For Action

Green Bus and Wheel-Trans Green Bus Program Update

Date: July 14, 2022
To: TTC Board
From: Executive Director, Innovation and Sustainability

Summary

This report includes updates and next steps on the Green Bus Program and Green Wheel-Trans Bus Program, with emphasis on recent requests from the Board for the status of the current eBus procurement, Canadian content requirements, the economics of advancing eBus adoption, and the TTC's reinvestment of permanent operating savings.

Green Bus Program

The TTC's Green Bus Technology Plan (Plan), approved by the Board in November 2017, identified a strategy to transition the conventional bus fleet to zero-emissions by the year 2040. The resulting Green Bus Program is currently ahead-of-schedule, on-budget, and is delivering on the projected benefits.

In April 2022, the TTC posted a Request for Proposal (RFP) for the procurement of approximately 240 battery-electric eBuses (base order) for deliveries between 2023 and 2025. Currently, the TTC is in Stage 2: Commercial Confidential Meetings (CCMs) of the procurement process, which allows for dialogue between the TTC and the proponent(s) on general conditions and technical requirements. The contract award is targeted for September 2022 with deliveries expected to commence in late 2023.

The TTC has submitted an application for grant funding under the federal government's Zero Emission Transit Fund (ZETF) and the application is currently under review. If successful, additional grant funding would allow for an increase in procurement quantity from 240 eBuses up to 400 eBuses and all associated electrification infrastructure.

All new bus (and rail vehicle) acquisition contracts, include a Canadian content requirement that complies with TTC's Procurement Policy, relevant trade agreements, and the Ministry of Transportation's Canadian Content for Transit Vehicle Procurement Policy (MTO Policy), which require municipalities procuring public transit vehicles to have a minimum of 25% Canadian content. While this is the specified minimum, the trade agreements prevent awarding contracts on the basis of a proposal to exceed 25% Canadian content. TTC transit vehicle acquisition contracts provide TTC the right to conduct an audit of the Canadian content.

The Green Bus Program is tracking toward completion in 2037, three years ahead of the 2040 target. Advancing adoption further would accelerate the realization of benefits and would continue to deliver net operating savings, even when considering the cost of capital and the time value of money associated with accelerating the procurement costs. In the future, when battery technology has matured sufficiently to deliver the range required, and when the TTC's Capital Budget and Plan includes funding beyond what is already fully committed, staff will return to the Board with a plan to advance eBus adoption that addresses all remaining constraints and interdependencies.

In the meantime, following the Board's direction, staff have been working with the City of Toronto to develop a financial mechanism through which the TTC can reallocate operating budget savings, from fleet electrification and other innovation and sustainability initiatives, to use as direct offsets for TTC operating budget expenditures and to secure funds for repayment of recoverable capital debt financing to self-fund implementation of the TTC's Innovation and Sustainability Program, including the greening of the TTC's fleets.

Green Wheel-Trans Bus Program

In 2017, the TTC also took its first step to replace its diesel-fuelled Wheel-Trans buses through introduction of 6m, and later 7m, gasoline-fuelled mini-buses. By Q3 2023, the entire Wheel-Trans fleet will have been transitioned away from diesel-fuelled buses and a public procurement for the first zero-emissions, battery-electric Wheel-Trans buses will have been issued to the market.

Recommendations

It is recommended that the TTC Board:

1. Receive this Green Bus Program and Wheel-Trans Green Bus Program Update for information;

2. Direct staff to report back to the TTC Board in January 2023 on the status of the eBus procurement through the CEO's Report; and

3. Endorse TTC staff's continued efforts to develop a financing strategy to enable the TTC to contribute to the funding of its Innovation and Sustainability Program implementation such that operating savings, from fleet electrification and other innovation and sustainability initiatives, can be reallocated to offset TTC operating costs and be secured to service debt borrowing costs for capital works arising from the implementation of the TTC's Innovation and Sustainability Program.

Financial Summary

This report is being provided as an update to the Green Bus and Wheel-Trans Green Bus Program and approval of the recommendations do not result in any additional financial impacts beyond what has been approved in the 2022-2031 Capital Budget and Plan and the 2022 Operating Budget.

The TTC's Green Bus Program, originally approved by the TTC Board in November 2017, recommended the purchase of hybrid-electric buses as a transition technology towards zero-emission buses. This included an initial procurement of 255 hybrid-electric buses currently in service and the procurement and delivery of 60 eBuses from the only manufacturers of long-range, battery-electric buses: BYD, New Flyer Industries, and Proterra. The TTC has provided updates on the head-to-head evaluation of the 60 eBuses to the Board, with the final report presented at its meeting on April 14, 2022.

The TTC's Green Bus Program includes the procurement of only eBuses starting in 2024, one year ahead of the 2025 target. The current program schedule will ensure full-fleet conversion to zero-emissions by 2037, which is three years ahead of the City of Toronto's TransformTO Net Zero Strategy target of 2040.

Funds for the Green Bus Program are included in the TTC's 2022-2031 Capital Budget and Plan, as approved by the TTC Board on December 21, 2021 and by City Council on February 17, 2022 under Program 4.11 Purchase of Buses. The 10-year Capital Budget and Plan includes $688.6 million in approved funding, for the procurement of approx. (based on vehicle pricing estimates at the time) 600 new buses, including 300 hybrid-electric buses and 300 eBuses for delivery between the years 2023 and 2025. With the recent contract awards for 336 hybrid-electric buses, where vehicle pricing is finalized, the remaining available funds allow us to procure approx. 240 eBuses.

This enables the TTC to procure approximately 576 of the 1,826 buses identified in its fleet plan during the 10-year capital planning timeframe. The remaining buses will require an additional $2.9 billion in funds over the next 15 years; $1.6 billion is unfunded in the current 10-year window and $1.3 billion in the five years post-2031.

The TTC is currently seeking $350 million in matching grant funding from Infrastructure Canada (INFC) through the Zero Emission Transit Fund (ZETF). This would allow the TTC to procure an additional 160 eBuses and the associated charging infrastructure. If successful, this would take our unfunded need down to 1,090 buses from 1,250 buses.

The TTC also has funding in its 2022-2031 Capital Budget and Plan of $77.6 million towards the Class 5 estimate of $656.8 million required to implement charging infrastructure through to 2031. This funding capacity was made possible with City Council's approval of additional City Building Funds in 2020.

Although operating cost savings of up to $50,000 per bus per year are possible, before consideration of financing costs, the TTC does not have the required funding to accelerate beyond the 400 eBuses that are possible through the ZETF application.

In addition, the 10-year Capital Budget and Plan includes $45.6 million for the purchase of the Wheel-Trans buses between 2022-2023. An additional $173.6 million remains unfunded in the current 10-year window and $116.2 million in the five years post-2031. Further, $42.8 million is identified in the TTC's Capital Investment Plan for the implementation of charging infrastructure for the Electric Wheel-Trans Bus fleet.

The Chief Financial Officer has reviewed this report and agrees with the financial impact information.

Equity/Accessibility Matters

A cornerstone of TTC's Corporate Plan 2018-2022 is a commitment to ensuring accessible, safe, reliable and inclusive transit services for all TTC customers. The TTC is also committed to promoting equitable opportunities and removing barriers within its supply chain and procurement initiatives. This section outlines recent advancements in procurement equity, accessibility and green procurement.

Equity

In support of the commitment to equity, diversity and inclusion, the latest hybrid-electric bus procurement and the current eBus procurement obligate the contractor to meet two procurement equity requirements: a diverse business enterprise requirement and an equity hired requirement. The diverse business enterprise requirement is a commitment, during the term of the contract, to spending a specified percentage of the contract price toward the support, initiative, policy, etc., of diverse business enterprises. The equity hired requirement is a commitment, during the term of the contract, to increase hiring of persons from equity deserving groups or communities. The contract provides the TTC auditing rights to confirm the contractor has met the requirements. Failure of the contractor to meet the requirements results in the payment by the contractor of liquidated damages.

Accessibility

A reliable transit network is critical for persons from equity deserving groups or communities relying on the TTC's services to get to work, get to school, access health services, and participate in recreational and cultural services, etc.

People who have experienced barriers to accessing public services, including public transit, typically have poorer economic and health prospects. Access to transit that is equitable, accessible, safe, reliable, and that grows with or ahead of the population will help improve health outcomes and economic prosperity across the city, region and nation.

All buses, regardless of the propulsion technology, will be compliant with the Canadian Standards Association D435 standard for accessible transit buses, which outlines requirements for safe transportation for persons with physical disabilities. All buses will also be compliant with the Accessibility for Ontarians with Disabilities Act, 2005 (AODA). The TTC strives to exceed the associated requirements outlined and has included the Advisory Committee on Accessible Transit (ACAT) in design reviews of its bus procurements.

Decision History

On November 13, 2017, the TTC Board delegated the authority to the TTC CEO to negotiate and enter into the following:

1. Up to three contracts for the supply of 30 long-range, battery-electric buses with BYD, New Flyer Industries and Proterra with a total project cost of up to $50 million;
2. Up to two contracts for the supply of 230 new-generation, hybrid-electric buses with Nova Bus and New Flyer with a total project cost of up to $230 million; and
3. All vehicles are to be delivered no later than March 31, 2019 to be eligible for PTIF funding.

Report:
Green Bus Technology Plan

Decision:
Green Bus Technology Plan

At the June 12, 2018 TTC Board meeting, staff presented an update on the TTC Green Bus Technology Plan. The TTC Board delegated the authority to the TTC CEO to procure an additional 30 long-range, battery-electric buses with BYD, New Flyer Industries and Proterra, to be delivered no later than March 31, 2020 to ensure eligibility for Public Transit Infrastructure Fund (PTIF) funding. In addition, staff were directed to begin preparations for the electrification of the TTC's first all-electric bus garage to support future procurements of battery-electric buses for a total project cost of $90 million.

Report:
Green Bus Technology Plan Update

The Board also requested the following:

1. To review the operations of the 75 Sherbourne service and on other routes with similar issues (noise and air quality) to see how electric buses and other measures could minimize the impacts along the residential neighbourhoods through which they operate;
2. To report on the eBus rollout plan, including details on charging stations and infrastructure requirements, and consider the feasibility of prioritizing the use of electric buses on routes that run on local and collector roads; and
3. The TTC confirms its target for procurement of only zero-emissions propulsion technology starting in 2025 and define zero-emissions propulsion technology as fossil-fuel-free.

Decision:
Green Bus Technology Plan Update

At the January 27, 2020 TTC Board meeting, staff presented the TTC's 2020-2029 Key Capital Priorities, which included recommendations on how to allocate the recent allocation of the City's Building Fund according to the TTC's state-of-good-repair backlog.

At this meeting, the TTC Board approved the allocation of:

- $686 million, representing approximately one third of the estimated 10-year cost, toward procurement of 614 buses; and

- $64 million, for eBus charging system infrastructure.

Report:
TTC's 2020-2029 Key Capital Investment Priorities: Subway Infrastructure and Accelerated Vehicle Procurements

Decision:
TTC's 2020-2029 Key Capital Investment Priorities: Subway Infrastructure and Accelerated Vehicle Procurements

At its February 25, 2020 meeting, the TTC Board received the TTC's Green Bus Program Update report for information and adopted the following motions:

1. Report back on potential partnership opportunities that could advance design, procurement, construction, and enable co-investment, co-ownership and co-maintenance of the TTC's electric vehicle charging infrastructure; and
2. Direct the TTC CEO to submit to the September 2020 TTC Board meeting a business case analysis for action on an expedited procurement plan for the 614 funded buses included in the revised 2020-2029 Capital Budget and Plan.

Report:
TTC Green Bus Program Update

Decision:
TTC Green Bus Program Update

At the October 22, 2020 TTC Board meeting, staff presented a report on the TTC's Fleet Procurement Strategy and Plan, including strategies for the acceleration of transit vehicle procurements, and highlighted promising technologies from the TTC's vehicle innovation pipeline. The Board adopted the following motions:

1. Delegate authority to the TTC Chief Executive Officer to award up to two contracts for the supply and delivery of approximately 300 hybrid-electric buses for the estimated cost of approximately $390 million, inclusive of all taxes and project delivery costs, based on the following:
    a. Negotiation of an acceptable agreement, satisfactory to the TTC Chief Executive Officer and General Counsel, with one or both of the only two qualified suppliers of hybrid-electric buses compliant with Transport Canada's Commercial Motor Vehicle Safety Standards; and

b. All buses are to be delivered between 2022 and 2023.

2. Request staff to report back to the TTC Board in Q2 2021 with the first-year test results of the eBus head-to-head evaluation and the resulting technical requirements for the supply and delivery of approximately 300 all-electric, long-range buses commencing in 2023 through 2025.

Report:
TTC Fleet Procurement Strategy and Plan

Presentation:
TTC Fleet Procurement Strategy and Plan

Decision:
TTC Fleet Procurement Strategy and Plan

At the April 14, 2021 TTC Board meeting, staff provided a report summarizing preliminary results of the TTC's eBus Head-to-Head Evaluation. The Board adopted the following recommendations:

1. The Board delegate authority to the TTC CEO to undertake a public procurement through issuance of a negotiated Request for Proposal (nRFP) and enter into up to two contracts for the supply of approximately 300 long-range, battery-electric buses (eBuses), based on the following:
    a. Limit the total contract award amount, including all applicable taxes, and project delivery costs to within the approved funding of approximately $300 million;

    b. Apply lessons learned through the TTC's eBus Head-to-Head Evaluation to prequalify potential suppliers based on demonstrated compliance with system compatibility requirements and Transport Canada's Motor Vehicle Safety Standards;

    c. All 300 eBuses to be delivered between Q1 2023 and Q1 2025; and

    d. Negotiation of an acceptable agreement that is satisfactory to the TTC General Counsel.

Report:
TTC's Green Bus Program: Preliminary Results of TTC's Head-to-Head eBus Evaluation

Decision:
TTC's Green Bus Program: Preliminary Results of TTC's Head-to-Head eBus Evaluation

At the February 10, 2022 TTC Board meeting, staff provided a report containing information about the position, plan, procedure, criterion and instruction to be applied to

negotiations carried on or to be carried on by or on behalf of the TTC for the principal agreement between the TTC and PowerON Energy Solutions LP (PowerON) for electric vehicle charging systems infrastructure. The Board adopted the following recommendations:

1. Approve the proposed negotiated terms with PowerON Energy Solutions LP (a subsidiary of Ontario Power Generation Inc.) for the co-investment, ownership, design, build, operation and maintenance of electrification infrastructure as set out in the Confidential Attachment.
2. Delegate authority to the CEO to enter into the TTC-PowerON Principal Agreement with PowerON Energy Solutions LP (a subsidiary of Ontario Power Generation Inc.),
    i) with an upset limit amount of $69.8 million in Canadian funds, inclusive of all taxes, for implementation of fleet electrification infrastructure;
    ii) subject to the receipt of further funding commitments by TTC towards remaining fleet electrification infrastructure, to amend the TTC-PowerON Principal Agreement upset limit up to $591 million in Canadian funds, inclusive of all taxes; and
    iii) subject to terms and conditions satisfactory to the TTC's General Counsel.
3. Request regular reporting back to the Board on the performance of PowerON Energy Solutions LP through staff's updates on the TTC's Green Bus Program.
4. Subject to the mutual agreement of the TTC and PowerON Energy Solutions LP (a subsidiary of Ontario Power Generation Inc.), the TTC to make public the executed TTC-PowerON Principal Agreement.

Report:
Principal Agreement with PowerON Energy Solutions LP (OPG) to Decarbonize TTC Operations, Fleet, and Facilities

Decision:
Principal Agreement with PowerON Energy Solutions LP (OPG) to Decarbonize TTC Operations, Fleet, and Facilities

At the April 14, 2022 TTC Board meeting, staff provided results of the TTC's final eBus Head-to-Head Evaluation. The Board adopted the following recommendations:

1. Receive for information the results of the TTC's eBus Head-to-Head Evaluation as outlined in this report; and
2. Delegate authority to the TTC Chief Executive Officer to: a. Enter into contribution agreement(s), where required, with government partners to receive any net new funding /financing for the TTC's Green Bus program; and b. Subject to commitment of matching funds from provincial and/or federal government partners, amend existing and pending contract(s) to increase the eBus procurement quantity and associated infrastructure works in proportion to the additional funds committed.

Report:
TTC's Green Bus Program: Final Results of TTC's Head-to-Head eBus Evaluation

Decision:
TTC's Green Bus Program: Final Results of TTC's Head-to-Head eBus Evaluation

Issue Background

The TTC's Green Bus Program, which was approved by the TTC Board in November 2017, identifies a procurement strategy to transition the fleet to zero-emissions by the year 2040. This plan is aligned with the City of Toronto's TransformTO Net Zero Strategy and the C40 Fossil-Fuel-Free Streets Declaration. The TTC's Green Bus Program includes the procurement of hybrid-electric buses as a transition technology until the steady-state procurement of only zero-emissions, battery-electric buses.

At the April 14, 2022 TTC Boarding Meeting, the TTC Board requested staff report back in July 2022 with the following:

1. Status update on the current eBus procurement;
2. Economics of advancing eBus adoption; and
3. TTC's reinvestment of permanent operating budget savings from fleet electrification.

This report includes updates and next steps on the Green Bus Program and Wheel-Trans Green Bus Program, with emphasis on recent requests from the Board for the status of the current eBus procurement, Canadian content requirements, the economics of advancing eBus adoption, and the TTC's reinvestment of permanent operating savings.

Comments

Green Bus Program

Hybrid-Electric Buses

Procurement Overview

Since the establishment of the Green Bus Program in 2017, the TTC has delivered 255 hybrid-electric buses. In addition, on February 28, 2022, the TTC awarded its last contracts for 336 hybrid-electric buses with deliveries commencing in 2023 (see Table 1). Currently, pre-production meetings to finalize the vehicle design and configuration, are ongoing with production scheduled to commence in Q4 of this year.

Green Bus Procurement Plan											
	2017-2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Hybrid	255	336									336
eBus	60	50	183	167	170	175	175	190	190	190	1490
Total	0	386	183	167	170	175	175	190	190	190	1826

Table 1: Hybrid-Electric Bus Procurement Plan (highlighted in yellow)

Benefits

The introduction of hybrid-electric buses have provided numerous benefits associated with service, the environment and finances as detailed in Table 2 below:

Benefits	Outcome
Service Impact	Reliability is more than double the Mean Distance Between Failure target of 30,000 km
Environment Impact	Reduce GHG emissions by 47% over conventional diesel buses and 25% (or 23 tonnes/bus/yr) over clean diesel buses.
Financial Impact	Reduce fuel cost by 47% over conventional diesel buses and 25% (or $12,700/bus/yr) over clean diesel buses, at current diesel pricing.
Other Key Benefits	• Engine stop/start technology to prevent idling in traffic and at bus stops; and • All-electric accessories, including doors, HVAC, power steering, and air compressor systems to improve reliability and facilitate transition to maintenance of zero-emissions, battery-electric buses.

Table 2: Hybrid-Electric Bus - Benefits

Next Steps

Hybrid-electric buses have the ability to switch into all-electric (EV) mode for up to five kilometres for zero-emissions operations. This function has been under test on five of the TTC's existing hybrid-electric buses, providing benefits to both noise and air quality at garages and subway stations. All 336 new hybrid-electric buses due in 2023 will be equipped with this feature.

Battery-Electric Buses

Procurement Overview

The TTC's first 60 eBuses were procured from BYD, NFI and Proterra with the first eBus entering service in June 2019. As of September 2020, all 60 eBuses procured have been in-service. In total, the eBus fleet has accumulated more than 2.5 million kilometres.

Green Bus Procurement Plan											
	2017-2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Hybrid	255	336									336
eBus	60	50	183	167	170	175	175	190	190	190	1490
Total	0	386	183	167	170	175	175	190	190	190	1826

Table 3: Battery-Electric Bus Procurement Plan (highlighted in yellow)

On April 4, 2022, the TTC issued a Request for Proposal (RFP) to the market for the procurement of 240 eBuses (base order) for delivery between 2023-2025 with the option to purchase up to 755 additional eBuses for delivery between 2023-2027. In addition, the RFP includes the option of purchasing 650 eBuses by other transit agencies in the Province of Ontario. While the RFP will be made available to other public transit agencies, each transit agency purchasing eBuses under the RFP will be required to arrange for separate agreements with the successful proponent(s).

The procurement process for the eBuses includes the following four primary stages:

Stage 1: Pass/Fail Requirements

This stage will identify the proponent(s) who are able to meet the TTC's mandatory requirements, which were informed by the Head-to-Head eBus Evaluation that was presented to the TTC Board in April 2022. With the RFP being the TTC's first large-scale procurement of eBuses, these requirements have been developed to ensure the longevity of the eBus structure and high system reliability.

Stage 2: Commercial Confidential Meetings

This stage will consist of commercial confidential meetings (CCMs) between the TTC and each qualified proponent from Stage 1. The CCMs allow for meaningful dialogue on the information provided by the proponent(s) with regards to the general conditions and technical requirements of the RFP. Through dialogue, each party is able to better understand the requirements of the RFP. This will help guide the proponent(s) in meeting the requirements set out in the RFP and for providing the most suitable eBus for the TTC.

Stage 3: Final Submission

This stage consists of the review and scoring of all content submitted by the proponent(s), including their technical proposal, responses to procurement equity and green procurement requirements and pricing. The TTC will rank proponent(s) in accordance to the overall total points scored.

Stage 4: Contract Award

This stage will consist of inviting the highest ranked proponent(s) to enter into contract for the supply of eBuses. The RFP has prescriptive conditions where the result may include splitting the 240 eBuses (base order) between two qualified proponents.

Currently, the TTC is on schedule to be at Stage 3 by the end of August with contract award targeted for September 2022.

Funding Status

Approved funding enables the TTC to procure approximately 240 of the 400 eBuses required to maintain the TTC's bus fleet to 2025. The TTC is currently seeking $350 million in matching grant funding from Infrastructure Canada (INFC) through the Zero Emission Transit Fund (ZETF), which would cover 50% of the eligible costs to procure approximately 400 eBuses and 540 charge points between 2022-2025. An application to INFC has been submitted and is currently under review. However, eBus procurements beyond the current procurement of 240 eBuses currently remain unfunded.

The City of Toronto is currently in discussions with the Canada Infrastructure Bank (CIB) with respect to future financing opportunities as it relates to a range of infrastructure, including Zero-Emission Buses. The TTC is working with the City to identify options within the TTC's fleet procurement plan for Zero-Emission Buses that may benefit from the City entering into a financing arrangement with the CIB. City Finance staff are reporting to City Council in July to seek authority to enter into a non-binding Memorandum of Understanding (MOU) to further assess and develop potential partnership opportunities. The TTC has engaged in early discussions with both the City and CIB and will continue to support the City as they explore options available.

Canadian Content

On March 20, 2008, the Premier of Ontario announced, effective September 1, 2008, all public transit vehicles procured using provincial funding must have at least 25% Canadian content. This requirement would be applicable to the procurement of any revenue vehicles, including city buses and light rail vehicles. In addition, the Premier required the application of liquidated damages which the contractor is to pay should the contractor fail to meet the minimum 25% Canadian content requirement.

At the December 16, 2009 Board meeting, staff presented the findings of a report prepared by Booz Allen Hamilton (BAH Report) outlining the highest practical level of Canadian content that could be achieved for low floor transit bus procurements while maintaining competition. Based on the findings in the BAH Report, the Board approved

a motion to implement the following Canadian content requirements for future TTC bus procurements:

i. A minimum of 50% Canadian direct assembly labour for future bus procurements.
ii. 40% Canadian content for 40-foot diesel powered buses.
iii. 30% Canadian content for 40-foot hybrid powered buses.
iv. 35% Canadian content for 60-foot diesel powered buses.
v. 30% Canadian content for 60-foot hybrid powered buses.

At the time, the Canadian content requirement in the MTO Policy was a minimum of 25%. Therefore, a municipality was permitted to require a higher percentage of Canadian content in transit vehicle procurements.

In 2017, the Government of Canada announced the implementation of the Canadian Free Trade Agreement (CFTA) and the Canada-European Union's Comprehensive Economic Trade Agreement (CETA). This resulted in changes to the provincial Ministry of Transportation's Canadian Content for Transit Vehicle Procurement Policy (MTO Policy) to ensure the provisions of the MTO Policy were aligned with, and did not contravene, the requirements of CFTA and CETA.

At the June 15, 2017 Board meeting, the Board approved the following recommendation by staff:

> *Adopt the MTO's Canadian Content for Transit Vehicle Procurement Policy; thereby replacing TTC's current Canadian Content Policy to prepare for the implementation of the CFTA and CETA which is anticipated to be passed into legislation after the third reading by the Canadian Government, thereby coming into effect July 1, 2017.*

The recommendation was necessary to ensure TTC's Procurement Policy regarding Canadian content aligned with, and did not contravene, the requirements of CFTA and CETA.

All current and future transit vehicle acquisition contracts, include a Canadian content requirement that complies with TTC's Procurement Policy, CFTA, CETA, and the MTO Policy which require municipalities procuring public transit vehicles to have a minimum of 25% Canadian content. As described, while this is the specified minimum, the trade agreements prevent awarding any favour for contract proposals that exceed the minimum of 25%.

The following is a list of recent and upcoming vehicle procurements:

i. 60 streetcars (awarded in 2021).
ii. 336 hybrid-electric buses (awarded in 2022).
iii. Approximately 300 battery-electric buses (award targeted for Q3 2022).
iv. New subway trains (award targeted for Q1 2023).

For all upcoming bus and rail vehicle procurements, TTC will continue to specify the 25% minimum Canadian content policy and engage an independent auditor to verify compliance.

Benefits

Similar to the hybrid-electric buses, the introduction of battery-electric buses have provided numerous benefits associated with service, the environment and finances (see Table 4 below) and will continue to do so with the delivery of the TTC's first large-scale procurement of eBuses expected to commence in late 2023. Projected benefits in the next 15 years are shown in Figure 1 below.

Benefits	Outcome
Service Impact	Reliability continues to improve and lessons learned from the eBus Head-to-Head evaluation were used to inform the current large-scale eBus procurement
Environment Impact	Reduce GHG emissions by 100% or 93 tonnes/bus/yr over clean diesel.
Financial Impact	Reduced fuel/energy cost by 77% or $40,000/bus/yr over clean diesel
Other Key Benefits	• Zero tailpipe emissions • Reduced operating noise • Improved vehicle reliability

Table 4: Battery-Electric Bus-Benefits

Using key assumptions associated with fuel costs, electricity costs and maintenance costs for both vehicle and charging infrastructure, costs savings and avoidances were calculated.

From 2023-2040, when the bus fleet is fully electrified, a total operating savings of $399.3 million (see Table 5) is projected based on the 2022 budgeted fuel cost of $1.13/Litre and an expectation that bus running maintenance costs for eBuses will be 25% lower starting in 2027.

Savings relative to the 2022 approved operating budget will be used to offset operating budget pressures or secure recoverable debt. In addition given recent and expected escalation in fuel prices, battery-electric buses are expected to avoid significant future operating costs estimated at $14 million to 2025 and up to $900 million between 2026 and 2040.

	2023-2025	2026-2030	2031-2035	2036-2040	Total
Operating Savings (Fuel/Maintenance)	($6,200)	($63,300)	($126,400)	($203,400)	($399,300)

Table 5: Cost Savings (000's)

As the TTC transitions to a zero-emissions fleet, continued reductions in fuel usage are projected (see Figure 1 below).

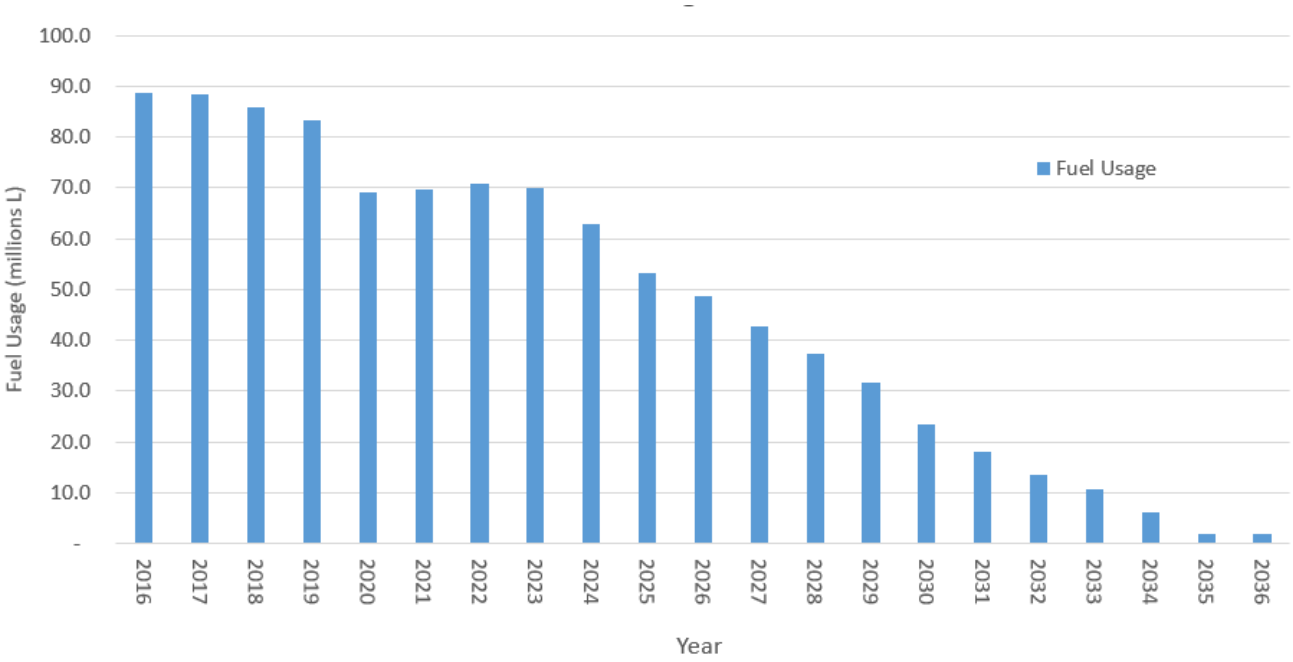

Figure 1: Fuel Usage

While reduced operating mileage due to the COVID-19 pandemic has affected the actual fuel usage data to date, it is anticipated that fuel usage will consistently reduce as the overall bus fleet converts to primarily battery-electric. Similarly, gradual reductions in GHG emissions are projected as we target a zero-emissions fleet by 2040. As reflected in the current eBus procurement plan, the TTC is striving to have a zero-emissions fleet by 2037 to allow for contingencies/delays or risks encountered during this transition.

By 2025, more than 50% of the fleet will be composed of hybrid-electric and battery-electric buses and all conventional diesel buses will have retired (see Figure 2 below).

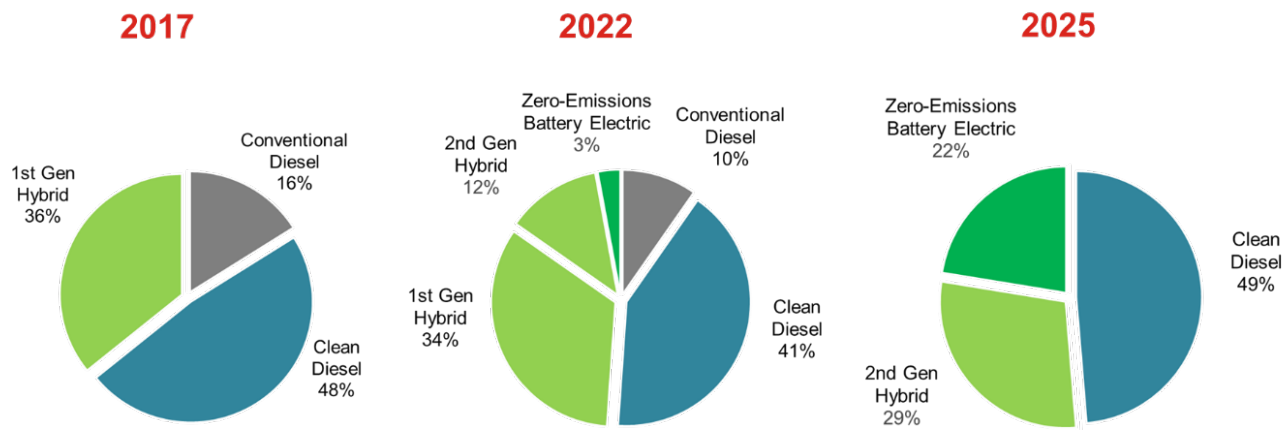

Figure 2: Fleet Composition

Advancing eBus adoption

The purpose of this analysis is to evaluate the economics of advancing the adoption of eBuses. As part of this analysis, the following has been evaluated:

1. Constraints and interdependencies including funding, charging infrastructure and technology; and
2. Economic impact of accelerating the procurement of eBuses.

1. Constraints and Interdependencies:

- Funding: As noted previously in the report, although the TTC continues to work with its government partners to secure matching funds, eBus procurements beyond the current procurement of 240 eBuses remain unfunded.

- Charging Infrastructure: A key constraint and interdependency with the advanced adoption of eBuses is the availability of charging infrastructure. Currently, the TTC is targeting the installation of charging infrastructure a minimum of six months prior to the delivery of the associated eBuses.

  With the finalization of the TTC-PowerON principal agreement targeted for Q3 2022, the TTC is ramping up work to install 540 charge points at eight garages between 2023-2025 to support the 400 eBuses anticipated for delivery during this timeframe.

  With the current procurement being the TTC's first large-scale adoption of eBuses, a conservative spare ratio between eBuses versus charge points is planned to include sufficient redundancy in the system to minimize the impact to the maintenance and operations of the fleet and to mitigate any associated risks. As such, advancing the adoption of eBuses would require additional funding and advancement of charging infrastructure.

- Technology: An important factor in the adoption of battery-electric buses is the ability to match the range performance of a diesel-powered bus. Each eBus in the current fleet of 60 battery-electric vehicles is able, on average, of driving approximately 180 kilometres based on battery capacities, energy density and bus efficiency. This results in our ability to cover approximately 45% of our blocks of service. With battery technology continuously evolving, we anticipate battery-electric buses procured between 2025-2030 will have battery capacity to cover approximately 80% of our blocks of service. This is based on the recent market trends observed where battery capacity has increased about 25-30% in a five-year span.

  As such, advancing the adoption of eBuses would not allow time for the battery technology to mature sufficiently, which may introduce operational risks where insufficient blocks of service are available to dispatch eBuses. This would result in the potential need for additional buses to bridge this gap in operations.

2. Economic Impact:

To evaluate the economic impact of the advanced adoption of eBuses, the TTC compared the Net Present Value (NPV) of various accelerated eBus adoption scenarios. Key assumptions and inputs to this analysis include operational costs related to fuel and electricity, projected maintenance savings and cost of interest associated with the issuance of debentures (see Appendix A for Economic Assumptions).

Based on the currently projected diesel fuel price of $1.5/L for 2023, operation of an eBus versus a clean-diesel bus would reduce operating costs for energy (i.e. net of diesel fuel savings and electricity costs) by approximately $40,000 per bus, per year. Further, starting in 2027 when staff have sufficient confidence to start budgeting maintenance savings, it is expected that an additional $10,000 per bus, per year will be realized.

The NPV value of these savings is calculated over the 13-year design life of a bus for all scenarios. These savings are then compared to the additional interest incurred from the accelerated purchase of eBuses. For illustrative purposes, NPV interest costs were based on 1% interest.

As shown in Table 6 below, relative to a base scenario with no acceleration, net of interest cost, approximately $27,000 in net additional savings could be achieved per bus for each year a bus purchase is accelerated.

Number of Years Accelerated	NPV Operating Savings	NPV Interest Cost to Accelerate at 1%	NPV Net Operating Savings	Savings Compared to Base Scenario
Base Scenario (No acceleration)	355,000	0	355,000	0
1	395,000	(13,000)	382,000	27,000
2	434,000	(25,000)	410,000	55,000
3	474,000	(37,000)	437,000	82,000

Note 1: all calculations are over the 13-year bus life

Table 6: Net Present Value

Although net cost savings are projected for the accelerated adoption of eBuses, the TTC does not have the required funding to accelerate beyond the 400 eBuses and associated electrification infrastructure that is outlined through the ZETF application, currently under review by the federal government. Further to this, beyond the fiscal constraint, acceleration in eBus deliveries would not allow time for the battery technology to mature sufficiently.

It should be noted that with the current eBus fleet, the TTC continues to monitor its in-service performance and its costs to operate and maintain. As we gain more data, our analysis will continue to be refined and updates will be presented at a future Board meeting as part of a Green Bus Program update.

Wheel-Trans Green Bus Program

Since 2017, 148, 6m ProMaster buses have been delivered. In addition, 22 of 138, 7m, ProMaster buses have been delivered with completion of all currently contracted deliveries planned for the end of 2023.

As part of the transition to a zero-emissions Wheel-Trans bus fleet, the TTC is planning to procure its last gasoline buses (6m and 7m) between 2028 and 2029. In parallel, the TTC will be commencing its battery-electric Wheel-Trans eBus pilot program as described below.

Wheel-Trans Bus Procurement Plan									
	2017-2021	2022	2023	2024	2025	2026	2027	2028	2029
Gasoline 7m	2	84	52	-	-	-	-	45	25
Gasoline 6m	148	-	23	59	20	-	-	20	32
Pilot eBus	-	-	-	5	10	-	-	-	-
7m eBus	-	-	-	-	-	-	-	45	28
6m eBus	-	-	-	-	-	-	-	18	30
Total	**150**	**84**	**75**	**64**	**30**	**-**	**-**	**128**	**115**

Table 7: Wheel-Trans Bus Procurement Plan

In December 2021, the TTC issued a Request for Information (RFI) on the availability of electric Wheel-Trans buses in the six to eight metre range to the market. Results from the RFI indicated that there is one vendor able to provide an electric vehicle in the six to eight metre range that meets the needs of Wheel-Trans. The vendor has indicated that it is expecting to have the Canadian Motor Vehicle Safety Standards (CMVSS) certification by Q1 2023, and a pilot vehicle for demonstration shortly thereafter. As such, it is anticipated that more Wheel-Trans eBuses that are CMVSS certified will be available in the coming years.

The TTC will continue to monitor developments in the market. However, it will use a similar approach for the Wheel-Trans electrification as was done for the electrification of the accessible-conventional bus fleet based on its success and lessons learned. An overview of the next steps in the electrification of the Wheel-Trans fleet is provided below:

Date	Description
2023-2029	Continued delivery of gasoline Wheel-Trans buses to ensure state of good repair vehicles are replaced at the end of their useful life
2024-2025	Delivery of Wheel-Trans eBus pilot vehicles
2026-2027	Two year evaluation of the pilot vehicles
2027	Issuance of a Wheel-Trans eBus RFP for bulk order
2030	Steady state procurement of electric Wheel-Trans buses

Table 8: Transition to Wheel-Trans eBuses

The introduction of 6m and 7m ProMaster gasoline powered buses have provided numerous benefits as summarized below. This includes the 6m ProMaster buses having

a Mean Distance Between Failure of approximately five times greater than that of the Friendly fleet. In addition, reduced fuel consumption and GHG emissions are projected to be approximately $4,500/bus/yr and 4,200kg/bus/yr over the 'Friendly' fleet when comparing to the 6m ProMaster buses. Data on the 7m ProMaster buses and the electrification of the Wheel-Trans fleet will be provided in a future report as information becomes available.

Benefits	Outcome
Service Impact	6m ProMasters have a Mean Distance Between Failure of 65,000km which is approximately five times greater than that of the Friendly fleet
Environment Impact	Reduce GHG emissions by ~33% or 4,200kg/bus/yr over the Friendly vehicle
Financial Impact	Reduce fuel cost by ~20% or ~$4,500/bus/yr over the Friendly vehicle
Other Key Benefits	• OEM product (e.g. no significant structural modifications required) • Improved driveability in the city • Continued operation of the Community Bus Program • Vehicle size meets ridership target of three passengers per hour • Lower capital cost

Table 9: 6m ProMaster Bus-Benefits

The TTC will explore the innovative use of smaller vehicles to deliver micro transit services that save money and reduce our emissions on lower-volume routes. Over a typical 100km low-volume shift, our 7m minibus would use 53% less fuel and generate 60% less GHG emissions compared to our clean-diesel bus.

This modal shift would not only reduce the TTC's emissions, but may also cost the TTC less per passenger to operate, opening opportunities for savings and/or service investment elsewhere.

Deployment of these vehicles on low-capacity conventional bus routes during off peak hours is currently being evaluated with trials expected to commence in late 2022.

Re-Investment of Operating Budget Savings

The TTC will actively seek opportunities for 'Green' grant funding and low-cost financing through all levels of government.

Projects from within the TTC's Capital Investment Plan that serve to reduce greenhouse gas emissions and/or improve climate change resiliency will be identified. From there, the TTC will work with its government partners to identify opportunities to leverage funding from all orders of government to fund the incremental capital costs of going green and that help address the state-of-good-repair backlog.

In addition to leveraged government funding, where the total capital costs of going green are not fully funded, TTC staff will continue to develop a financing strategy that will seek to leverage operating budget savings that result from green initiatives to contribute to funding the implementation of the TTC's Sustainability Strategy and Roadmap.

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Signature

Bem Case
Executive Director – Innovation and Sustainability

Appendix A-Economic Assumptions

Category	Value
Bus Life Cycle	13 Years
Vehicle Price	$1,2 Million
Mileage (annual)	65,000 Km
Interest Rate	1%
Diesel Price	$1.5

Table 10: Key Assumptions – General

	Year 1	Year 2	Year 3	Year 4	Year 5
Cost of Electricity	$11,310	$11,356	$11,766	$12,002	$12,242
Cost of Fuel	$51,187	$51,211	$53,255	$54,320	$55,407
Maintenance Savings (starting in 2027)	$8,450	$8,619	$8,791	$8,967	$9,146
Total Savings	$48,327	$49,294	$50,278	$51,285	$52,311

Table 11: Key Assumptions - Operation Costs/Savings per Bus