Appendix A
to RPF-24-23

GREEN FLEET STRATEGY UPDATE 2023

FINAL REPORT (DRAFT)

CITY OF BURLINGTON

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1 EXECUTIVE SUMMARY

About the Green Fleet Strategy Update

The primary objective of the City of Burlington's (the City's) Green Fleet Strategy Update in 2023 is to reassess the fleet transition roadmap, and its economic and environmental impacts so as to amend the 2008 Green Fleet Strategy with the most appropriate low-carbon or zero-emissions fleet alternatives which can support the City's broader goal of achieving corporate carbon neutrality for its corporate, fire, transit and equipment fleet by the year 2040.

Methodology and Approach

The Green Fleet Strategy Update began with an assessment of the current state of the City's fleet inventory and operations. It involved understanding the fleet mix and its performance requirements. Following the current state assessment, a market scan identified currently available and future zero-emissions alternatives for different vehicle categories and weight classes. A landscape review complementing the market scan enabled benchmarking of actions undertaken by similar jurisdictions. Eventually, a fleet transition strategy and implementation roadmap including economic modelling compared pathways to two potential future states – one with internal combustion engine (ICE) vehicles resulting from business-as-usual (BAU) procurement policies and the other involving a green fleet. The comparative assessment specifically evaluated the periodic and cumulative profiles of greenhouse gas (GHG) emissions, capital expenditures and operating expenditures associated with the two transition pathways.

The green fleet transition pathway, according to the City's preferences, is shaped by the following principles:

- Diesel and gasoline ICE vehicles (also referred to as GHG vehicle technologies or GHG technologies) to be ideally replaced by zero-emissions technologies with no tailpipe emissions. Hybrid-electric technology will be used as an intermediate pre-electrification solution where feasible.
- Alternative low-carbon fuel technologies must be avoided to the best possible extent considering the City's ambitious GHG reduction targets for the year 2040 and the complexities of operating a fleet using multiple fuels.
- Fit for purpose and opportunities for down-sizing of a vehicle may be considered at the time of replacement.
- Opportunities for down-sizing of an entire vehicle group to be considered as part of annual service reviews with each user group, based on utilization ratios as well as operational needs to support optimal service delivery models.

Existing State Part I

The City of Burlington owned and operated a fleet of 353 vehicles as of the end of year 2022. Each of the City's fleet Operating Groups (or Departments) – Public Works (Corporate Fleet Services), Fire Department and Transit Department – use a mix of vehicles such as passenger cars, sports-utility vehicles (SUVs), pickup trucks, vans and fire trucks. The mix is categorized into nine Vehicle Groups which include Cars/Minivans/SUVs, Fire/Emergency Vehicles, Medium-Duty Vehicles, Heavy-Duty Vehicles, Pickups/Vans, Tractors/Loaders, Street Sweepers, Transit Buses, and Utility Vehicles/Gators.

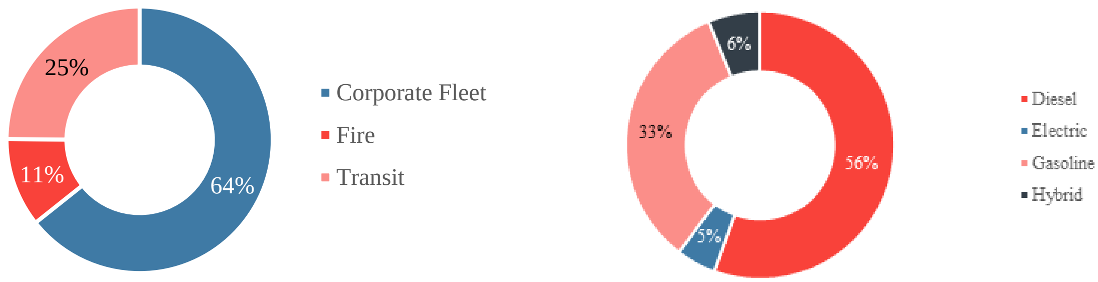

Figure 1: Distribution of vehicles by fleet-operating group and fuel type

A majority of the vehicles in the City's fleet are propelled by ICEs. A fleet transition to lower-carbon or zero-emissions alternatives has begun starting with the light-duty passenger vehicle segment. 11% of the fleet uses electric or plug-in hybrid vehicle technology. However, 89% of the City's fleet still relies on fossil fuels, with an almost equal split between gasoline and diesel.

Further, utilization varies substantially depending on the function and size of a vehicle-group within each operating department. The commercial availability of zero-emissions alternatives and high utilization levels (average annual mileages per vehicle ranging up to 12,000 and 16,000 kilometres) make light- and medium-duty vehicles such as cars, minivans, SUVs, pickup trucks and vans the most appropriate candidates for imminent decarbonization.

Existing State Part II

Emissions analysis indicates a general downward trend in the Scope 1 and CAC emissions from fleet operations driven by the decreasing average annual fossil fuel consumption per vehicle from 8,297 litres in 2019 to 6,254 litres in 2022. Such a reduction in fuel consumption can be partly attributed to the transition of light-duty passenger vehicles to EV and PHEV technology.

Closer observation indicates that:

- **Scope 1 emissions** have primarily declined for the diesel operated portion of the fleet whereas they have increased for the gasoline operated portion in contrast.
- **Scope 2 emissions** have increased from 2019 to 2022 because of an addition of EVs and PHEVs, the only contributors to Scope 2 emissions in this study. Addition of these vehicle technologies to the fleet results in indirect emissions from the increased consumption of electricity by the City of Burlington, which in turn multiply at a rate equivalent to the Ontario grid emissions-intensity factor. The grid emissions-intensity factor accounts for the weighted average of GHG emissions arising from all electricity generation sources in the province.
- **CAC emissions** have declined, predominantly due to a decreasing consumption of diesel from 2019 to 2022.

Scope 1 GHG emissions and CACs will continue declining in the near-term with the electrification of light- and medium-duty passenger vehicles. The downward trend is expected to slope steeper in the medium-term depending on the technology readiness of electric or hybrid-electric variants of medium- and heavy-duty vehicles.

Future State

Phase 1: Year 2024 to 2028

It is recommended that the replacement of light-duty and passenger vehicles with battery electric or hybrid electric alternatives at the end of their EUL take precedence in Phase 1 of the transition. A variety of models in this vehicle segment are beginning to be widely adopted and are capable of delivering a reliable power and range performance at par with diesel and gasoline vehicles.

Specifically, it is recommended that 61 cars, minivans, sports utility vehicles (SUVs), pickups and vans as well as 30 conventional and paratransit buses together constituting a quarter of the total fleet be replaced in the first Phase.

A green transition for transit buses is recommended to commence in Phase 1 considering the availability and increasing large-scale deployment of battery electric and hydrogen fuel cell electric buses in Canada and abroad. Immediate advancement towards decarbonization of transit buses also:

- Builds significant early momentum towards the City's 2040 net-zero goals through substantial emission reduction gains early on
- Allows for the distribution of costs across the procurement period to avoid large peaks in procurement costs in Phase 2 and Phase 3 when more heavy-duty vehicles, construction vehicles and fire trucks will line up for replacement with potentially expensive emerging zero-emissions alternatives

Any necessary replacements of vehicles in other categories may remain limited to conventional technology (GHG technology) given the lack of current or imminently anticipated commercially ready low-carbon or zero-emissions alternatives.

Phase 2: Year 2029 to 2033

Advancement towards full electrification started in Phase 1 may continue with 64 additional light-duty and passenger vehicle, as well as 30 transit bus replacements with zero-emissions or hybrid-electric alternatives in Phase 2. The replacement of fire trucks as well as medium-duty (MDV), heavy-duty (HDV) and utility vehicles may also begin in Phase 2 considering the anticipated commercial advancement of relevant zero-emission vehicles and fuelling technologies. A substantial proportion of the fleet - 42 per cent - will transition in Phase 2.

Phase 3: Year 2034 to 2040

Remaining fire trucks as well as MDVs, HDVs and utility vehicles, especially new GHG units procured during Phase 1, all of which constitute up to 15 per cent of the City's fleet, may be eventually replaced with zero-emissions alternatives in Phase 3.

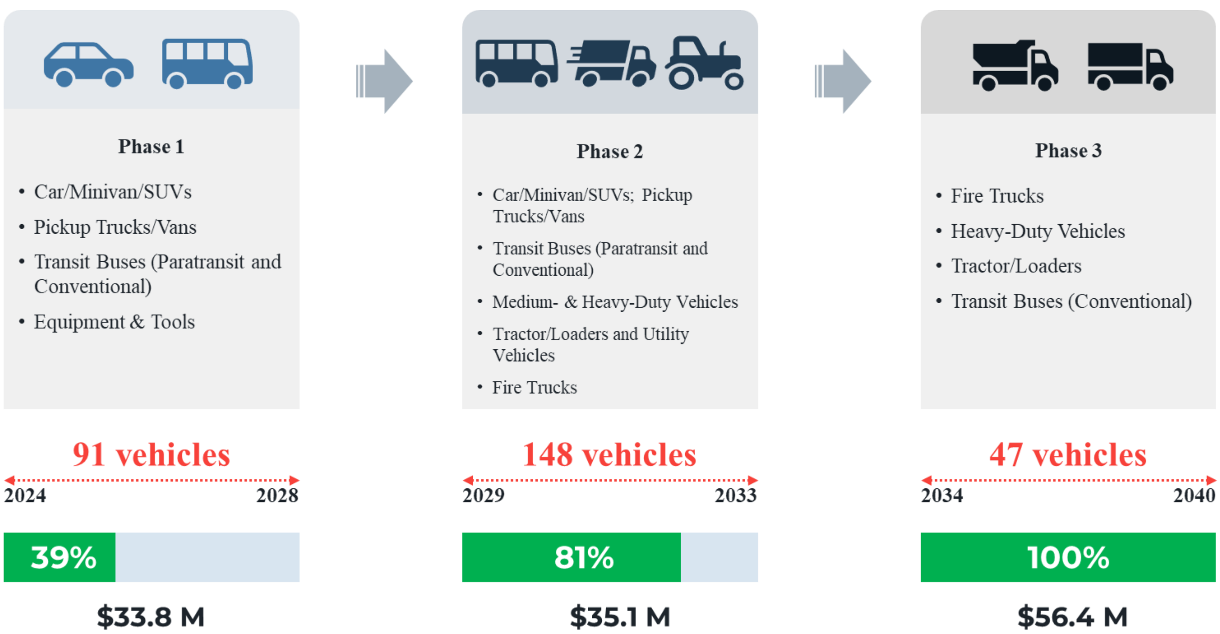

Figure 2: Fleet transition phasing strategy

The recommended fleet transition strategy would result in the following fleet composition with the last diesel vehicles being retired in the year 2040.

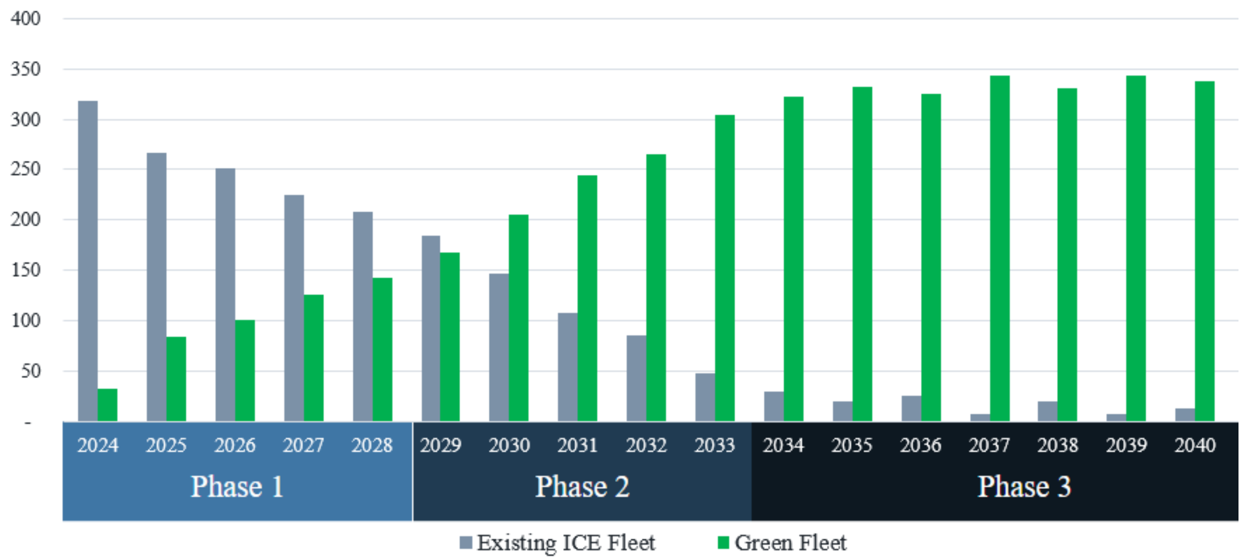

Figure 3: Fleet transition outline for the City of Burlington's updated Green Fleet Strategy

The gross costs of a green fleet transition between the years 2024 and 2040, including vehicle operating costs within that period are expected to surpass $432 million compared to $362 million in the case of business-as-usual procurement policies. This amounts to a nearly 19 per cent increase in the cumulative fleet expenditure for the City.

Assuming that 10% and 30% of these total costs are offset by external capital funding contributions for public transit and municipal fleets from now until 2027 and 2030 respectively, the green fleet scenario will cost approximately $423 million to the City of Burlington. In other words, the modeled external capital funding for vehicle procurement until year 2030 has the potential to relieve the municipal expenditure burden by a maximum of $9 million based on current assumptions. The figure below offers additional perspective by demonstrating the periodic capital cost profile for the green fleet transition.

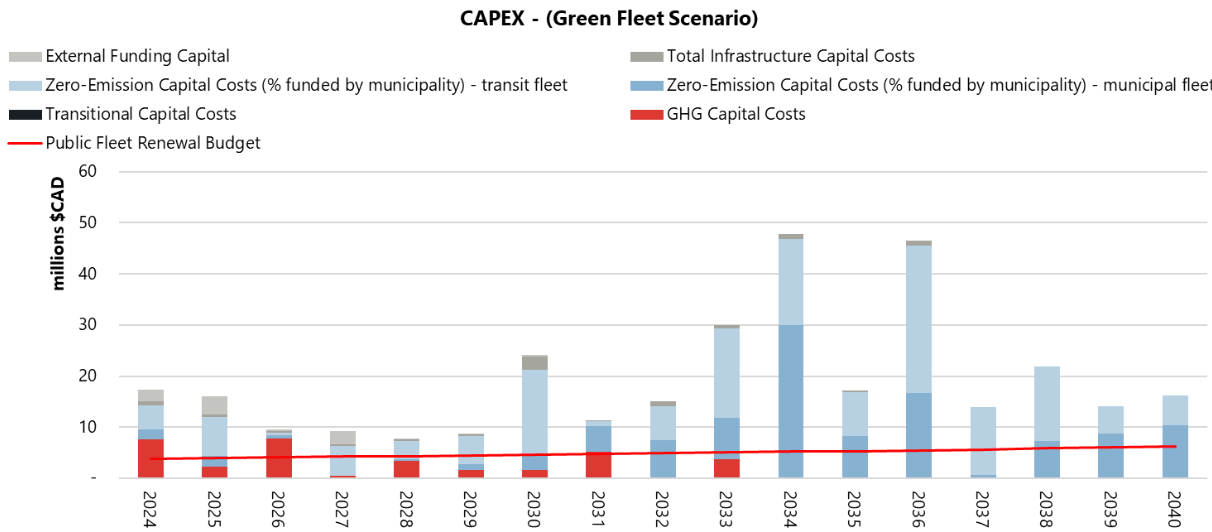

Figure 4: Periodic capital expenditure profile for the green fleet transition

The capital expenditure profile for the green fleet scenario is likely to be untenable within the City of Burlington's current fleet renewal budget. Forecasts are most notable for years 2030, 2033, 2034 and 2036, exceeding the City's annual budget by a factor of 400 per cent or more.

Except for year 2024, the expenditure peaks may be attributed in equal parts to the high volume of vehicles to be replaced and the high capital cost per unit as vehicle categories with newly commercialized zero-emissions alternatives become due for replacement. Fire trucks, HDVs, MDVs and Tractor/Loaders – categories predominantly due for transition in years with expenditure peaks – all cost at least 50 per cent more than their ICE variants.

Given the nature of the expenditure profile, the City Council may consider an alternative green fleet transition scenario that accounts for distribution of capital requirements across the procurement time horizon.

Maintenance costs of an increasingly green fleet immediately start diverging from an otherwise diesel fleet. The operating cost decline due to lower maintenance costs of an electric vehicle is augmented by increasing savings in fuel and carbon costs as more vehicles continue their transition to battery electric variants, especially between years 2029 and 2036. A future green fleet is expected to incur half the estimated annual BAU operating costs starting in year 2040.

Tailpipe emissions from vehicles will drop to zero leading up to the year 2040 as the green fleet inventory expands to all vehicle groups. The fleet will undergo a notable drop in overall Scope 1 and 2 emissions during the period of the fleet transition from 2024 to 2040 as well – amounting to a 57 per cent cumulative reduction compared to continued diesel vehicle replacements. It amounts to approximately 28,000 tonnes of cumulative emissions reductions. Years 2029 to 2036 see the steepest decline in emissions owing to the large number of GHG-vehicle replacements during this period.

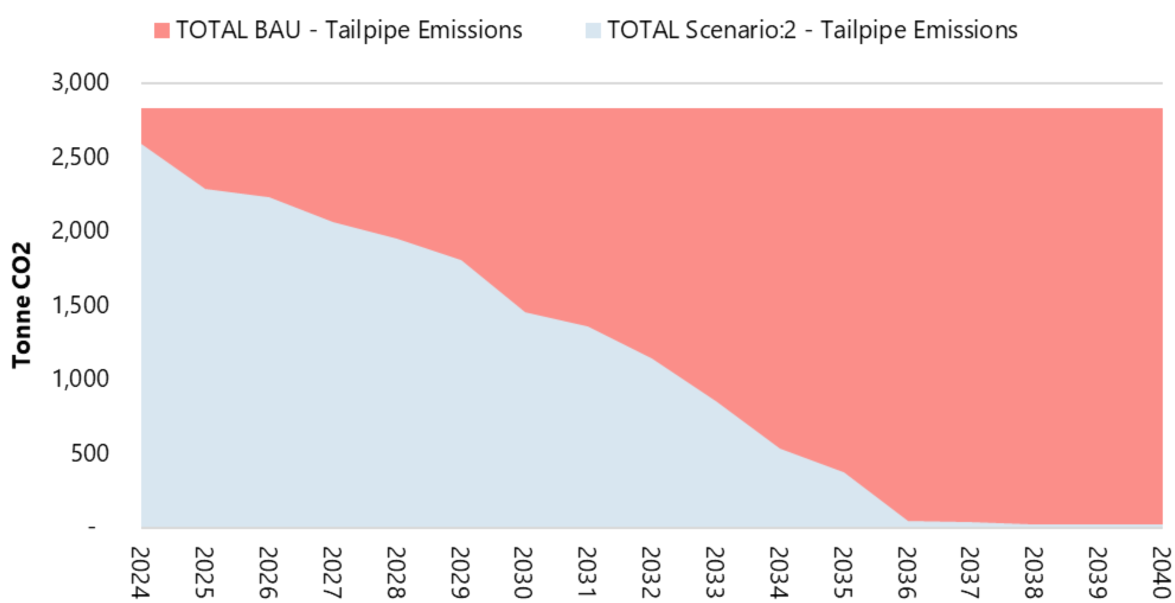

Figure 5: Tailpipe emissions trajectories for the green fleet transition compared to Business-as-Usual procurement

Low-carbon hydrogen has the potential to play an important role as an alternative fuel to eliminate tailpipe emissions from certain vehicle groups for which battery-electric technology would limit performance capabilities. While the hydrogen fuel cell electric vehicle (FCEV) market diversifies to different vehicle types, hydrogen supply infrastructure is the other critical value chain link requiring advanced planning. Early engagement and partnership planning with other potential regional end-users of hydrogen would allow the City of Burlington to share the risks and opportunities involved in piloting and deploying a hydrogen supply chain for its fleet.

Piloting vehicles and sometimes, entire value chains, before committing to their large-scale deployment can be a valuable ‘stepping-stone’ initiative to create familiarity with and reliance on a new technology. This includes understanding the ability of a vehicle to perform its required duty cycle, identifying its strengths, and identifying weaknesses that require solutions on the vehicle or service-delivery planning side. Such familiarity helps refine the procurement strategy and fleet transition rate to better inform the selection of suitable charging or fuelling solutions.

Based on the fleet transition roadmap and strict performance demands dictated by strenuous duty cycles, it is recommended that the City initiate pilot projects for the following vehicle categories to acquire user experience, gather empirical performance data and prepare for asset management of newly commercializing zero-emission models:

- Phase 1
  - Fire trucks
  - Heavy-duty vehicles
  - Medium-duty vehicles
  - Utility vehicles
- Phase 2
  - Construction vehicles

It is also recommended that the City upgrade its telematics and maintenance recording systems to track a wide variety of zero-emissions vehicle performance data.

Conclusion

Technology readiness of zero-emissions alternatives and a flexible fleet transition budget will be critical links in a successful green fleet transition to net-zero emissions by 2040. The City is well positioned to build momentum on its fleet transition with the electrification of light-duty vehicles and transit buses – vehicle groups which have seen substantial commercial advancements in recent years – in the first phase from year 2024 to 2028. Gross expenditure projections for a fleet transition will see substantial spikes as the electrification of heavy-duty vehicles begins in phase 2 of the transition starting in year 2029. However, GHG emissions reductions are also expected to see a steeper decline in this phase. The final phase of the transition will see electrification of construction vehicles and the last remaining diesel fire trucks and heavy-duty vehicles.

Utility and charging infrastructure upgrades will need to lead ZEV purchases, however, this study does not evaluate the timing of such upgrades by facility or parking location. Hydrogen supply and refueling may demand additional partnership building and infrastructure planning should electrification through FCEVs be deemed a suitable alternative for certain vehicle groups.

Commitments to large-scale ZEV procurements as well as detailed engineering-design and installation of infrastructure may be ideally preceded by pilot projects. Pilot projects will help build operational familiarity while collecting empirical performance data of emerging ZEV models.

Large-scale ZEV deployment preparation is best supplemented by a robust change management and communications strategy. Such a strategy will be critical to prepare internal as well as external stakeholders for a smooth fleet transition. Specifically, staff training for and on-boarding to upcoming changes to the current fleet operating paradigm will be crucial to adopt new vehicle and infrastructure operations and maintenance practices.