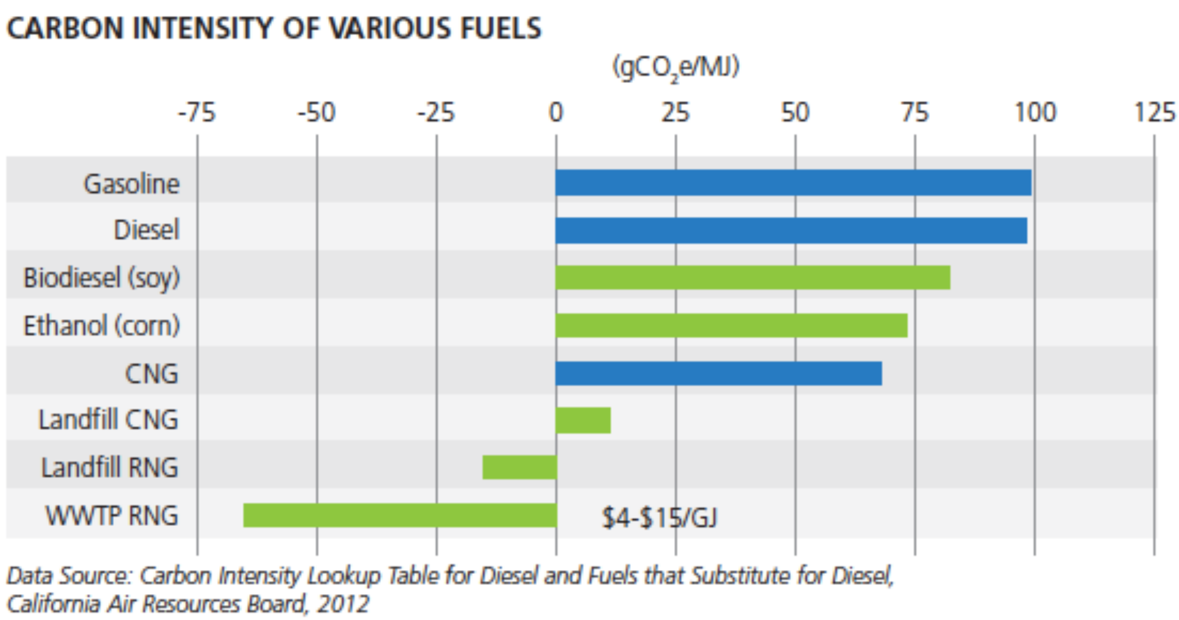
[107] Source: https://www.capterra.com/route-planning-software/
[108] Source: https://blog.route4me.com/2020/05/carbon-emissions-reduction-route-optimization-helps-cut-tons-carbon-emissions/
[109] Source: https://blog.route4me.com/2020/05/carbon-emissions-reduction-route-optimization-helps-cut-tons-carbon-emissions/

Low-Carbon Fuel Switching

Of all current-day fuel-reduction solutions, fuel switching is often the most expedient way to reduce emissions in the short term. As awareness of climate change issues amplify, the use of low-carbon fuels is gaining increased domestic and global interest. Fuel switching is a process of diverting a fleet's fuel consumption away from traditional fossil-based sources to either alternate or renewable energy sources.

Figure 8 (below) shows the carbon intensity of various fuels relative to baselines for traditional fossil gasoline and diesel.

Figure 8: Carbon Intensity of Various Fuels

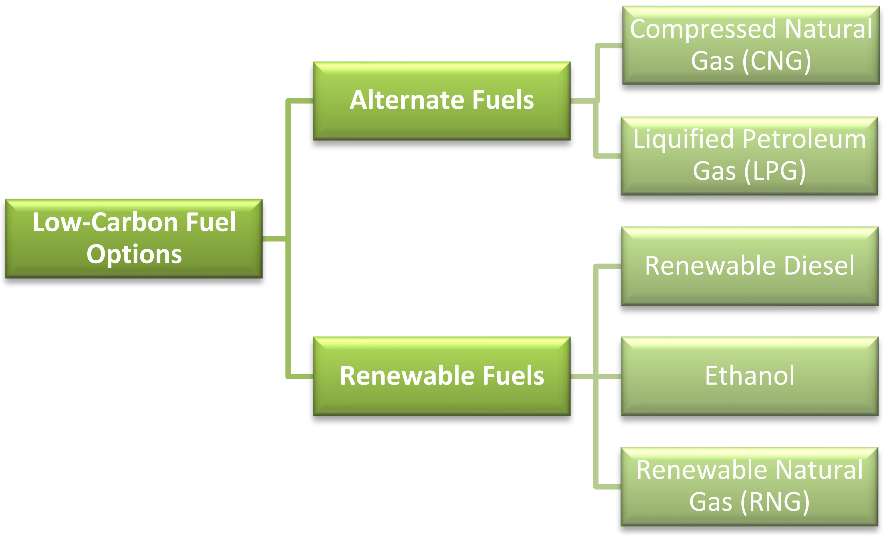


No Pain, No Gain!

Unfortunately, regardless of which fuel-switching options are selected, the reality is that each will require some degree of effort to implement. For example, although transit buses are capable of using biodiesel and/or renewable diesel, obtaining the fuels would likely bring new operational challenges such as switching bulk suppliers and/or requiring extra efforts from vehicle drivers to attend different retail fuel stations instead of those they are accustomed to frequenting. Adding B10 biodiesel to the in-house fuelling supply system will require minor modifications, extra work routines, and procedures for staff to follow.

Figure 9 (below) provides an overview of the low-carbon fuel alternatives now available to reduce a fleet's fuel consumption and GHG emissions.

Figure 9: Low-Carbon Fuel Options



An alternate route to changing the fuel used to power an internal combustion engine is to introduce a complete change such as battery-electric or hydrogen fuel cell vehicles. Some jurisdictions have already legislated elimination of the internal combustion engine in coming years. How successful that will be remains to be seen, but in response to the need to and regulation supporting the transition away from fossil fuels, zero-emission electric and fuel cell trucks are already planned for production. These technologies will be explained in later sections of this Appendix. First, we will explore low-carbon fuel options, also known as the "messy middle."

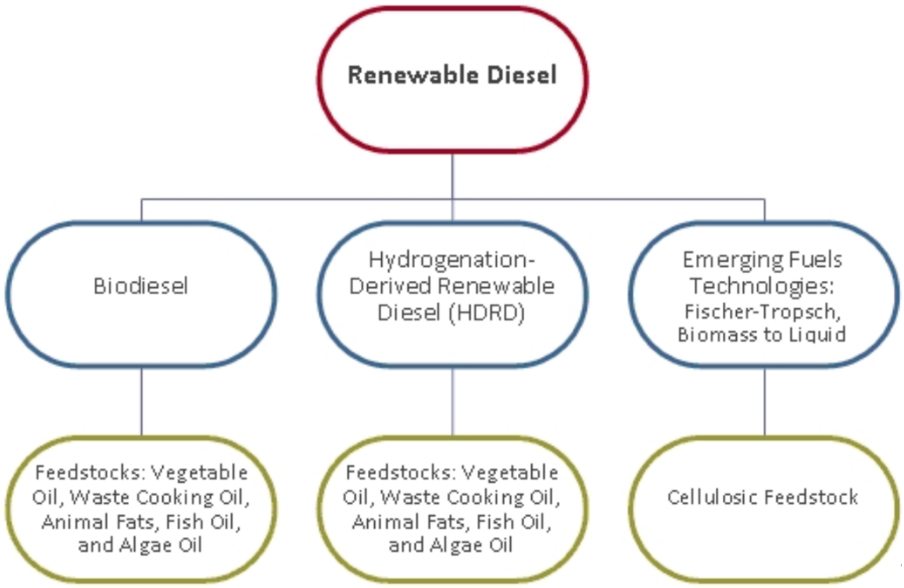
Renewable Diesel

Renewable diesel is a fossil diesel fuel substitute currently made from plant and animal oils and fats as well as from cellulosic feedstock consisting of agriculture and forest biomass[110].

There are two main renewable diesels – biodiesel and hydrogenation-derived renewable diesel (HDRD), explained below – and other technologies to convert biomass into renewable diesel are being developed (outlined in *Figure 10)*[111]. All diesel fuel sold in Canada contains a percentage of renewable diesel owing to a renewable fuels standard.

[110] Source: https://www.nrcan.gc.ca/energy/alternative-fuels/resources/nrddi/3669
[111] Source: https://www.nrcan.gc.ca/energy/alternative-fuels/resources/nrddi/3669

Figure 10: Renewable Diesel Types and Feedstocks



Biodiesel Overview

Biodiesel is a renewable fuel made from vegetable oil and waste cooking oil, animal fats such as beef tallow and fish oil, and even algae oil[112]. In technical terms, biodiesel is a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters made by chemically reacting lipids (e.g., vegetable oil, soybean oil, animal fat) with alcohol-producing fatty acid esters. Biodiesel is often referred to as fatty acid methyl ester or FAME[113].

Biodiesel can be blended in a variety of ratios with conventional fossil diesel. Much of the world uses a system known as the “B” factor to state the amount of biodiesel in any fuel mix (e.g., B2 indicates 2% biodiesel and 98% fossil diesel). Biodiesel blends include: B2, B5, B10, B20, blends greater than B20, and B100 (100% biodiesel, also known as “neat” biodiesel).[114]

Canadian regulations require fuel producers and importers to have an average renewable fuel content of at least 2% based on the volume of diesel fuel and heating distillate oil that they produce or import into Canada. The regulations include provisions that govern the creation of compliance

[112] Source: https://www.nrcan.gc.ca/energy/alternative-fuels/resources/nrddi/3669
[113] Source: https://www.neste.com/what-difference-between-renewable-diesel-and-traditional-biodiesel-if-any
[114] Source: https://www3.epa.gov/region9/waste/biodiesel/questions.html

units, allow trading of these units among participants and also require record-keeping and reporting to ensure compliance[115].

Blends of 20% biodiesel and lower can be used in diesel equipment with no or only minor modifications, although certain manufacturers do not extend warranty coverage if equipment is damaged by poor quality fuel in these blends.

Biodiesel used in its pure form (B100) may require certain engine modifications to avoid maintenance and performance problems. A new system recently emerged involving the use of a heated fuel storage tank in which the engine starts on standard diesel, and then after warm-up of the fuel tank, switches over to B100. The system is said to allow the use of B100 year-round in cold, winter conditions.

Hydrogenation-Derived Renewable Diesel vs Traditional Biodiesel

Hydrogenation-derived renewable diesel (HDRD) is made from animal fats or vegetable oils – alone or blended with petroleum – refined by a process called hydro treating. HDRD and traditional biodiesel (also known as fatty acid methyl ester or FAME, as stated earlier) are often confused; however, they are distinctly different products, even though both are made from organic biomasses. The differences can be found in their production process, cleanliness, and quality.

Unlike biodiesel, HDRD is made primarily from waste and residues and impurities are removed during the hydro treating process at a high temperature[116]. The outcome is a colorless and odorless fuel of an even quality that has an identical chemical composition to fossil diesel. It is also often called an "advanced biofuel" or "second-generation biofuel."

Traditional, first-generation FAME-type biodiesel, on the other hand, is produced by esterifying vegetable oils or fats. The esterification process restricts the use of poor quality or impure raw materials, such as waste and residues. The quality of traditional biodiesel also varies in other respects based on the raw materials used.

HDRD is cleaner and has a lower carbon footprint than petroleum-based diesel, and it can also operate at colder temperatures than fossil diesel and biodiesel. Therefore, HDRD can be used in higher concentrations than biodiesel and even as a standalone product in diesel engines. However, it generally cost significantly more than traditional biodiesel; biodiesel has been on average 60% cheaper than HDRD from 2010-2017[117].

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[115] Source: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/renewable.html
[116] Source: https://www.neste.com/what-difference-between-renewable-diesel-and-traditional-biodiesel-if-any
[117] Source: https://www.naviusresearch.com/wp-content/uploads/2019/05/Biofuels-in-Canada-2019-2019-04-25-final.pdf

Biodiesel At a Glance

Table 24: Strengths and Weaknesses of Biodiesel

Strengths	Weaknesses
1. Safe and non-toxic 2. Proven, mature technology in North America and Europe 3. No conversion costs to vehicles 4. Minor costs to convert fuelling infrastructure (tanks and pumps) 5. Warranty approved by most engine manufacturers[118,119,120] 6. Increases lubricity and therefore is known to extend engine life (Note: Today's ultra-low sulfur diesel suffers from reduced lubricity and biodiesel is commonly used to counteract this issue.) 7. Can reduce GHG emissions, depending on blend used and source of biodiesel	1. Although production is abundant, there are a limited number of vendors and distributors; locating vendors/suppliers may be challenging 2. Viscosity issues related to the higher-blends (B5 or higher) in cold weather conditions that require special attention 3. Possible perception that "food" production is sacrificed for fuel production 4. Potential of higher fuel cost, depending on blend and market conditions (Note: Prior to the recent market situation for oil, B20-B50 was approximately the same price or less than fossil diesel.) 5. Marginal level of reduced energy efficiency, which varies from 1% in the case of B20 reaching 7.5% in the case of B100

Biodiesel Emissions Reduction Potential

GHG emissions reductions are dependent on the biodiesel blend used; for a given unit mass or volume, the higher the blend, the lower the GHG emissions. In terms of lifecycle emissions reductions, B20 reduces CO_2 by 15% in comparison to conventional diesel per unit mass/volume[121]. In terms of net vehicle operation emissions reductions, we must look at the same distance travelled and fuel economy (i.e., the amount of fuel required to achieve the same work). The energy content of pure biodiesel (B100) is close to 8% lower than pure diesel[122]. Considering this energy loss, using

[118] Source: www.neste.com . Neste is a producer of renewable diesel. The company describes itself as the global leader in the renewable diesel market and wants to develop significant business from non-traffic renewable product markets by the end of the decade.
[119] Source: http://biodiesel.org/using-biodiesel/oem-information
[120] Source: https://www.afdc.energy.gov/fuels/biodiesel_blends.html
[121] Source: https://www.fueleconomy.gov/feg/biodiesel.shtml
[122] Source: Department of Energy GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) Model, Jan 20, 2011.

blends ranging from B5 to B20, the latter of which may be restricted to summer due to gelling in cold weather, requires slightly more fuel than pure diesel and lowers operative GHG emissions by an estimated 10% as a whole. Using biodiesel can also reduce several other tailpipe emissions including particulates and unburned hydrocarbons[123].

Biodiesel – Ease of Implementation

There are no vehicle conversion or infrastructure costs associated with biodiesel use. Therefore, either biodiesel or HDRD could be immediately introduced without delay to begin reducing emissions for a fleet following research into the optimal blends for operational needs and cold-weather considerations.

Biodiesel Production in Canada

In 2016, Canadian biodiesel production increased due to new production capacity coming on-line. Canada's biodiesel production was estimated to reach 400 million liters in 2016 and forecast to reach 550 million liters in 2017 but is still below the level needed to meet the federal mandate. The balance will continue to be met by imports.

Primary feedstocks remain canola, animal fat, and recycled oils. Canola feedstock was expected to account for nearly 29 percent of Canadian biodiesel production by the end of 2016 and in 2017. Cooking oil was forecast to account for 49 percent of the feedstock in 2016 and 46 percent in 2017. Soybean oil was expected to increase to 20 percent by 2017.

Biodiesel Gelling

Biodiesel is essentially oil; therefore, it solidifies in cold temperatures (commonly referred to as gelling). If the fuel begins to gel, it can clog engine filters and eventually thicken enough to prevent flow from the fuel tank to the engine. The temperature at which crystals begin to form is called the cloud point. The cloud point varies considerably from one biodiesel source to another. Due to Canadian climate conditions, the flow properties of biodiesel are an important consideration. It must be noted that even petroleum diesel can gel, thus additives are often used during wintertime as a preventative. In the case of biodiesel blends, such additives can aid in reducing the cloud point during winter months.

According to the U.S. Department of Energy, the temperature at which B100 starts to gel will vary with the feedstock and can range from 0°C to 15°C. Soy is the most common source of biodiesel, and has a cloud point of 0°C.

[123] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/biodiesel/3509

Biodiesel blending aids in reducing the cloud point temperature, as conventional diesel has a considerably lower cloud point temperature. The goal for users is to ensure that the fuel's cloud point temperature is appropriate for weather conditions. The U.S. Department of Energy sought to obtain a biodiesel blend with cloud point safe for use in cold weather. They used a specially formulated cold weather conventional diesel fuel that has a cloud point of -38°C. This diesel was mixed with soy biodiesel to make a B20 blend. As a result, the cloud point of that B20 blend was -20°C. [124]

Keeping the biodiesel and diesel fuel to a lower blend (e.g., B10) will have better cold weather operability properties than a higher blend (e.g., B20 +).

Operational Considerations when Choosing Higher Biodiesel Blends

To minimize risk, a higher blend (B20 or higher, depending on the cloud point of a particular biodiesel) could be used in the warmest months of the year and B5 could be used during the rest of the year. Many Canadian and U.S. fleets using biodiesel follow this practice.

To maximize the overall impact of the biodiesel's usefulness in reducing GHGs it is recommended that the highest possible biodiesel blend be used during the summer months. For example, if diesel consumption remains relatively constant month-to-month, then using B5 during cold months (winter) and shoulder seasons (some of spring and fall) and B20 the rest of the year may be approximately equal to using an average annual blend of B10. However, for deeper emissions reduction, if B60 were used from June to August, and B5 during colder months, the yearly average equivalent would increase to B18.75.

Future Technologies to Support B100 Use

Emerging technologies are looking to address the cloud point issues via fuel heating systems. One such provider is *Optimus Technologies*[125] that offers heated fuel system solutions. This could prove to be a cost-effective way to use pure B100 biodiesel to maximize emissions reduction potential.

Given that these technologies are relatively new and results of further testing in real-world applications are limited, as well as the associated risks involved, FCC does not recommend considering this solution for widespread implementation at this time. Nevertheless, a fleet should periodically evaluate this and other technological advancements for potential application, with an openness to pilot-testing any technologies under review.

[124] Source: https://www.afdc.energy.gov/uploads/publication/biodiesel_handling_use_guide.pdf
[125] Source: https://www.optimustec.com

ASTM Standards

The American Society for Testing and Materials (ASTM) sets out standards for biodiesel, diesel, and heating oil. Four ASTM standards have relevance to consumer use of biodiesel and biodiesel blends, which are[126]:

- ASTM D6751 - Biodiesel Blend Stock Specification B100
- ASTM D975 - Diesel Fuel Specification
- ASTM D7467 - 17 Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)
- ASTM D6468 - Standard Test Method for High Temperature Stability of Middle Distillate

Most commonly, manufacturers that support B20 usage will require the biodiesel to conform to ASTM specifications. B100 must conform to ASTM D6751 prior to blending, and the finished B20 blend must conform to ASTM D7467. Any product marketed as biodiesel must meet the standard set by the ASTM D6751.

BQ9000

Customers should purchase the biodiesel blend from a BQ9000 Certified Marketer. The B100 fuel used in the blend should be sourced from a BQ9000 Accredited Producer. BQ9000 Certified Marketers and Accredited Producers can be found at www.bq-9000.org.

Biodiesel fuel should meet ASTM D6751 or ASTM D7467 standards and fuel should be used within 6 months of production.

Storage and Handling

Biodiesel fuels have shown poor oxidation stability, which can result in long-term storage problems. When biodiesel fuels are used at low ambient temperatures, filters may plug and the fuel in the tank may thicken to the point where it will not flow sufficiently for proper engine operation. Therefore, it may be prudent to store biodiesel fuel in a heated building or storage tank, as well as heat the fuel system's fuel lines, filters, and tanks.

Additives also may be needed to improve storage conditions and allow for the use of biodiesel fuel in a wider range of ambient temperatures. To demonstrate their stability under normal storage and use conditions, biodiesel fuels tested using ASTM D6468 should have a minimum of 80% reflectance after aging for 180 minutes at a temperature of 150°C. The test is intended to predict the resistance of fuel to degradation at normal engine operating temperatures and provides an indication of overall fuel stability.

[126] Source: Fleet Challenge publication – Fleet Managers Comprehensive Guide to Use and Storage of Biodiesel

Biodiesel fuel is an excellent medium for microbial growth. Since water accelerates microbial growth and is naturally more prevalent in biodiesel fuels than in petroleum-based diesel fuels, care must be taken to remove water from fuel tanks. The effectiveness of using conventional anti-microbial additives in biodiesel is unknown. The presence of microbes may cause operational problems, fuel system corrosion, premature filter plugging, and sediment build-up in fuel systems.

Health and Safety

Pure biodiesel fuels have been tested and found to be nontoxic in animal studies. Emissions from engines using biodiesel fuel have undergone health effects testing in accordance with EPA Tier II requirements for fuel and fuel additive registration.

Tier II test results indicate no biologically significant short-term effects on the animals studied other than minor effects on lung tissue at high exposure levels. Biodiesel fuels are biodegradable, which may promote their use in applications where biodegradability is desired (e.g., marine or farm applications). Biodiesel is as safe in handling and storage as petroleum-based diesel fuel.

Vehicle Warranties

Back in 2003, the Engine Manufacturers Association issued a technical statement indicating biodiesel use up to B5 should not cause engine or fuel systems problems[127]. Most North American engine manufacturers now offer full support using biodiesel blends up to a B20 with no vehicle modifications required[128].

Heavy-Duty Vehicle Warranties

Detroit Diesel, Caterpillar, Volvo and Cummins are the big four manufacturers of HD truck diesels. They all support the use of B20 in most of their modern engines. Older engines were produced with rubber, which is eroded by biodiesel, instead of Viton injections system seals. In general, most modern engines are suited for biodiesel of up to 20% and ASTM standard biodiesel is required (almost all commercially produced biodiesel is ASTM standard).

Renewable Diesel Summary

Should supply be readily available, and the price point competitive with fossil diesel, renewable diesel may have good potential for a fleet due to the following:

- Implementation is straightforward and can be done without significant change management.
- No vehicle modifications are required.

[127] http://www.truckandenginemanufacturers.org/file.asp?A=Y&F=7036%2Epdf&N=7036%2Epdf&C=documents
[128] http://biodiesel.org/news/news-display/2017/01/17/automakers-fuel-the-u.s.-market-with-more-biodiesel-capable-diesel-vehicle-models

- Minimal to no price increase for biodiesel.
- Higher biodiesel blends offer significant lifecycle and net operation GHG emissions reduction.

Ethanol Fuel

Ethanol is a renewable fuel made from various plant materials known as biomass or feedstocks. Corn and wheat are most commonly used to produce ethanol. In most North American jurisdictions, renewable fuel standards require all gasoline sold to be a 5-10% ethanol blend (E5-10). Ethanol burns cleaner and more completely than gasoline or diesel fuel; blending ethanol with gasoline increases oxygen content in the fuel, thereby reducing air pollution[129].

A higher blend of ethanol, known as E85 (85% ethanol, 15% gas), is available in some areas and can lead to significant GHG reductions. The 15% gasoline is needed to assist in engine starting because pure ethanol is difficult to ignite in cold weather[130]. This fuel must be used in dedicated "flex-fuel" vehicles (FFVs), which can run on any combination of gasoline and ethanol blends (up to 85%). However, in some jurisdictions, it may be challenging to find a local supplier of E85 as it is only available through specialized providers.

Production of Ethanol

In chemical terms, ethanol production involves the fermentation of sugars or starches contained in grains or other feedstocks. Ethanol fuel is then distilled and dehydrated to create a high-octane, water-free alcohol[131].

Several steps are involved in making ethanol available as a vehicle fuel. First, biomass feedstocks are grown, collected, and transported to an ethanol production facility. Then, ethanol is made from these feedstocks at the production facility along with by-products such as animal feed and corn oil. Next, the fuel is transported to a blender/fuel supplier. Finally, ethanol is mixed with gasoline by the blender/fuel supplier at the desired blend (up to 85%) and distributed by truck to fueling stations.[132]

Feedstock Sources and Environmental Considerations

Corn and wheat are the most common feedstocks used to produce ethanol, requiring arable land to be grown. As a result, there are environmental considerations, including:

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[129] Source: https://afdc.energy.gov/fuels/ethanol_fuel_basics.html
[130] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/ethanol/3493
[131] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/ethanol/3493
[132] Source: https://afdc.energy.gov/fuels/ethanol_fuel_basics.html

- Using food crops to produce fuel (i.e., the perception of food used as fuel)
- Using arable land to produce fuel reduces the available land to produce food, which potentially leads to increased food prices
- Use of fertilizers and pesticides to grow food-grade crops
- Upstream lifecycle emissions associated with land use, fertilizer production, crop growth, crop harvesting, crop transportation, and ethanol production

As biofuel technologies develop, the focus is turning towards feedstocks that take up less space and land, require less fertilizer and pesticide, and are more energy efficient. These include "cellulosic" feedstock or energy crops, namely tall grasses like switchgrass and miscanthus as well as fast-growing trees like hybrid poplar and willow. Energy crops are attractive because they produce energy efficiently, require only modest amounts of fertilizer and pesticides, and require less fertile soil than is needed for other crops.

Technologies are currently being developed to produce ethanol from wood and algae. It is expected that non-edible plant materials will become sources of ethanol in the future. Cellulosic materials cannot be used as food, so concerns for food production and pricing issues, as is the case with corn and wheat, would be avoided.

Emissions Reduction Potential

Emissions reductions from using ethanol as fuel instead of pure gasoline varies according to biomass used and percentage blend. Although the production and burning of ethanol produce emissions, the absorption of carbon dioxide from the growing of feedstocks can result in the net effect being a large reduction of GHG emissions compared to fossil fuels such as gasoline. The higher the ethanol blend, the greater the GHG reductions. [133]

E85 contains about 29% less energy than gasoline per unit volume[134]. Given this energy loss, about 42% more E85 is required to achieve the same amount of work as gasoline.

In terms of lifecycle GHG emissions, E10 made from corn produces 3-4% less GHG emissions compared to gasoline, and E10 made from wood or agricultural cellulosic materials produces 6-8%

[133] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/ethanol/3493
[134] Source: Department of Energy GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) Model, Jan 20, 2011.

less emissions compared to gasoline[135]. Corn-based E85 is estimated to reduce lifecycle GHG emissions by 25-50% compared to gasoline[136]. If cellulosic feedstocks are used, ethanol can have lifecycle GHG emissions reductions ranging from 88 – 108% compared to refined petroleum, meaning that potentially more carbon dioxide is captured when the feedstock crops are grown than released by a vehicle when ethanol is burned[137].

In terms of strictly tailpipe emissions, E85 has a GHG emissions reduction potential of about 30% when compared to the same volume of gasoline[138], but this value is significantly reduced when accounting for energy equivalency. However, using "net vehicle operation" emissions factors from GHGenius Version 5.01a results in an overall operative GHG emissions reduction of over 80% (i.e., the carbon that is sequestered through the biomass growth nearly completely offsets carbon output from combustion).

Ethanol Cost

Given the significant energy losses per unit volume as compared to gasoline, the cheaper cost of E85 per unit volume compared to gasoline does not always offset the higher volume required to achieve the same distance travelled, potentially making E85 more expensive than gasoline.

Flex-Fuel Vehicles

E85 cannot be used in a conventional, gasoline-only engine. Vehicles must be specially designed to run on E85. These flex-fuel vehicles can run on E85, gasoline, or any blend of the two. These vehicles feature specially designed fuel systems and other components that allow a vehicle to operate on a mixture of gasoline and ethanol, with mixtures varying from 0 percent to 85% ethanol. Also, given that ethanol is not as energy-efficient as gasoline and thus more fuel is required, the fuel tank in a flex-fuel vehicle must be larger than a conventional vehicle. These cars and trucks have the same power, acceleration, payload, and cruise speed as conventionally fueled vehicles and are priced similarly to gasoline-only vehicles.

Ethanol Supply and Storage

In some jurisdictions, it will be challenging to find a local supplier of E85 as it is only available through specialized providers. Alternatively, it could be stored and dispensed in bulk from an onsite fuel station. Ethanol tanks require a water monitoring system. In addition, a 10-micron filter, signage, and other upgrades are required to ensure the system is compliant.

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[135] Source: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/alternative-fuels/biofuels/ethanol/3493
[136] Source: https://www.tandfonline.com/doi/pdf/10.3155/1047-3289.59.8.912
[137] Source: https://afdc.energy.gov/fuels/ethanol_benefits.html
[138] Source: http://www.patagoniaalliance.org/wp-content/uploads/2014/08/How-much-carbon-dioxide-is-produced-by-burning-gasoline-and-diesel-fuel-FAQ-U.S.-Energy-Information-Administration-EIA.pdf

Ethanol Summary

E85 has an excellent emissions reduction potential for a fleet, particularly when the fleet is already E85 capable (i.e., has flex-fuel vehicles). If electric vehicles are not a viable option, new light-duty vehicles purchases should be flex-fuel capable to further enhance the GHG reduction potential for a fleet.

The implementation of E85 vehicles can be expedient if there are only minimal costs and effort required to prepare the infrastructure for E85 storage. In addition, the availability of E85 supply in a particular jurisdiction must be confirmed to proceed with this alternative fuel option. The downfall is that there are significant energy losses per unit volume as compared to gasoline, which may, depending on market conditions, make E85 more expensive because more is required to achieve the same distance travelled.

Natural Gas

Natural gas (NG), a fossil fuel composed of mostly methane, is one of the cleanest burning alternative fuels. It is also thought to be safer than traditional fuels since, in the event of a spill, NG is lighter than air and thus disperses quickly when released. NG can be used in the form of compressed natural gas (CNG) or liquefied natural gas (LNG) to fuel cars and trucks. Vehicles that use NG in either form are called natural gas vehicles (or NGVs).

NG is found in abundance in porous rock formations and above oil deposits. After NG is extracted from the ground, it is processed to remove impurities and compressed to be stored and transported by pipeline. CNG is used in traditional gasoline internal combustion engine vehicles that have been modified, or in vehicles which were manufactured for CNG use, either alone (dedicated), with a segregated gasoline system to extend range (dual-fuel), or in conjunction with another fuel such as diesel (bi-fuel). CNG is most commonly used in fleet vehicles like buses and heavy-duty trucks because it requires a larger fuel tank than gasoline and diesel fuel[139].

In Canada, business case modelling[140] demonstrated that the use of natural gas (NG) by medium and heavy-duty truck applications provides substantial economic and environmental benefits. The cost and placement of fuel storage tanks is the major barrier to wider and quicker adoption of CNG as a fuel. However, CNG offers many advantages for fleets, and although there are major upfront capital costs ($1m or far more), savings may ensue.

[139] Source: https://consumerenergyalliance.org/2019/04/energy-explorer-cng-vs-lng/#:~:text=The%20reason%20you%20see%20CNG,requires%20a%20larger%20fuel%20tank.&text=Like%20CNG%2C%20LNG%20is%20compressed,state%20into%20a%20liquid%20state
[140] Source: Natural Gas Use in the Medium and Heavy-Duty Vehicle Transportation Sectorin Roadmap 2.0 June 2019

According to the Canadian Urban Transit Association (CUTA) more Canadian cities are transitioning their public transportation fleets away from diesel-powered buses and opting for transit vehicles fueled by NG[141], a trend that is gaining momentum across North America and worldwide. This is due in part to government regulations that mandate a reduction in nitrogen oxide and greenhouse gas emissions that harm air quality, as well as a heightened sense of awareness about the health threats caused by local and toxic diesel particulate emissions.

CNG at a Glance

Table 25: Strengths and Weaknesses of CNG

Strengths	Weaknesses
1. Lower fuel cost than gasoline or diesel on an energy-equivalent basis 2. Can be used in heavy-duty truck applications 3. A CNG-powered vehicle gets approximately the same fuel economy as a conventional gasoline vehicle on a diesel-gallon-equivalent basis 4. Potentially reduces GHG emissions by more than 20% compared to a diesel vehicle[142,143] 5. Lower CACs compared to other fuels 6. Low safety risk 7. Piping directly to fuelling sites reduces upstream emissions resulting from delivery	1. Vehicle conversion costs are significant but payback is typically in 3-10 years depending on the application and usage 2. An in-house CNG fuelling system carries *significant* capital costs 3. Additional electricity costs for CNG refuellers 4. Potentially increased fueling time: if slow refuellers are employed, fuelling will take overnight; with fast refuellers, fuelling will take approximately the same time as traditional gas/diesel vehicles 5. Scarcity of refuelling centres in Canada

Safety

According to the U.S. Department of Energy's Alternative Fuels Data Center, NGVs are safer than vehicles powered by gasoline or diesel and the industry is highly regulated to address any additional safety concerns. There are an estimated 11 million NGVs[144] in use in over 30 countries globally. Codes, standards and regulations ensure that CNG vehicles are safe and that CNG refueling stations have been installed according to industry standards.

[141] Source: https://cutaactu.ca/en/news-media/natural-gas-buses-cost-operational-and-environmental-alternative
[142] Source: https://brc.it/en/categorie_faq/cng/
[143] Source: https://envoyenergy.ca/cng-benefits/#:~:text=Commercial%20fleets%20all%20over%20the,solution%20for%20fuelling%20their%20fleets
[144] Source: Closing the Loop. Canadian Biogas Association. 2015.

Compressed natural gas (CNG) has several inherent properties that make it safer than diesel or gasoline, including the following:

- It has a higher ignition temperature than gasoline (about 1022°F, compared to about 482°F for gasoline).
- Natural gas burns only if the concentration in air is within specific limits, which is between 5 and 15 percent; this property along with a high ignition temperature make combustion of CNG very unlikely.
- It is lighter than air, thus in the unlikely event of a leak it dissipates quickly into the atmosphere.

In addition, the CNG industry is highly regulated and there are a series of safety measures in place, including the following:

- Natural gas is odourless; however, for safety reasons it is odorized to enable easy leak detection. According to a safety article in the *Natural Gas Vehicle Knowledge Base*, the average person can detect odorized natural gas at concentrations as low as 0.3 percent.
- Fuel cylinders are significantly stronger than diesel tanks and fuel tanks are up to a half-inch thick and are made of steel, or a composite designed to be stronger than steel.
- Cylinders and tanks are fitted with valves to handle high pressure, prevent leakage and eliminate risks of explosion.

In the U.S., the Federal Transit Administration followed 8,331 natural gas utility, school, municipal, and business fleet NGVs that traveled 178.3 million miles on CNG. They found that the NGV fleet vehicle injury rate was 37% lower than the gasoline fleet vehicle rate. Furthermore, the examined fleet was involved in seven fire incidents, only one of which was directly attributable to failure of the natural gas fuel system. Finally, there were no fatalities compared with 1.28 deaths per 100 million miles for gasoline fleet vehicles.

Emissions Reduction Potential

Based on the same work performed, a CNG vehicle has tailpipe GHG emissions about 20-30% less than a comparable diesel vehicle[145,146]. NGVs also emit up to 95% less nitrogen oxides (NO_x)

[145] Source: https://brc.it/en/categorie_faq/cng /
[146] Source: https://envoyenergy.ca/cng-benefits/#:~:text=Commercial%20fleets%20all%20over%20the,solution%20for%20fuelling%20their%20fleets

compared to diesel and gasoline vehicles[147]. Furthermore, CNG vehicles do not emit particulate matter (PM10), a main cause of air pollution[148].

Feasibility Considerations

The business case for natural gas is, in most cases, made on the differential in price between diesel fuel and natural gas – the higher initial investment costs for NGVs are typically offset by the fuel savings by using CNG over diesel. New NGVs for fleets may cost up to $50,000 more than conventional diesel fleet vehicles (based on truck Classes 7, 8 and 9)[149,150]. New CNG buses can cost $120,000 more than conventional diesel buses[151,152], likely making the payback period longer than for trucks, depending on kilometres driven.

CNG conversions are available for all classes, with costs ranging from less than $10,000 to over $45,000 CAD. CNG powered trucks could be re-fueled with overnight slow-fill systems which cost much less than fast-fill systems. Trucks being considered for conversion to CNG must have ample available frame space for CNG tanks and often this is not possible due to the types of add-on equipment and bodies mounted on the trucks. In the event of a power interruption, such as during a severe weather event or some other cause, overnight slow re-fuellers would cease to function and CNG powered vehicles would be sidelined, which could negatively affect an organization's emergency preparedness plans.

An operational concern is that in certain situations, such as an electrical power interruption, CNG compressor or other fuel system failure, etc., dedicated CNG vehicles (i.e., vehicles powered solely by CNG) would be sidelined, and this is a significant risk that must be managed.

Infrastructure Costs

CNG filling station infrastructure costs could run well more than $1 million, depending on capacities and complexities, and this is a conservative estimate. A CNG station would consist of the following elements:

- Compressor
- Storage
- Dispenser
- Slow and fast fill positions
- Engineering and permitting

[147] Source: Northwest Gas Association – Natural Gas Facts
[148] Source: https://brc.it/en/categorie_faq/cng/
[149] Source: Closing the Loop. Canadian Biogas Association. 2015.
[150] Source: Consultations with Change Energy
[151] This value represents the additional cost, in CAD, of a CNG transit bus over a traditional diesel bus.
[152] Source: Electric Buses in Cities: Driving Towards Cleaner Air and Lower CO_2. Bloomberg Finance L.P. 2018.

- Site prep and gas service

Types of Filling Infrastructure

There are three main types of CNG fuelling stations:

(1) Slow fill refuellers: use a compressor only; fuelling typically takes place overnight
(2) Fast-fill refuellers: storage capacity is required; fuelling time is 8 minutes per vehicle
(3) Hybrid refuellers: have both slow and fast-fill-up

Thinking Ahead

Despite the increased capital costs for NGVs and their fuelling systems, many fleets have embraced the technology and apparently achieved success from their investments. We emphasize that NG is a fossil fuel – albeit a clean burning one – and it is important to keep in mind the global shift away from internal combustion engines and non-renewable fossil fuels. Some jurisdictions have already legislated the end of the internal combustion engine.

Zero-emission battery-electric vehicle (BEV) options are available "here and now" in the case of light-duty vehicles, transit buses, and refuse trucks. Fully electric trucks are expected to come to market soon. Experts agrees that the world is transitioning to BEVs, and with this reality, the use of NG as a vehicle fuel may be considered as an interim solution for organizations wishing to achieve immediate carbon reductions in the short-term while awaiting the availability of BEVs. Unless subsidies were available to offset the cost, a major investment in an NG fuelling system would need to be a long-term capital investment for it to be cost-effective. Few would disagree that a large capital investment with a protracted payback period would not be a prudent decision for what may be an interim, short-term solution with a marginal business case.

Natural Gas Summary

Should the goal be for a NG fuelling system to be a long-term capital investment, NG may have good potential for a fleet due to the following:

- A CNG vehicle saves fuel costs and has significantly reduced tailpipe CO_2 emissions compared to a diesel vehicle.

- NGVs nearly eliminate the emissions of nitrogen oxides (NO_x), and do not emit particulate matter (PM10).

- NG is considered safer than traditional fuels since, in the event of a spill, NG is lighter than air and thus disperses quickly when released.

Renewable Natural Gas

An alternative to fossil sources is renewable natural gas (RNG), which is a methane biogas – a gaseous product of the decomposition of organic matter obtained through biochemical process such as anaerobic digestion. It is recovered from landfills, wastewater treatment plants, anaerobic digesters at dairies, food processing plants, or waste processing facilities that are cleaned to meet natural gas pipeline standards.[153]

RNG, or biomethane, is a fully renewable energy source that is fully interchangeable with conventional natural gas. Like conventional natural gas, RNG can be used as a transportation fuel in the form of compressed natural gas (CNG) or liquefied natural gas (LNG).

RNG production has become an important priority thanks to its environmental benefits. RNG production is usually based on capturing and purifying the gas from collected organic waste — anything from crop residues and animal manures to municipal organic wastes and food processing by-products.

RNG at a Glance

Table 26: Strengths and Weaknesses of RNG

Strengths	Weaknesses
1. Interchangeable with fossil natural gas 2. Can be used to power natural gas vehicles without conversion 3. Very low GHG emissions 4. RNG can be produced year-round without intermittency	1. Costs for an anaerobic digester are considerable and depend on the required size and capacity

Production

In general, the feedstocks for RNG systems can be grouped into five broad categories, based on the primary source of the organic material:

- Agricultural organics
- Residential source separated organics (SSO)
- Commercial SSOs
- Landfill gas
- Wastewater treatment residuals

153 Source: https://www.mjbradley.com/sites/default/files/MJB%26A_RNG_Final.pdf

Anaerobic digestion is a process during which the waste (from landfills or wastewater treatment plants) is converted into methane and carbon dioxide in a digester or holding tank. The gas produced is then cleaned or purified to meet utility pipeline specifications. The digesters can be located at wastewater treatment plants, landfills, or at green bin waste facilities.

Emissions Reduction Potential

When RNG is used to fuel fleet vehicles, GHG emissions reductions are significant; different sources estimate the lifecycle reduction to be between 75% and 90% compared to diesel. The carbon dioxide that is generated during the production and combustion of RNG is used in the regeneration of new biomass, representing a closed-loop cycle for carbon dioxide that is released[154].

Feasibility Considerations

Without the commercial availability of RNG in a fleet's jurisdiction, a fleet would need to invest in an anaerobic digester to make their own RNG. This would add to the already large cost of $1m or much more to build a CNG fuelling station. Also, unlike CNG which would likely offer fuel cost savings, compressed RNG is approximately equal in price to diesel and gasoline in terms of diesel litre equivalent (DLE)[155]. Therefore, in many situations the use of RNG is not a financially viable option. However, with GHG reduction potential of up to 90% compared to diesel, a fleet manager may still want to consider RNG as an option.

RNG Summary

The use of RNG is a natural progression from the use of fossil-based CNG. While use of natural gas as fuel requires large infrastructure investments, RNG has a very high emissions reduction potential.

RNG is thus an important fuel to consider for use in medium and heavy-duty vehicles. Nevertheless, the technology of producing RNG is still under development and it is expected to become more widespread in the near future.

Liquified Petroleum Gas

Propane, otherwise known as liquefied petroleum gas (LPG), is produced as part of natural gas processing and crude oil refining. In natural gas processing, the heavier hydrocarbons that naturally accompany natural gas, such as LPG, butane, ethane, and pentane, are removed before the natural gas enters the pipeline distribution system. In crude oil refining, LPG is the first product that results in the refining process.

[154] Source: Closing the Loop. Canadian Biogas Association. 2015.
[155] Source: Closing the Loop. Canadian Biogas Association. 2015.

Propane is a gas that can be turned into a liquid at a moderate pressure (160 pounds per square inch). It is stored in pressure tanks at about 200 psi and 100 degrees Fahrenheit. When propane is drawn from a tank, it changes to a gas before it is burned in an engine.

Application

Propane has been used as a transportation fuel since 1912 and is the third most commonly used fuel in the United States, behind gasoline and diesel. More than four million vehicles fuelled by propane are in use around the world in light-, medium- and heavy-duty applications. Propane holds approximately 73%[156] of the energy of gasoline and so requires more storage volume to drive a range equivalent to gasoline, but it is usually price-competitive on a cents-per-km-driven basis.

Propane vehicle conversions and fueling systems generally cost much less than natural gas systems.

Emissions Reduction Potential

In terms of tailpipe emissions, propane has a GHG emissions reduction potential of about 33% when compared to the same volume of gasoline based on GHGenius version 5.01a. However, as mentioned, propane contains about 27% less energy than gasoline per unit volume. Given this energy loss, about 37% more fuel is required to achieve the same amount of work as gasoline. Therefore, the emissions reduction for the same work performed is actually around 9.5% when compared to the energy equivalent of gasoline (i.e., for the same distance travelled the emissions for a vehicle running on propane are about 90.5% of those of a gasoline vehicle, which is 67% multiplied by 1.37 accounting for the additional volume required to achieve the same work).

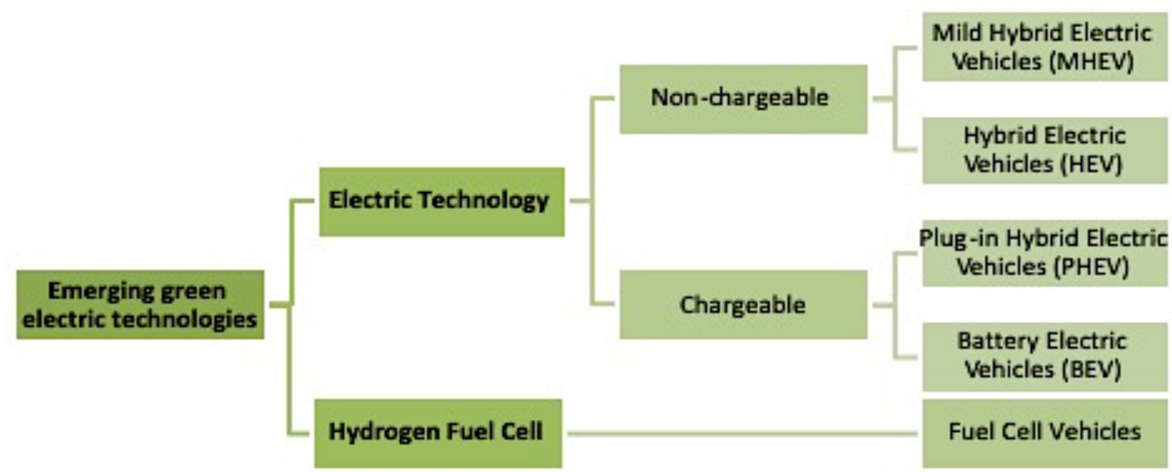
Electric Vehicle Technologies

Over the past decade, electric transportation technologies including hybrid-electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery-electric vehicles (BEVs), have been rapidly developing and quickly gaining popularity in the market. Electric vehicle (EV) technologies offer significantly reduced or no tailpipe emissions and vastly improved energy efficiency.

Please see *Figure 11* (below), which outlines EV technologies. Note that while hydrogen fuel-cell vehicles (FCEVs) are included under the umbrella term of emerging electric technologies, this technology is unlikely to become cost-competitive soon – if ever for most vehicle applications. Moreover, most of the hydrogen fuel produced today comes from fossil-fuel sources, thereby deeming the technology highly ineffective at reducing overall lifecycle greenhouse gas (GHG) emissions. More information on FCEVs can be found later in *Appendix F*.

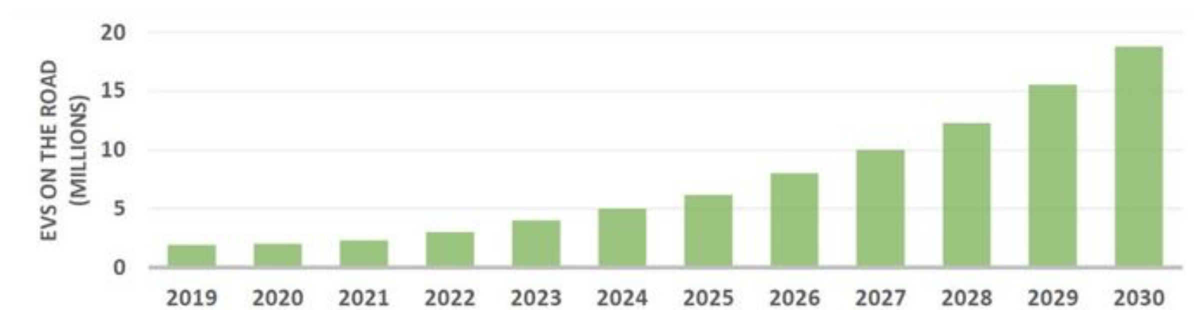
[156] Source: Department of Energy GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) Model, Jan 20, 2011.

Figure 11: Electric Vehicle Technologies



Today, EVs have reached their tipping point and sales are booming while the public vehicle charging infrastructure rapidly grows. Demand for EVs accelerated during the 2010s and is expected to continue accelerating during the 2020s, as shown in *Figure 12* for the United States.

Figure 12: Forecasted EV Growth in US (Source: Edison Electric Institute)



For fleet managers looking to reduce their annual fuel budget and corporate emissions, battery-electric, hybrids, and plug-in hybrids are a good option. Savvy fleet managers will seek applications where the type of vehicle used will deliver sufficient fuel cost savings to offset their additional cost of capital and, after the vehicles are fully depreciated (usually ~5 years), deliver net cost savings until the end of their economic lifecycle (often ~10 years).

There are a number of light-duty electric vehicle technologies currently available in the market. They include:

- **Mild Hybrid Electric Vehicles (MHEVs)**, which are equipped with internal combustion engines (ICEs) and a motor-generator in a parallel combination allowing the engine to be turned off whenever the vehicle is coasting, braking, or stopped and which restart quickly. MHEVs use a smaller battery than full hybrid electric vehicles (HEVs, see below) and do not have an exclusively electric mode of propulsion; rather, the motor-generator has the ability to both create electricity and boost the gas engine's output, resulting in better performance and reduced fuel use. Examples of MHEVs are the Honda Insight and the 2019 Ram 1500. [157]

- **Hybrid Electric Vehicles (HEVs)**, which use two or more distinct types of power, such as an ICE and a battery-powered electric motor as the modes of propulsion, albeit with very limited range when in electric mode. When an HEV accelerates using the ICE, a built-in generator creates power which is stored in the battery and used to run the electric motor at other times. This reduces the overall workload of the ICE, significantly reducing fuel consumption and extending range. Examples of HEVs include the Toyota Prius and Ford Fusion Hybrid. [158]

- **Plug-In Hybrid Electric Vehicles (PHEVs)**, which use rechargeable batteries, or another energy storage device, that can be recharged by plugging into an external source of electric power. PHEVs can travel considerable distances in electric-only mode, typically more than 25 km and up to 80 km for some models, due to their much higher battery capacity than hybrids. When the battery power is low (usually ~80% depleted), the gasoline ICE turns on and the vehicle functions as a conventional hybrid. Such vehicles typically have the same range as their gasoline counterparts. Examples of PHEVs include the Chevrolet Volt and Toyota Prius Prime.[159]

- **Battery-Electric Vehicles (BEVs)**, or all-electric vehicles, which are propelled by one or more electric motors using electrical energy stored in rechargeable batteries. BEVs are quieter than ICE vehicles and have no tailpipe emissions. In recent years, BEV range has been considerably extended, thereby providing much wider BEV applications and reducing range anxiety. Today, many BEV models have EPA-estimated ranges exceeding 400 km, which provide much greater reliability when travelling longer distances. Recharging a BEV can take significantly longer than refuelling a conventional vehicle, with the difference depending on the charging speed. For a light-duty vehicle, a full battery charge using a Level 2 charger takes several hours, but charging from a nearly depleted battery to 70% at a fast (Level 3) charge station can take only 30 minutes[160]. Examples of light-duty BEVs include the Nissan Leaf, Chevrolet Bolt, Kia Soul, and Tesla Model 3.

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[157] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/
[158] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/
[159] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/
[160] Source: https://www.autotrader.ca/newsfeatures/20180410/types-of-electric-vehicles-explained/

While commercial battery-electric (BEV) pickups, trucks and vans are still limited/ have not yet arrived in the market, options are expected to become more plentiful in the next few years. Medium and heavy-duty battery-electric trucks are quickly being developed by many manufacturers. Demand for those offered by Tesla, Volvo, Freightliner, and others exceeds current supply and will soon be available for fleet purchase. Battery-electric buses and refuse trucks are currently available for purchase.

Plug-in hybrid electric vehicles would also be an excellent solution for low-mileage, return-to-base fleets, or for high-mileage units whose BEV range is currently insufficient to fulfill daily needs. PHEVs have a much larger all-electric range as compared to conventional first-generation hybrid vehicles, and they eliminate any range anxiety that may be associated with all-electric vehicles because the combustion engine works as a backup when the batteries have become depleted. For fleet vehicles that return to base each night, PHEVs (as well as BEVs) are ideal for overnight, Level 2 charging. It is entirely conceivable that low-mileage PHEVs could be driven every day almost entirely on electric power, functioning like fully electric vehicles.

Battery-Electric Vehicles

There is no question that BEVs are taking over traditional internal combustion engine (ICE) vehicles in a big way. Some jurisdictions have already legislated the end of ICEs. If they haven't done so already, fleet managers should start making plans for BEVs now.
While their upfront costs will be higher, BEVs have increasingly proven to be a viable solution to rising fuel costs and emissions. Since BEVs have few moving parts, tune-ups or oil changes are never required, and they seldom, if ever, require brake relining due to regenerative braking. And, best of all, they burn zero fuel.

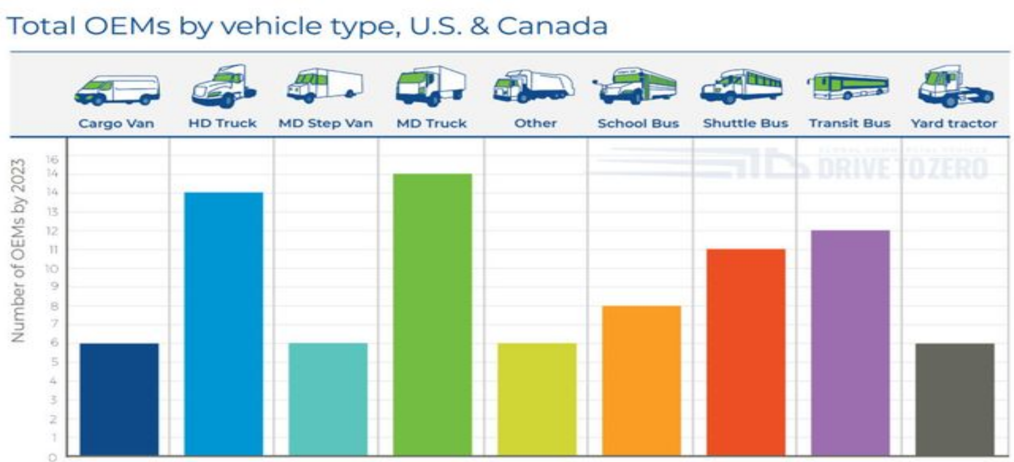
Since the release of the first mass-produced BEV, the Nissan Leaf, which debuted in 2010 with an EPA range estimated at only 73 mi or 117 km[161], there has been a surge in lithium-ion battery production leading to a drastic decline in prices. Today, several more affordable BEV models have ranges exceeding 400 km, which provide much greater reliability when travelling longer distances. For example, the 2020 Tesla Model 3 Standard Plus has an EPA-estimated range of 402 km[162], while the 2020 Chevrolet Bolt has an EPA-estimated range of 417 km[163].

There has also been significant expansion in charging infrastructure through publicly available charging stations. As of early 2020, there were nearly 5,000 charging outlets across Canada, and Natural Resources Canada is investing $130 million from 2019-2024 to further expand the country's charging network, making range anxiety even less of a barrier to BEV ownership.

[161] Source: https://www.mrmoneymustache.com/the-nissan-leaf-experiment/
[162] Source: https://www.tesla.com/en_ca/model3
[163] Source: https://www.chevrolet.com/electric/bolt-ev

In addition to battery-electric pickups that are soon to emerge, battery-electric buses and emerging battery-electric medium- and heavy-duty trucks such as those planned by Tesla, Volvo, Freightliner, and other manufacturers are attracting considerable interest because of the elimination of tailpipe GHG and CAC emissions, in addition to the potential for significant maintenance and fuel cost savings. In *Figure 13* (below), we see that the OEMs are quickly ramping up with other types of commercial EV trucks (medium- and heavy-duty truck categories) that are suited for municipal work environments and utilities.

Figure 13: Total EV OEMs by 2023 (Source: Calstart)



Fleet managers who operate battery-electric trucks and buses can see massive savings in maintenance and fuel costs. BEVs have considerably fewer parts than internal combustion engine (ICE) vehicles. A drivetrain in an ICE vehicle contains more than 2,000 moving parts, compared to about 20 parts in an BEV drivetrain. This 99% reduction in moving parts creates far fewer points of failure, which limits and, in some cases, eliminates traditional vehicle repairs and maintenance requirements, creating immense savings for fleet managers. BEVs do not require oil changes or tune-ups, have no diesel exhaust fluid (DEF), and their brake lining life is greatly extended over standard vehicles due to regenerative braking. Though each fleet's electrification journey will be different, the transition to electric power can offer significant cost reductions over the long term.

A new study[164] quantified what commercial EV-makers have been saying for years: electric trucks and buses are a triple win. They save money for fleet operators, and reduce both local air pollution and GHG emissions. The study, which was commissioned by the National Resources Defense Council (NRDC) and the California Electric Transportation Coalition, and conducted by the

164 Source: Posted January 2, 2020 by Charles Morris (https://chargedevs.com/author/charles-morris/) & filed under Newswire (https://chargedevs.com/category/newswire/) , The Vehicles (https://chargedevs.com/category/newswire/the-vehicles/)

international research firm ICF, looked at the value proposition for fleet operators of battery-electric trucks and buses (BETs).

Today, BETs have an upfront price premium compared to legacy diesel trucks and buses. However, the costs of battery packs and other components are rapidly falling, and the study found that, by 2030 or earlier, electric vehicles will offer a lower total cost of ownership (TCO) for nearly all truck and bus classes, even without incentives.

In *Table 27* (below), we provide a summary of the strengths and weaknesses of BEVs.

Table 27: Strengths and Weaknesses of BEVs

Strengths	Weaknesses
- Well-designed, no noise, few moving parts, long warranties - Little/no maintenance - Government grants and incentives may be available - Effectively eliminates need for idling-reduction initiatives - Very positive driver feedback - Very positive public opinions - Potential for significant lifecycle GHG emissions, depending on electricity source	- High capital cost particularly for battery-electric trucks/buses - Limited availability of new battery-electric trucks - Potentially significant capital costs required for charging infrastructure, particularly if 480V (DCFC) charging equipment is installed - Existing electrical capacity at facilities may require significant upgrades for charging multiple vehicles - Potential driver range anxiety that may require a change management approach - Although unlikely, potential for costly battery replacements in aged BEVs

Air Quality and Upstream Emissions

Air quality is a growing concern in many urban environments and has direct health impacts for residents. Tailpipe emissions from internal combustion engines are one of the major sources of harmful pollutants, such as nitrogen oxides and particulates. Diesel engines in particular have very high nitrogen oxide emissions and yet these make up the majority of the global bus fleet. As the world's urban population continues to grow, identifying sustainable, cost-effective transport options is becoming more critical.

Battery-electric vehicles (BEVs) require electricity to recharge the batteries; therefore, electricity is effectively a "fuel" in these types of vehicles. Battery-electric vehicles (BEVs) may be defined as zero emissions vehicles (ZEVs) since the California Air Resources Board (CARB) defines a ZEV as a vehicle that emits no exhaust gas from the onboard source of power[165]. However, CARB's definition

[165] Source: California Air Resources Board (2009-03-09). "Glossary of Air Pollution Terms: ZEV"

accounts for pollutants emitted at the point of the vehicle operation and the clean air benefits are usually local. Depending on the source of the electricity used to recharge the batteries, air pollutant emissions are shifted to the location of the electricity generation plants. For example, if electricity used for charging vehicles comes primarily from “dirty” sources such as coal, lifecycle vehicle emissions will result.

From a broader perspective, to minimize lifecycle GHG emissions, the electricity used to recharge the batteries must be generated from renewable or clean sources such as wind, solar, hydroelectric, or nuclear power. In other words, if BEVs are recharged from electricity generated by fossil fuel plants, they cannot truly be considered as zero emission vehicles (ZEVs). Upstream emissions should be considered when evaluating the effectiveness of BEVs in reducing emissions. Generally, when considering upstream emissions from electricity supply, BEVs still emit > 50% less GHG emissions than their gasoline or diesel counterparts[166], and in some cases emit over 80% less in a grid composed of mostly renewable electricity[167]. This level of emissions reduction is what cities need in order to collectively achieve the “deep decarbonization” necessary to mitigate the most serious impacts of climate change.

Charging Technologies

The time it takes to charge a BEV is dependent on a multitude of factors, including:

- The type (level) of charger used (i.e., Level 1, 2, or 3);
- The vehicle’s technology (i.e., the maximum amount of current allowed by the vehicle, in amps);
- Battery capacity (generally increases with vehicle size);
- Driving range (dependent on battery capacity and vehicle size)
- Starting charge level (charging rate slowly diminishes as battery levels approach 100%)

The charging rate is expressed in kilometers/miles of range per hour of charging. It is estimated by dividing driving range by the time for a full charge (i.e., 0 to 100%) and is dependent on the battery capacity of a vehicle, varying significantly with different vehicle types and battery sizes (see *Table 9*, below). The time for a full charge is estimated by dividing battery capacity, in kWh, by charging power (calculated from current and voltage) and adding a 10% inefficiency[168 169].

Characteristics of the varying levels of chargers ranging from Level 1-3 are shown for vehicles of different classes in *Table 28*[170] (below):

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166 Source: https://www.eei.org/issuesandpolicy/electrictransportation/Pages/default.aspx
167 Source: https://blog.ucsusa.org/rachael-nealer/gasoline-vs-electric-global-warming-emissions-953
168 Source: https://www.caranddriver.com/shopping-advice/a32600212/ev-charging-time/
169 Source: https://www.inchcalculator.com/widgets/?calculator=electric_car_charging_time
170 Source: https://calevip.org/electric-vehicle-charging-101

Table 28: Characteristics of BEV charging levels for different vehicle classes

BEV Charging Levels	Outlet Voltage	Amperage	Added Range Per Hour		
			LD	MD	HD
Level I	120V	12-16 amps	5-10 km	< 5 km	< 2 km
Level II	240V	16-40 amps	22-56 km	10-25 km	5-12 km
Level III	480+V	100+ amps	>200 km	> 70 km	> 35 km

Level 1 chargers can be plugged right into a standard outlet. They are the most economical option for private owners; however, at such a low charging rate it is usually not practical to use Level 1 chargers exclusively. For example, it would take about 40 hours to fully charge a light-duty BEV with a range of 400 km starting at 20% battery (80 km range remaining).

Level 2 chargers are common in private households as well as public spaces such as mall parking lots. They incur an installation cost but are similar to common 240V installations such as the outlets that power clothes dryers. For a light-duty BEV with a range of 400 km and at 20% battery (80 km range remaining), it would take about eight hours to fully charge. Level 2 charging is usually done overnight during the off-peak period. Installing Level 2, 240V chargers, including the wiring infrastructure involved, typically range in cost from around $1,500-10,000, depending on electrical system requirements. The vast majority of the time, BEV owners only need a Level 2 charger; the exception is when travelling longer distances and/or not returning-to-base at the end of the work day. Another possible exception is for heavy-duty vehicles that take longer to charge due to their battery size. For these applications, much faster charging rates are required through Level 3 charging.

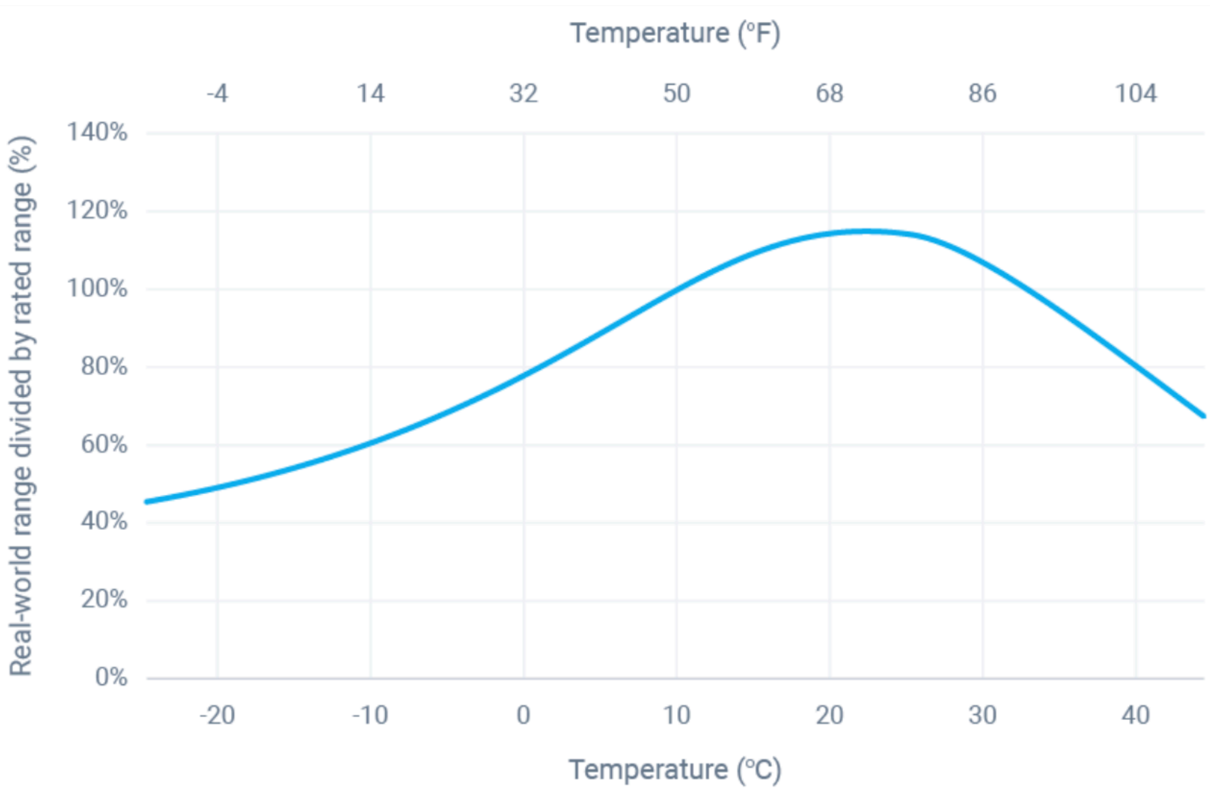
Level 3, or direct current fast chargers (DCFCs), requiring inputs of 480+ volts and 100+ amps (50+ kW)[171], are specialized systems designed to quickly charge vehicles and provide flexibility to owners travelling longer distances or in need of a partial quick charge. For a light-duty BEV with a range of 400 km and at 20% battery (80 km range remaining), it would typically take less than one hour to fully charge. Installations of DCFCs require a commercial electrician due to the electrical load and wiring requirements[172]. The costs for installing a Level 3 DCFC vary greatly. Costs for a fast-charging station are dependent on the electrical supply available at the chosen charging site, site preparation costs including trenching, cable runs, and many other installation considerations. Equipment and installation costs for DC fast charging stations can range from $50,000 to $200,000[173].

[171] Source: https://calevip.org/electric-vehicle-charging-101
[172] Source: https://calevip.org/electric-vehicle-charging-101
[173] Source: https://www.toronto.ca/wp-content/uploads/2020/02/8c46-City-of-Toronto-Electric-Vehicle-Strategy.pdf

Impact of Temperature on Battery Performance

Canadians enjoy the ebbs and flows of seasonality and extreme temperatures. BEV range is adversely affected by cold and hot temperatures because of auxiliary heating and cooling – that is, heating/cooling the vehicle cabin, and heating/cooling the battery itself to maintain optimal performance. Batteries are susceptible to temperature fluctuations which hinder, but in some cases helps, range. For example, on a typical winter day in central Canada with a temperature at -15°C, range can drop by over 50% of the EPA estimated range, meaning that a BEV with a range of 400 km will only be able to drive 200 km (*Figure 14*, below). Conversely, at temperatures in the low-twenties, range can significantly exceed the EPA-estimated range given that other conditions are optimal (e.g., starting temperature, terrain, and driver habits). With some preparation and knowledge, owners, and operators of BEVs can mitigate the effects of temperature on performance by pre-conditioning their vehicle (i.e., warming up or cooling down before use) as well as keeping their vehicle plugged in when temperatures are extreme; this allows the system to maintain battery temperature controls and prolongs battery life.[174]

Figure 14: The Effects of Temperature on BEV Range



[174] Source: https://www.geotab.com/blog/ev-range/

Training Options and Recommendations

While there is a paucity of BEV technician training in Canada, due to the rapid onset of electric mobility we suspect that reality will soon change. A pilot for a new EV Maintenance Training Program for automotive technicians was successfully completed at BCIT and is available to the public[175].

There is an Electric Vehicle Technology Certificate Program offered by SkillCommons, managed by the California State University and its MERLOT program, which offers free and open learning materials electric vehicle development, maintenance, alternative/renewable energy, and energy storage[176]. There is also a Hybrid and Electric Vehicles course offered at Centennial College in Toronto, which appears to focus more on hybrid systems than fully electric vehicles[177].

Before BEVs are deployed in a fleet to any great extent, we recommend high-voltage training for technicians. Published high-voltage guidelines specific to vehicle technicians servicing BEVs are not readily available through traditional sources. However, we suggest that anyone working with high voltage in any format, including BEVs, should be provided guidance on applying Occupational Health & Safety Management System fundamentals. This includes a "plan, do, check, and act" philosophy while working with energized electrical equipment[178]. Such training is available for non-electrical workers from Lineman's Testing Laboratories (LTL) of Weston, Ontario. LTL offers an awareness-level course for non-electrical workers which is claimed by the company to provide a basic-level understanding of workplace electrical safety.

Aside from awareness training, fleet technicians should also have access to, and be trained on the use of, electrical-specific personal protective equipment (PPE). Such PPE would include tested and certified non-conductive gloves as well as non-conductive tools and equipment as a last line of defence, ensuring all such gear is appropriately used and maintained. Protective gloves and other PPE, as well as non-conductive tools, must be re-tested periodically to ensure safety.

BEV Summary

For light-duty vehicles and buses, and soon for medium- to heavy-duty trucks, BEVs have excellent potential for a fleet due to the following:

- Significant lifecycle GHG emissions reductions

[175] Source: https://commons.bcit.ca/news/2019/12/ev-maintenance-training/
[176] Source: http://support.skillscommons.org/showcases/open-courseware/energy/e-vehicle-tech-cert/
[177] Source: https://db2.centennialcollege.ca/ce/coursedetail.php?CourseCode=CESD-945
[178] Source: https://training-ltl.ca/

- Significant reduction in operational costs due to elimination of fuel consumption, low costs for electricity, and minimal maintenance costs

- Relatively low charging infrastructure costs in comparison to infrastructure costs for other fuel-reduction / emission-reducing technologies such as compressed natural gas (CNG)

In planning for BEV phase-in, it would be prudent to consider installing at least one Level 3, direct current fast charger (DCFC) for high-mileage units and/or units that do not return-to-base on a regular basis. Moreover, such a fast charger would enable fleet management staff to relatively quickly charge their vehicles in situations where plugging in for overnight charging may not been possible or for emergency situations. For heavy-duty BEVs, it is important to consider that, depending on available amperage, a full charge may take several hours even with DCFCs.

Evaluation of the fleet to identify vehicles that have a potential for a replacement with a BEV should be completed. Furthermore, change management is recommended to be part of the transition process to help drivers accept and adapt to BEVs and overcome any lingering range anxiety.

Hydrogen Fuel-Cell Electric Vehicles

Hydrogen fuel cells can produce electricity for motive power with zero tailpipe emissions and, therefore, in theory they can offer enormous environmental and sustainable energy benefits. Fuel cells are flexible in size, power density, and application. There are differing opinions as to whether the next phase zero-emission vehicle (ZEV) batteries will be recharged with onboard hydrogen fuel cells.

Although fuel-cell technology has been around since 1960 (GM introduced the first fuel-cell vehicle, the Electrovan, in 1966), adaptation of the technology has been slow. Only in recent years, supported by the focus on zero-emissions technologies, has the hydrogen fuel cell regained momentum. Leading (light-duty) vehicle manufacturers including Honda, Toyota and Hyundai have launched their first mass-production hydrogen-powered vehicles.

Sources of Hydrogen and Emissions

Hydrogen is the most abundant element in the universe. It can be produced from several sources including:

- Fossil sources include natural gas, coal, and oil; and

- Renewable energy sources such as wind, solar, geothermal, and hydroelectric power.

Hydrogen also has a potential to be made locally at large central plants or in small, distributed units at or near the point of use.

Although hydrogen vehicles have no tailpipe emissions, currently most hydrogen is produced from fossil sources. As a result, presently there are no emissions benefits to switching to a hydrogen-powered vehicle – the lifetime emissions may be the same, or even higher, than those of conventional fuels.

At the same time, this technology has a high potential to be very clean through use of renewable sources, which would effectively eliminate all fuel-related emissions. Alas, due to low demand this technology is still too expensive to be commercially viable.

Currently, much work is taking place around the world toward "green" hydrogen from renewable sources. The hydrogen fuel-cell trucks shown in *Illustration 6* (below) will be refueled with green hydrogen made from hydropower in Switzerland, as opposed to "grey" hydrogen made from methane with very high CO_2 emissions, which is the case in most countries.

Illustration 6: Hydrogen Fuel-Cell Trucks Bound for Switzerland

Fuel-Cell Technology for Transportation

Hydrogen fuel-cell electric vehicles (FCEVs) are like electric vehicles in that they use an electric motor to power the drive wheels and have no smog-related or greenhouse gas tailpipe emissions. Rather than being plugged in to charge a battery, these vehicles use onboard fuel cells to generate electricity.

In a fuel cell, hydrogen from the fuel tank (filled similarly to gasoline/diesel) is combined with oxygen from the air to electrochemically generate electricity. Water is also produced in this process[179]. The

[179] Source: https://www.epa.gov/greenvehicles/hydrogen-fuel-cell-vehicles

electricity generated is used to power the vehicle. A fuel cell is two to three times more energy efficient than traditional gasoline or diesel engines.

In the zero-emissions transportation area, fuel cells have particular benefits over purely battery-electric vehicle (BEV) technology, namely they can easily meet the extended range requirements and offer rapid refuelling to satisfy driver and consumer interests. However, the effectiveness of BEVs in converting chemical to kinetic energy (also known as the fuel-to-wheel efficiency factor) is still superior to FCEVs. Moreover, the cost of electricity is much cheaper than the cost of hydrogen fuel.

Technological Advancement

One of the main issues with the development of hydrogen transportation has been the shortage of hydrogen fuelling stations. Manufacturers are not willing to produce vehicles that customers cannot fuel, while developers are reluctant to build hydrogen stations (costing up to $2,000,000 and more) due to lack of demand.

A critical mass must be reached for most transportation technologies to develop and expand, typically done through governmental leadership and financial support, as with the evolution of battery-electric vehicles.

California has made significant investments to develop the fuelling station network to support hydrogen-fuelled vehicles. As of Spring 2017, there were thirty-six hydrogen fuelling stations in the U.S.; all but three were in California. There are currently about 2,000 hydrogen vehicles on California roads.

There are several medium and heavy-duty hydrogen vehicles being developed[180]:

- **California-based US Hybrid Inc.**, a company that has been building fuel cell engines for transit buses, step vans, and military vehicles for several years, recently unveiled its first Class 8 fuel cell port drayage truck featuring its proton-exchange membrane (PEM) fuel cell engine that will run at the Ports of Los Angeles and Long Beach. The fuel cell truck is estimated to have a driving range of 200 miles under normal drayage operation and can be fully refueled in less than nine minutes.

- **Toyota Motor Corp.** has unveiled their "Project Portal" venture, a Class 8 truck powered by a hydrogen fuel cell. Toyota will begin testing the concept vehicle in real-world use shuttling shipping containers between the ports of Los Angeles and Long Beach and

[180] Source: http://www.gladstein.org/hydrogen-fuel-cell-trucks/?elqTrackId=6a5315625a44431c811600250fbe96e3&elq=f9398669248a444fa236415f8ae2dde6&elqaid=1302&elqat=1&elqCampaignId=700

various freight depots up to 70 miles away. Toyota is also producing a light-duty FCEV, the Mirai, in limited quantities.

- Kenworth Truck Co. was the first major heavy-duty truck maker to join the fuel cell race and recently announced they are developing a hydrogen fuel cell tractor to haul freight from the Southern California ports to nearby warehouses. The tractor uses lithium-ion batteries to power an electric motor.

- UPS unveiled an extended range Class 6 fuel cell vehicle that it will deploy in its "Rolling Laboratory" fleet of alternative fuel and advanced technology vehicles.

Fuel-Cell Powered Public Transit

In British Columbia, 20 fuel-cell buses were operated in its transit fleet between 2010 and 2014. At the time, it was the largest fleet of its kind in the world, providing regular revenue transit service to residents in the community of Whistler, British Columbia[181]. In late 2014, the program was discontinued. It was estimated that the cost of Whistler's hydrogen buses were $1.34 per kilometre to maintain, versus 65 cents per kilometre for diesel-powered buses.

In the short-term, and possibly the long-term as well, hydrogen vehicle technology is infeasible. Although progress on FCEVs development has picked up speed, the technology has not yet been fully commercialized and will likely never be cost-competitive with BEVs. Thus, it is extremely difficult to make projections of fuel-cell vehicle classes available in the future and their related costs.

Hydrogen Fuel Cell Summary

Fuel cell technology has a very high potential for future applications for vehicles in all classes, but its practicality is still very much in doubt. The technology currently is still very expensive, lifecycle emissions are high and FCEVs as well as fuelling stations are not widely available. As a result, any projections of fuel cell application in the future must be approached with caution and understanding of the inherent limitations. Therefore, it is recommended that a fleet monitor the development and availability of fuel-cell technology for future applications in fleet operations.

[181] Source: http://www.chFC.ca/say-h2i/cars-and-buses/cars-and-buses

North Battleford

Treaty Six Territory | Heartland of the Métis | Saskatchewan | Canada

Playground Renewal & Expansion Program

CITY OF NORTH BATTLEFORD- PARKS AND RECREATION

City of North Battleford

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City of North Battleford

Overview

Public playgrounds/play spaces and splash parks are part of the heart of our community and improve the overall wellness of our residents. They provide children with the opportunity to practice key skills- social, emotional, cognitive, and physical. Playgrounds/play spaces also entice teens and adults to get outside and be active. When it comes to Parks & Open Spaces, the **Battlefords Joint Parks & Recreation Master Plan** has the following objectives:

Vision:

"Parks and Recreation in the Battlefords supports residents and visitors to lead healthier lives, to achieve fulfillment and to be more connected to each other and their community."

Goal:

Healthier Facilities & Parks

- Deliver high quality parks & recreation infrastructure efficiently & effectively
  - Identify facilities in need of renewal & development
  - Set priorities for targeted upgrades as part of ongoing capital & operational planning
  - Incorporate unstructured recreational opportunities and play elements in parks & open spaces

Renewal/Expansion Program Objective

The objective of the program is:

- Identify the current state of City playgrounds/play spaces & spray parks to expand offerings and opportunities through a documented renewal/expansion program.
- Ensure that effective planning and management practices are in place.
- Make sure that the renewal program considers accessibility and inclusivity and that future playgrounds are designed to meet the needs of the local area and community.
- Consider an appropriate mix of amenities to suit all ages and abilities.
- Ensure there is a focus on improving the overall service provision offered at all locations and that the 'play' experience extends beyond the structured unit.
- Ensure that all planning also considers operational requirements and levels of service.

Demographics- 2021 Census Data

Population	Demographic Breakdown
Total Population	**13,386**
0-4 Years	**920**
5-9 Years	**910**
10-14 Years	**905**
15-19 Years	**940**
20+ Years	**9,711**

Inventory

City Owned-

- **10** Playgrounds with equipment
- **1** Adult Fitness Space
- **1** Natural Play Space/Mobility Swing
- **1** Skateboard Park
- **3** Splash Parks

School Property

- **7** Playgrounds with equipment

City of North Battleford

CURRENT PLAYGROUND/ SPLASH PARK/PLAY SPACES INVENTORY

1.	**Senator Herb Sparrow Park Playground** *Recommended for 5-12 years of age*		This playground is heavily used by area residents. It sits next to the Battlefords Boys & Girls Club which increases the daily usage.	Location: 13TH Avenue and 104th Street *Behind the BBGC* *On 104th Street*
2.	**Centennial Park-Skateboard Park** *Recommended for 5+ years of age*		The skateboard park is used for skateboards, BMX bikes and scooters. This is a gathering area for youth in the evenings and on weekends.	Location: 18th Avenue and 104th St. *Next to the Access Communications Centre Arena*
3.	**Centennial Park-Natural Play Space & Mobility Swing** *Recommended for 18 months to 12 years of age*		This park sits between the tennis courts and splash park in Centennial Park. It was developed in partnership with BECIP. It contains natural structures to explore and to play on. The play space also has a play structure with a swing set along with a mobility swing.	Location: 18th Avenue and 104th Street *Between Tennis Courts and Spray Park*
4.	**Centennial Park-** **Adult Fitness Space** *Recommended for 14+ years of age*		This Fitness Centre is expandable and is in the area of Centennial Park that is next to the walking trail and splash pad.	Location: *Next to the Scott Drive parking lot* *Off Scott Dr. & Douglas Ave.*

City of North Battleford

PLAYGROUNDS/SPLASH PARKS/PLAY SPACES

5.	**Kinsmen Park Playground** *Recommended for 18 months to 12 years of age*		The Kinsmen Playground is residential & is heavily used It has many individual pieces plus a main structure.	Location: 18th Avenue *Between 95th St. and Walker Drive.*
6.	**Fairview Heights Park Playground** *Recommended for 5-12 years of age*		This playground is part of a larger park which includes a soccer field and basketball courts. It is in a newer family-oriented area. The Activity Centre building is no longer usable.	Location: 202 Clements Drive *Located in Fairview Heights*
7.	**Killdeer Park Playground** *Recommended for 5-12 years of age*		This pocket playground is located behind a condominium and a series of apartments. There is no designated parking area for the playground.	Location: Killdeer Drive behind Condominium complex
8.	**Confederation Park Playground** *Recommended for 18 months to 12 years of age*		This is an older pocket playground located in a residential area and has room for expansion.	Location: Gardiner Drive *Located between Gardiner Drive and Clark Drive*

City of North Battleford

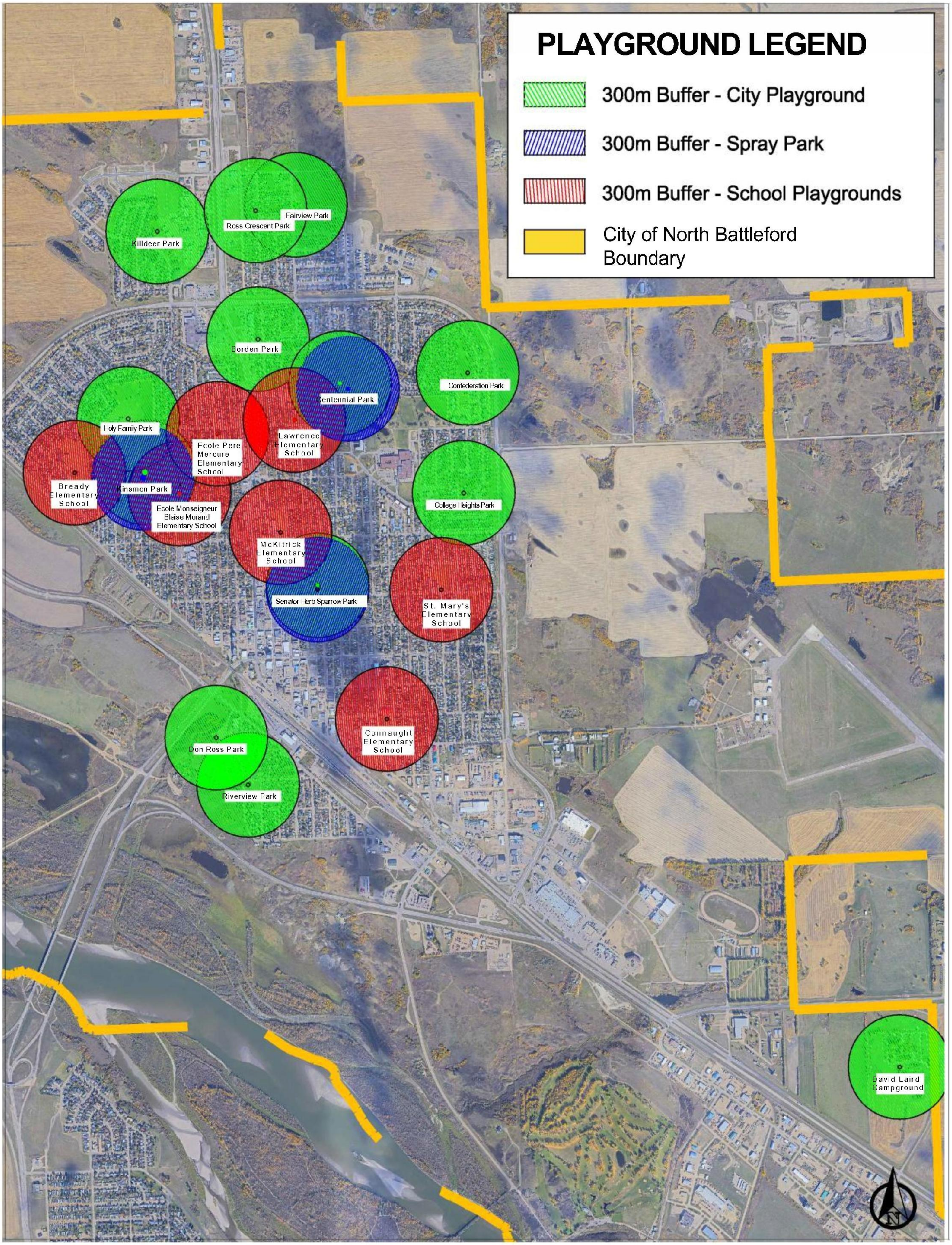
PLAYGROUNDS/SPLASH PARKS/PLAY SPACES

9.	**College Heights Park Playground** *Recommended for 5-12 years of age*		This pocket playground is in a residential low traffic area with apartments near by. There is room for expansion.	Location: Between St. Laurent Drive and Thompson Cres.
10.	**Riverview Park Playground** *Recommended for 5-12 years of age*		Only full playground In Riverview. It is centrally located and has room for expansion.	Location: 95^{th} Street and 7^{th} Avenue Adjacent to the Don Ross Centre
11.	**Borden Park Playground** *Recommended for 5-12 years of age*		This pocket playground is in a low traffic residential area and has room for expansion.	Location: Borden Drive
12.	**David Laird Campground Playground** *Recommended for 5-12 years of age*		This playground is in the campground and centrally located near the pavilion, office, washrooms, and campsites.	Location: Off Highway 40 just past the WDM and City Cemetery

City of North Battleford

PLAYGROUNDS/SPLASH PARKS/PLAY SPACES

13.	**Don Ross Centre- Blue Jays Diamond Playground** *Recommended for 5-12 years of age*		This play area is still in development. This would be the 2nd play structure in Riverview.	Location: 891- 99th Street *Located behind the Don Ross Arena next to the Blue Jays Diamond*
14.	**Ross Cres. Park Playground** *Recommended for 5-12 years of age*		This is a low traffic residential pocket playground that has room for expansion.	Location: Ross Crescent
14.	**Centennial Park- Splash Park** *Recommended for 18 months to 12 years of age*		The splash pad is centrally located within Centennial Park along the walking trail. It has washrooms, shelter and is in a high traffic area of the park.	Location: A large parking lot for access to this pad is located off Scott Drive and Douglas Avenue. Same lot as the Adult Fitness Centre
15.	**Kinsmen Park-** **Splash Park** *Recommended for 18 months to 12 years of age*		The splash pad is located next to the parking lot for the park and is adjacent to the playground equipment. It has washrooms, is well shaded and in a high traffic area.	Location: 18th Avenue *Between 95th St. and Walker Drive*
16.	**Senator Herb Sparrow** **Rotary Splash Park** *Recommended for 18 months to 12 years of age*		The splash pad is located behind the NB Boys & Girls Club. It is in a high traffic area due to its location.	Location: 13TH Avenue and 104th Street *Behind the BBGC On 104th Street*


PLAYGROUND LEGEND
300m Buffer - City Playground
300m Buffer - Spray Park
300m Buffer - School Playgrounds
City of North Battleford Boundary
Killdeer Park
Ross Crescent Park
Fairview Park
Borden Park
Centennial Park
Confederation Park
Holy Family Park
Ecole Pere Mercure Elementary School
Lawrence Elementary School
Bready Elementary School
Kinsmen Park
Ecole Monseigneur Blaise Morand Elementary School
College Heights Park
McKitrick Elementary School
Senator Herb Sparrow Park
St. Mary's Elementary School
Connaught Elementary School
Don Ross Park
Riverview Park
David Laird Campground
N

ASSESSMENTS AND RECOMMENDATIONS

Senator Herb Sparrow Playground: 104th Street & 13th Avenue

Senator Herb Sparrow Park: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2020	25	2045	Blue Imp	$70,000	No
Playground Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Excellent	5-12 years of age	Limited	Steel & Hard Plastic	Sand	Adjacent Spray Park
Playground Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street	None	2 Wooden 1 Concrete	1 Barrel	Trees	None
Playground Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes 1 main light pole	No	No	No	Yes ID & Rules

Recommendations: 2023-2026

1. Paint light pole
2. Level the sand around all structures
3. Install 2 metal picnic tables and 2 metal benches
4. Replace border ties that creates a barrier
5. Install an up-to-date garbage/recycle/dog waste disposal station (3 piece).
6. Install 1 double swing set
7. Install 1 bike rack
8. Consider access features to improve overall accessibility

ASSESSMENTS AND RECOMMENDATIONS

Senator Herb Sparrow-Rotary Splash Park (104th St. & 13th Avenue)

Senator Herb Sparrow – Rotary Splash Park: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2005	25	2030		$60,530	No
Senator Herb Sparrow- Rotary Splash Park: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Very Good	18 months +	Accessible	Steel	Concrete	Playground
Senator Herb Sparrow- Rotary Splash Park: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street	None	2- 1 concrete 1 wooden	1 Barrel	Trees	None
Senator Herb Sparrow- Rotary Splash Park: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes 1 main light pole	No	No	No	Yes ID & Rules

Recommendations: 2023-2030

1. Crack-fill pad
2. Replace main drain with a stainless-steel main drain
3. Seal pad with linseed oil
4. Install 2 metal benches & 1 metal picnic table
5. Install 1 garbage bin
6. Install/replace features
7. Install 1 bike rack
8. Replace wooden sign
9. Install separate water meters- one for the splash park and one for BBGC
10. Replace activator, electronic components & control valves

ASSESSMENTS AND RECOMMENDATIONS

Centennial Park- Skateboard Park: 18th Avenue & 104th Street


Centennial Skateboard Park: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2008	25	2033	Spectrum Skate Park Creations- Vancouver BC	$367,132	No
Centennial Skateboard Park: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	5+ Years	Limited	Steel & Concrete	Concrete	Security Camera
Centennial Skateboard Park: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Access Centre Parking Lot	4 metal	0	2 barrel	Slat-roof Pergola	None
Centennial Skateboard ParkSetting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	4 Light Poles	Hickson Hut in Summer	Drinking Fountain	None	Yes ID & Rules

Recommendations: 2023-2030

1. Crack Seal concrete pad and asphalt walkway in the Fall.
2. Replace fountain
3. Repaint concrete, pergola & rails
4. Install 1 metal picnic table under pergola
5. Resurface & expand the skate park by 2034
6. Re-coat top layer of concrete pad, re-paint where required.
7. Replace – main identifier and rules sign
8. Replace grassed area within the pad with an alternative product to reduce maintenance costs and improve aesthetics.

ASSESSMENTS AND RECOMMENDATIONS

Centennial Park- Natural Play Space & Mobility Swing



Centennial Natural Play Space & Mobility Swing: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2016- Swings 2018-NPS 2021- Mobility Swing	20 15 15	2036 2033 2036	Blue Imp Austrailian Maker Australian Maker	$6,000 $100,000 $65,000	No No No
Playground Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Excellent	18 months to 12 years of age	Limited	Steel & Hard Plastic	Sand Pebbles	None
Playground Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Access Centre Parking Lot	1 wooden bench	2 Wooden	2 Barrel	Trees	None
Playground Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes 1 main light pole	Yes- Hickson Hut or Splash Park	No	No	Yes ID & Rules

Recommendations: 2023-2030

1. Refinish wooden picnic tables.
2. Install 1 natural looking metal bench
3. Re-gravel and level walking path to and through the structure
4. Re-bark the grounds
5. Install a picnic shelter
6. Replace garbage barrels with updated garbage/recycling bin system (2 piece + 1 bin)
7. Plant prairie grasses to improve the natural aesthetic
8. Plant more trees to create a windbreak
9. Replace wood play structures (ie: logs)

ASSESSMENTS AND RECOMMENDATIONS

Centennial Park- Adult Fitness Space (Off of Scott & Douglas Ave.)

Centennial Adult Fitness Centre: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2021	**20**	**2041**	**Blue Imp**	**$17,186**	**No**
Playground Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Excellent	**14+ Years**	**Limited**	**Steel**	**Bark**	**None**
Playground Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot	**1 wooden bench**	**1 Wooden**	**1 Barrel**	**None**	**None**
Playground Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	**Yes- Indirect In Parking Lot**	**Yes- Hickson Hut or Splash Park**	**No**	**No**	**Yes ID & Rules**

Recommendations: 2023-2030

1. Replace garbage barrels with updated waste/recycling/dog waste disposal station (3 piece)
2. Install a Picnic Shelter
3. Install 1 metal picnic table and 2 metal benches
4. Increase workout equipment and area- include Senior Specific equipment
5. Upgrade sign
6. Install 1 bike rack
7. Re-bark surface and replace railway ties

ASSESSMENTS AND RECOMMENDATIONS

Centennial Park- Splash Park (Off of Scott & Douglas Ave)

Centennial Splash Park: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2011	25	2036	Park N' Play	$165,522	No
Splash Park Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	18 months +	Accessible	Steel	Cement	Washrooms Storage
Splash Park Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot	1 wood bench	2 Wooden	2 Barrel	Trees/ Overhang from Washrooms	No
Splash Park Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes Light poles	Yes	Yes	Yes	Yes ID & Rules

Recommendations: 2023-2030

1. Paint all pieces of equipment/building
2. Crack-fill pad & seal with linseed oil.
3. Repair brick walking path
4. Install/Replace features
5. Replace garbage barrels with updated waste/recycling/dog waste disposal station (3 piece)
6. Upgrade the washrooms and kitchenette
7. Replace wooden benches with 2 metal benches
8. Replace wooden picnic tables with 2 metal picnic tables
9. Replace sign
10. Replace electronic components, activator & control valves

ASSESSMENTS AND RECOMMENDATIONS

Kinsmen Park Playground- (18th Ave. Between 95th St. and Walker Drive)

Kinsmen Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
1992 2012	20 25	2012 2037	Unknown Blue Imp	$17,098 $49,895	Yes No
Kinsmen Playground Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	18 months-12 years	Accessible	Steel	Cement	Washrooms Storage
Kinsmen Playground Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot	1 wood bench	2 Wooden	2 Barrel	Trees/ Overhang from Washrooms	No
Kinsmen Playground Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes Light poles	Yes	Yes	Yes	Yes ID & Rules

Recommendations: 2023-2028

1. Replace garbage barrels with updated waste/recycling/dog waste disposal station (3 piece and 1 bin)
2. Upgrade washroom & kitchenette
3. Replace old swing set with 1 single arch swing set
4. Top up gravel in parking lot
5. Upgrade sign
6. Re-bark surface area and replace railway ties
7. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Kinsmen Park Splash Park- (18th Ave. Between 95th St. and Walker Drive)

Kinsmen Splash Park: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2005	20	2025	Park N' Play	$68,488	No
Kinsmen Splash Park Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	18 months +	Accessible	Steel	Cement	Washrooms Storage
Kinsmen Splash Park Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot	2 wood benches	1 Wooden	2 Barrel	Trees/ Overhang from Washrooms	No
Kinsmen Splash Park Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
Yes	Yes Light poles	Yes	Yes	No	Yes ID & Rules

Recommendations: 2023-2030

1. Replace 1 bin
2. Upgrade washroom facilities & kitchenette
3. Crack-seal cement pad/seal with linseed oil
4. Replace wooden control box top in ground
5. Upgrade sign
6. Install/replace features & install 1 bike rack
7. Re-paint perimeter, features
8. Replace wooden benches and tables with 2 metal tables & 2 metal benches
9. Re-surface asphalt area with splash pad anti-slip cement
10. Replace activator, electronic components & control valves

ASSESSMENTS AND RECOMMENDATIONS

Fairview Heights Park Playground (202 Clements Drive)

Fairview Heights Playground: Life-Cycle Data					
Year Installed	Life Expectancy (Years)	Replacement Year	Manufacturer	Initial Cost	Equipment Obsolete?
2009 2014 (add on)	20 20	2029 2034	1 Stop Playgrounds See saw	$54,717 $1,800	No No
Fairview Heights Playground: Condition & Design					
Overall Condition	Target Ages	Accessibility	Structure Material	Surface Material	Additional Amenities
Excellent	5-12 years	Accessible	Steel/Plastic	Bark	Activity Centre
Fairview Heights Playground: Setting (A)					
Parking	Benches/ Seating	Picnic Tables	Garbage Bins	Shade/ Shelter	Fencing
Parking Lot	2 metalbenches	none	1 Barrel	None	No
Fairview Heights Playground: Setting (B)					
Pathway/ Sidewalk Access	Lighting	Public Washrooms	Potable Water	Bike Racks	Signage
No	None	No	No	No	Yes ID & Rules

Recommendations: 2023-2030

1. Replace garbage barrels with updated garbage/recycling/dog waste disposal station (3 piece)
2. Top up gravel in parking lot
3. Upgrade sign
4. Re-bark surface area and replace railway ties
5. Install new features
6. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Killdeer Park Playground (Killdeer Drive- behind Apartments)

Killdeer Park Playground: Life-Cycle Data					
Year Installed	Life Expectancy (Years)	Replacement Year	Manufacturer	Initial Cost	Equipment Obsolete?
2001 2014-Super Dome -See Saw	30 20	2031 2034	Unknown Playworld	$11,120 $4,229 $1,276	No No No

Killdeer Park Playground: Condition & Design					
Overall Condition	Target Ages	Accessibility	Structure Material	Surface Material	Additional Amenities
Very Good	5-12 years	Accessible	Steel/Plastic	Sand	None

Killdeer Park Playground: Setting (A)					
Parking	Benches/ Seating	Picnic Tables	Garbage Bins	Shade/ Shelter	Fencing
Parking Lot – limited	No	No	No	No	No

Killdeer Park Playground: Setting (B)					
Pathway/ Sidewalk Access	Lighting	Public Washrooms	Potable Water	Bike Racks	Signage
No	No	No	No	No	Yes ID & Rules

Recommendations: 2023-2028

1. Replace garbage barrels with updated garbage/recycling/dog waste disposal station (3 piece)
2. Replace swing set with 1 double arch swing set
3. Top up and level sand- replace railway ties
4. Upgrade sign
5. Install 1 metal bench and 1 metal picnic table
6. Install new features & 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Ross Crescent Park Playground (On Ross Crescent)

Ross Crescent Park Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
1996	30	2026	Unknown	$10,828	No
Ross Crescent Park Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	5-12 years	No	Steel/Plastic	Sand	Storage Shed
Ross Crescent Park Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street Parking	1 wooden bench	No	1 bin	No	No
Ross Crescent Park Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	No	No	No	No	No

Recommendations: 2023-2030

1. Replace garbage barrels with updated garbage/recycling station (2 piece)
2. Repaint swing set/ metal poles
3. Top up and level sand- replace railway ties
4. Install sign and playground rules to a metal sign
5. Install 1 metal bench and 1 metal picnic table
6. Install new features- individual, low to ground, accessible
7. Remove old storage shed
8. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Don Ross Centre- Blue Jays Diamond Playground

Don Ross Playground Structure: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2016- Net 2021- Swings	25 25	2041 2042	1 Stop Playground Blue Imp	$4,000 $3,000	No No
Don Ross Playground Structure: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Excellent Excellent	5-12 years 5-12 years	No No	Steel/Rope Metal	Bark Bark	None None
Don Ross Playground Structure: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot	No	No	1 bin	No	No
Don Ross Playground Structure: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	No	No	No	No	No

Recommendations: 2023-2030

1. Install updated waste/recycling station (2 piece)
2. Install new swing set (1 single)
3. Top up and level bark, replace worn railway ties
4. Install sign
5. Install 1 metal bench
6. Install new features & expand footprint- individual, low to ground, accessible
7. Install a fence barrier between parking lot and play area for safety.
8. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Riverview Park Playground (95th Street and 7th Avenue in Riverview)

Riverview Park Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2004	25	2029	Jeffs Playground Pro	$22,000	No
Riverview Park Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Poor	18 months – 12 years	No	Steel/hard plastic/ wood	sand	None
Riverview Park Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street Parking	1 wooden bench	No	1 bin	No	No
Riverview Park Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	No	No	No	No	Yes ID & Rules

Recommendations: 2023-2030 **REPLACE PLAY STRUCTURE**

1. Install updated garbage/recycling/dog waste disposal station (3 piece)
2. Install new single swing set with an accessible swing
3. Top up and level sand/bark, replace worn railway ties
4. Replace sign
5. Install 1 metal bench and 1 metal picnic table
6. Paint retouches
7. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

College Heights Playground (Between St. Laurent Dr. & Thompson Cres.)

College Heights Park Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
1996	25	2021	Unkown	$12,375	No Yes- Swings
College Heights Park Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good Swings- Fair	5 – 12 years	No	Steel/hard plastic/ wood	bark	None
College Heights Park Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street Parking	2 wooden benches	No	1 bin	No	No
College Heights Park Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	Yes	No	No	No	Yes ID & Rules

Recommendations: 2023-2030

1. Install updated garbage/recycling station (2 piece)
2. Install new single swing set that also includes an accessible chair
3. Top up and level bark, replace worn railway ties
4. Replace sign
5. Replace wooden benches with 1 metal bench and 1 metal picnic table
6. Paint retouches
7. Replace metal slide with plastic slide
8. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Confederation Park Playground (Between Gardiner Dr & Clark Dr.)

Confederation Park Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
1998 2014	25 20	2023 2034	Unkown 1 Stop Playground	$9651 $2,500	No No
Confederation Park Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good	5 – 12 years	No	Steel/hard plastic/ wood	bark	None
Confederation Park Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street Parking	2 wooden benches	No	1 bin	No	No
Confederation Park Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	No	No	No	No	Yes ID & Rules

Recommendations: 2023-2030 **REPLACE HIGH BAR STRUCTURE**

1. Install updated garbage/recycling station (2 piece)
2. Replace high bars structure with a new structure
3. Top up and level bark, replace worn railway ties
4. Replace sign
5. Replace wooden benches with 2 metal benches and 1 metal picnic table
6. Paint retouches
7. Replace metal slide with plastic slide
8. Install low to the ground features
9. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

Borden Park Playground (Borden Drive)

Borden Park Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2003-structure **2014-swing set**	**25** **20**	**2028** **2034**	**Unkown** **1 Stop Playground**	**$11,736** **$3,200**	**No** **No**
Borden Park Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Good **Excellent**	**5 – 12 years** **18 mo-12 yrs.**	**No**	**Steel/hard plastic/ wood**	**bark**	**None**
Borden Park Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Street Parking	**2 wooden benches**	**No**	**1 bin**	**No**	**No**
Borden Park Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	**No**	**No**	**No**	**No**	**Yes** **ID & Rules**

Recommendations: 2023-2030

1. Install updated garbage/recycling station (2 piece)
2. Top up and level bark, replace worn railway ties
3. Replace sign
4. Replace wooden benches with 2 metal benches and 1 metal picnic table
5. Paint retouches
6. Install low to the ground features
7. Install 1 bike rack

ASSESSMENTS AND RECOMMENDATIONS

David Laird Campground Park & Playground (Off Highway 40 to PA)

David Laird Campground Park & Playground: Life-Cycle Data					
Year Installed	**Life Expectancy (Years)**	**Replacement Year**	**Manufacturer**	**Initial Cost**	**Equipment Obsolete?**
2010-structure 1980- shelter ?- sand volleyball crt.	25 20 15	2038 2000 Unknown	Unkown Unknown Unknown	$11,736 $4,518 Unknown	No Yes Yes
David Laird Campground Park & Playground: Condition & Design					
Overall Condition	**Target Ages**	**Accessibility**	**Structure Material**	**Surface Material**	**Additional Amenities**
Excellent Poor Poor	5 – 12 years All ages 5 + years	No Yes No	Steel/hard plastic Wood Netting/metal poles	Bark Concrete Sand	None None None
David Laird Campground Park & Playground: Setting (A)					
Parking	**Benches/ Seating**	**Picnic Tables**	**Garbage Bins**	**Shade/ Shelter**	**Fencing**
Parking Lot- limited	No	No	1 bin	Yes	No
David Laird Campground Park & Playground: Setting (B)					
Pathway/ Sidewalk Access	**Lighting**	**Public Washrooms**	**Potable Water**	**Bike Racks**	**Signage**
No	No	Yes- campground	Yes- outdoor faucet	No	No

Recommendations: 2023-2030

1. Install updated waste/recycling station (2 piece) + 2 bins
2. Upgrade wooden shelter
3. Top up and level bark, replace worn railway ties
4. Install sign with name and playground rules
5. Replace wooden benches with 1 metal bench and 1 metal picnic table
6. Paint retouches
7. Replace Sand Volleyball net & poles, top up sand
8. Add 1 bike rack

PLAN > PLAYGROUND/SPLASH PAD BENCHES
CURRENT INVENTORY TYPE



Bench types at most playgrounds and splash pads

Recommendation: Replace wooden benches with metal benches

Wooden benches are the more ‘natural’ approach; however, they wear faster, are susceptible to fire & vandalism and require replacement sooner.

Metal benches can be updated by paint and are more fire and vandalism resistant. The install of bench and concrete pad done in-house by Parks Staff.

The average cost of a metal bench with concrete pad or concrete insert ranges between $1,100 -$1,400 dependent upon style. We would continue to use the metal styles already in place.

Total Number of new metal benches: 21

Approximate cost (2022): $1,200- $1,400

Total: $25,200-$29,400 (+ Taxes)

LOCATION	# BENCHES	LOCATION	# BENCHES
Herb Sparrow Playground	2	Confederation	2
Herb Sparrow Splash Park	2	College Heights	1
Adult Fitness Centre	2	Borden	2
Centennial Splash Pad	2	Killdeer	1
Kinsmen Splash Pad	2	Ross Cres.	1
Natural Play Space	1	DRC	1
Riverview	1	David Laird	1

PLAN > PICNIC TABLES CURRENT INVENTORY TYPE

Most playgrounds and splash pads have wooden picnic tables

RECOMMENDATION: REPLACE WOODEN PICNIC TABLE WITH METAL TABLE (Below)

Wooden picnic tables are susceptible to the environment. Wooden tables require ongoing maintenance (sanding, repairs, removal of graffiti). Metal tables require less maintenance and last longer. The City does not have a lot of picnic tables in its Parks and the ones in its Playgrounds are mostly wooden and are requiring replacement. Tables would be anchored into place.

Total number of new metal picnic tables: 16

Approximate cost (2022): $1,400-$1600

Total: $22,400-$25,600 + taxes

LOCATION	# TABLES	LOCATION	# TABLES
Herb Sparrow Playground	2	Confederation	1
Herb Sparrow Splash Park	1	College Heights	1
Adult Fitness Centre	1	Borden	1
Centennial Splash Pad	2	Killdeer	1
Kinsmen Splash Pad	2	Ross Cres.	1
David Laird Campground	1	Centennial Skate Park	1
Riverview	1		

PLAN > GARBAGE/RECYCLE/DOG WASTE SYSTEMS & BINS
CURRENT INVENTORY TYPE

Most playgrounds have barrel garbage bins. Barrel bins are the most economical and they can be painted, moved, or replaced easily. We do not have recycle bins or dog waste disposal stations at our playgrounds. It is recommended that we upgrade the look and versatility to a two-box or a three-box system which would incorporate garbage, recycling or garbage/recycling and dog waste disposal. Barrels would still be utilized where needed.

These are the units currently at the InnovationPlex. They work well.

Can be purchased in 2 or 3 pieces.

LOCATION	Bins	2 piece	3 piece	LOCATION	Bin	2 piece	3 piece
Herb Sparrow Playground			1	Confederation		1	
Herb Sparrow Splash Park	1			College Heights		1	
Adult Fitness Centre			1	Borden		1	
Centennial Splash Pad			1	Killdeer			1
Kinsmen Splash Pad	1			Ross Cres.		1	
David Laird Campground	2	1		DRC Blue Jays		1	
Riverview			1	Natural Play Space	2	1	
Kinsmen Playground	1		1	Fairview Heights			1

RECOMMENDATION: INSTALL 2- OR 3-PIECE SYSTEMS WITH SOME BIN BACK-UP

Total Number of (2 piece) Garbage/Recycle Stations: **7**

Total Number of (3 piece) Garbage/Recycle/Dog waste Stations: **7**

Total Number of (Bins)Barrels**: 7**

2022 Approximate Cost: **Bins**> $200 each   Total: $1,400 + taxes

2022 Approximate Cost: **2 Piece Garbage/Recycle** > $2,000 each.   Total $14,000 + taxes

2022 Approximate Cost: **3 Piece Garbage/Recycle/ Dog Waste** > $3,000 each

Total: $21,000 + taxes

Grand Total: 2022 Approximate Cost: $36,400+ taxes

PLAN > SWING SETS & SLIDES   CURRENT INVENTORY TYPE

Current swing set types
In City Playgrounds

The older swing sets (above) should be replaced with the arch swing set which is more durable and sturdier. Most of our playgrounds have the arch swing sets. They come in single or double lengths and the structure can accommodate a variety of swing types- bucket, regular, infant, mobility.

Current slide types in City Playgrounds

The City has a few playgrounds with aging metal slides. The rest of the older structure is sound. When required, the metal slide should be replaced with a plastic slide- they are not as durable as the metal slide but the do not get as hot and are less expensive to replace.

LOCATION	Swing Set New/Replaced	Slides New/Replaced
Herb Sparrow Playground	1 Double- New	
Kinsmen Playground	1 Single- Replacement	
Killdeer Playground	1 Double- Replacement	
College Heights	1 Single- Replacement	1 single plastic to new plastic
David Laird Campground	1 Double- New	
Riverview Playground	1 Single- Replacement	
Confederation Playground		1 single metal to 1 plastic

RECOMMENDATION: INSTALL/UPGRADE SWING SETS & SLIDES

TTL. No. single piece arch swing sets**: 3** Approx. Cost: $2,500-$3,500 **Total: $7,500- $10,500**

TTL. No. double piece arch swing sets: **3** Approx. Cost: $4,500-$6,000 **Total: $13,500-$18,000**

TTL. No. plastic slides(child): **2** Approx. Cost: $400-$600 **Total: $800- $1,200**

Grand Total 2022 Approximate Cost: $21,800- $29,700 plus taxes

PLAN > BIKE RACK   CURRENT INVENTORY TYPE

The City currently has a bike rack at

- Centennial Skateboard Park
- Centennial Park Splash Pad.

For security reasons, each of our playgrounds should have a bike rack available.

Total Number of Bike Racks Required: 14

Approximate 2022 Cost/rack: $500 + taxes   Total: $7,000

PLAN > PICNIC SHELTER

The City currently does not have any picnic shelters in its parks or playgrounds. Outdoor amenities were identified as the top priority under the Parks & Open Spaces section of the Recreation Master Plan.

Two playground areas would be enhanced by the installation of a picnic shelter:

1. Centennial Park Adult Fitness Centre- it is in a mostly under-developed area of the park and is adjacent to the trail system.
2. Centennial Natural Play Spaces- It is centrally located and an area where families gather.

Total of Picnic Shelters Required: 2

Approximate 2022 Cost/ 10X12 Shelter: $38,000- $48,000   Total: $76,000- $96,000

PLAN > SECURITY CAMERAS

Security is an ongoing issue in our parks and playgrounds. Security cameras in our playgrounds that currently have lighting and buildings would be of assistance.

Areas still requiring cameras:

1. Centennial Splash Pad
2. Kinsmen Playground/Splash Pad
3. Senator Herb Sparrow Playground

Total Security Cameras required: 3 (2 cameras each)

Approximate 2022 Cost: $5,000-$8,000   Total: $15,000- $24,000

EXPANSION (NEW PLAYGROUNDS/SPLASH PARKS)

1. PLAYGROUNDS

The City currently has city-wide coverage. The Yellow-Sky area, when developed, will require Green spaces and playgrounds. This component will be added at that time.

Riverview Park: Main Structure & Slide Structure

Riverview Park requires some structure replacement. The main structure and slide are in poor condition. The swing set with the tire is in excellent condition and does not require replacement.

Approximate 2022 Cost of Replacement: $65,000- $90,000 Main & Slide Structure

Confederation Park: High Bar Structure

The High Bar structure at Confederation Park requires replacement and updating. The rest of the structures are in good condition.

Approximate 2022 Cost of Replacement: $8,000- $10,000

2. SPLASH PARKS

Based on the current locations of our splash parks, 2 areas are not adequately serviced

a. **Riverview**
   i. Riverview Park is large enough to accommodate the development of a splash park. The closest splash park for residents in this area is Kinsmen Park.

b. **Connaught School Area**
   i. The closest splash park in this area is Senator Herb Sparrow Park. A splash park in this area would alleviate some of the heavy use at Senator Herb Sparrow Park and provide a shorter walking/biking distance for residents. The location is heavily residential. Open lots are few. A review of options should be conducted.

The cost of a Splash Park is dependent upon size and number/type of features.

Approximate 2022 Cost Range: $75,000-$500,000

SPLASH PARK BUILDING UPGRADES

The Splash Park Washroom/kitchenette at Centennial Park and Kinsmen Park require upgrading. This includes the interior, equipment, exterior facia, and roof.

Approximate cost per building: $30,000

APPENDIX A: CHART OF RECOMMENDATIONS

CITY OF NORTH BATTLEFORD

SUMMARY OF RECOMMENDATIONS

	Re-Paint	Level Sand/Bark	Replace Picnic Tables	Replace Benches	Refinish wooden tables	Install Picnic Shelter	Replace Border Ties	Install 2 Pc Garbage	Install 3 Pc Garbage	Install Garbage Bin	Install Single Swing Set	Install Double Swing Set	Install Plastic Slide	Install Bike Rack	Add Features	Crack Fill	Replace Ashphalt	Replace Main Drain	Seal With Linseed Oil	Activator/valves/electronics	Replace water meters	Repair Walkways	Replace Cement Pad	Upgrade Sign	Replace Fountain	Resurface Concrete Pad	Replace grassed area with concrete	Plant Prairie Grasses or Trees	Upgrade washrooms/kitchenette	Top Up gravel in Parking Lot	Remove Storage Shed	Replace Structure	Install Fence	Upgrade wooden structure	Replace sand volleyball net/sand
Herb Sparrow Playground	*	*	2	2			*		1			1		1	*																				
Centennial Skate Park	*		1													*							*	*	*	*	*								
Centennial Natural Space		*		1	*	1		1		2					*							*						*							
Centennial Adult Fitness		*	1	2		1	*		1					1	*									*											
Kinsmen Playground		*							1	1	1			1										*						*					
Fairview Heights		*					*		1					1	*									*						*					
Killdeer Playground		*	1	1			*		1			1		1	*																				
Confederation	*	*	1	2			*	1					1	1	*									*								*			
College Heights	*	*	1	1				1			1		1	1										*											
Riverview	*	*	1	1					1		1			1										*								*			
Borden	*	*	1	2			*	1						1										*											
David Laird	*	*	1	1				1		2		1		1										*										*	*
Don Ross		*		1			*	1						1	*									*									*		
Ross Cres.	*	*	1	1				1						1	*									*							*				
Cent. Splash Pad	*		2	2					1						*	*			*	*		*		*					*						
Kinsmen Splash Pad			2	2						1				1	*		*			2				*					*						
Herb Sparrow Splash			1	2			*			1				1	*	*		*	*	*	*			*											
TOTAL	9	13	16	21	1	2	8	7	7	7	3	3	2	14	11	3	1	1	2	4	1	2	1	14	1	1	1	1	2	2	1	2	1	1	1