

# Bus Electrification Strategy

Technical Implementation Details and Assumptions

## Introduction

The City of Calgary (The City) committed to corporate emission-reduction goals in the 2022 Calgary Climate Strategy—Pathways to 2050, and emission reduction goals will continue to be a key strategic priority for Council and Administration in the 2023-2026 business cycle. Moving to a fleet of zero emission buses is an essential part of Council's key focus areas to combat the climate crisis and advance social equity.

The City will use a phased approach to acquire zero emission buses, transform operations, prepare the workforce, and build the necessary infrastructure to support this transition. This attachment details this transition for 2023-2026 which will require Calgary Transit operational changes and infrastructure upgrades to facilitate the deployment of up to 259 battery electric buses (BEBs). This transition is contingent on funding and financing options from the Canada Infrastructure Bank (CIB) and Zero Emission Transit Fund (ZETF).

Through the ZETF, the Government of Canada is investing \$2.75 billion over five years, starting in 2021 to support the purchase of 5,000 zero emission buses and build supporting infrastructure, including charging infrastructure and facility upgrades. This funding ends in 2025, and claims must be submitted by March 31, 2026.

Calgary Transit has worked with WSP Canada Inc. to develop a Fleet Transition Plan overall, which includes a Bus Electrification Strategy (The Strategy) that will have up to 259 BEBs onsite by 2026. The strategy includes identifying the operational changes and infrastructure upgrades to facilitate the deploy BEBs.

## Calgary Transit Fleet Electrification Planning Study

WSP Canada was retained to undertake a Fleet Electrification Planning Study (The Study) for Calgary Transit to support the preliminary planning of transit electrification and funding requests. The Study was used to inform the development of the Bus Electrification Strategy, The City's 2023-2026 capital budget, and funding and financing applications for the ZETF and CIB, respectively.

The Fleet Electrification Planning Study covered the following:

- Current State Assessment,
- Evaluation of electrical power services,
- Review of operational goals and scenario development,
- Greenhouse Gas (GHG) emission impacts,
- Comparative of charging options,
- Infrastructure gap analysis, and
- Implementation planning and costs.

Fleet electrification and deployment of BEBs has been deemed to be a necessary initiative to achieve net-zero and is in alignment with Council's key focus areas and strategic direction of a climate resilient

Calgary. The Study provides an analysis comparing the capital and operating costs between maintaining a diesel fleet and transitioning to a low carbon fleet within a study horizon of 2040. The Study also highlights operational changes and infrastructure investments required for fleet electrification and demonstrates a technically feasible plan for fleet electrification. Several assumptions were made to develop the Bus Electrification Strategy. For instance, it was assumed that the fleet would remain diversified to manage exposure to fuel cost risk and increase operational flexibility. The City will continuously re-evaluate technology, costs, and funding sources throughout the implementation of The Strategy.

This attachment provides a summary of the proposed implementation strategy for the 2023-2026 Service Plans and Budgets. A summary of the schedule, assumptions, charging infrastructure, electrical requirements, operational impacts, and Calgary Transit's fleet replacement plan are below.

## Schedule

**Table 1 – Anticipated Schedule for Deployment of Battery Electric Buses\***

Milestone	Date
Start Utility planning with ENMAX	January 2023
Owner's Engineer RFP (Request for Proposals) Close	April 2023
Infrastructure & Bus RFP Close	August 2023
ENMAX construction start	October 2023
Infrastructure Construction Start	June 2024
Infrastructure commissioning	December 2025
Initial BEBs in onsite	December 2025

\*Schedule / timelines are subject to change

## Battery Electric Buses (40-foot) Operational Specifications and Assumptions

**Table 2 – Technical Specifications**

Specification	Details
Battery Capacity	550kWh
Charging Strategy	In-Depot
Approximate Range (km)*	400km
Heating	Auxiliary Diesel
Useful Life	16 years
Average annual mileage	45,000km
Battery replacement years	6 and 12

Battery replacement cost	\$500 a kilowatt hour
Maintenance cost	\$0.48/km

\*BEB range is determined by several factors including ambient temperature, road grade, number of passengers on board, etc.

## Charging Infrastructure

The following garages will need to undergo construction to support charging for the BEBs:

- Spring Gardens garage opened for operations in 1976 and is located at 928 32 Ave NE, and Deerfoot Trail. Spring Gardens currently houses a mix of 30-foot and 40-foot buses and has a capacity of 465 forty-foot equivalent (FFE), and
- Anderson garage opened for operations in 1976 and is located at 11425 Anderson Station Way Southwest and Macleod Trail. Anderson Garage currently stores 40-foot buses and has a capacity of 108 FFE.

A phased approach will be undertaken to complete all construction work at Anderson and Spring Gardens. Work will occur sequentially at specific lanes to minimize impacts to Calgary Transit operations. If necessary, to accelerate the construction schedule further, more than one lane may be under construction at a time.

## ENMAX Upgrades

As part of the 2022 electrification planning study completed by WSP, consultations were held with ENMAX to communicate preliminary short-term and long-term network capacity requirements due to the proposed fleet electrification plan. Several meetings with ENMAX were held between March and August 2022 to discuss the Calgary Transit's energy requirements based on anticipated power demand as well as electrical network capacity forecasts and limitations at Anderson and Spring Gardens facility. The scope of electrification at each facility is limited to the current grid capacities communicated by ENMAX for each site.

The forecasted capacity information provided by ENMAX was used to shape the Bus Electrification Implementation Strategy up to 2026 and the transition to up to 259 BEBs. Calgary Transit and ENMAX will work together in next business cycle to achieve the required grid capacity for future fleet electrification. Engagement with ENMAX will be important to ensure adequate electrical capacity is available at Spring Gardens and Anderson garages.

## Fleet Reallocation and Schedule redesign

BEBs require special operational considerations including battery operational range, impact of weather, and planning for charging times. Upon introducing BEBs, transit agencies have required either a reduction in service levels on transit routes or more buses to replicate existing service levels (where diesel/compressed natural gas buses are currently used). The transition to BEBs will significantly alter Calgary Transit's service and operations at all levels. A change of this magnitude will require staff preparation and increased resources for training. While BEBs will replace the oldest diesel buses in the fleet they will require substantial analysis and redesign of existing operating and scheduling.

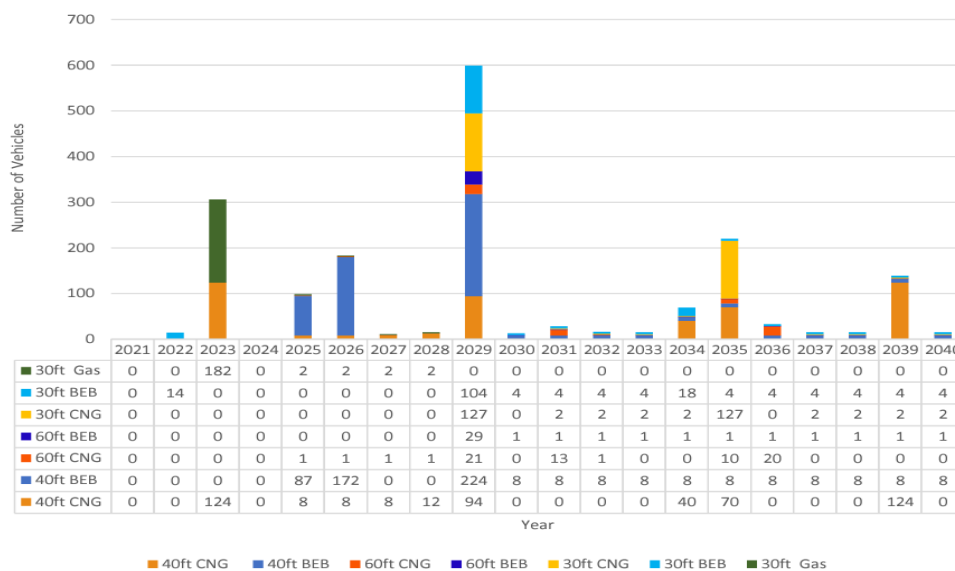
The Fleet Electrification Planning Study used WSP's proprietary BEB simulation software kit, Battery Optimization Lifecycle Tool (BOLT), to predict the performance of BEBs operating in Calgary Transit's service model. The analysis shows that operational modifications will be required for Calgary Transit to

optimize the transit network, considering some of the technological limitations of BEBs. This includes deploying additional buses to maintain pre-pandemic levels of service and accommodate growth while transitioning to a zero emission fleet.

## Fleet Acquisition

The Bus Electrification Strategy was developed by applying the vehicle replacement schedule based on Calgary Transit’s asset list and lifecycle assumptions and adjusting to availability of supporting infrastructure. Vehicles are replaced in the year they exceed their planned lifecycle allowing for a progressive transition. The fleet acquisition budget for 2023-2026 includes funding for gasoline shuttles and compressed natural gas (CNG) buses. The proposed fleet acquisition including gasoline, CNG and BEB are shown in the figure below. The City will adjust Calgary Transit’s Fleet Replacement Plan based on changes to technology, costs, and funding sources throughout future business cycles and implementation of The Strategy.

**Figure 1 – Calgary Transit’s Fleet Replacement Plan**



## Project Risks

**PROJECT RISK**

**DIRECTION/DESCRIPTION**

Supply chain issues results in charging equipment or bus delivery delays.

Early engagement with charging infrastructure and bus suppliers to determine expected lead times for materials. Ensure long lead items are procured early.

<p>Buses do not perform as specified resulting in reduce range and operational impacts.</p>	<p>Provide expected service design (i.e., expected deployment blocks) to bidders in Request-For-Proposals to confirm that range requirements can be met. Ensure remediation clauses are included in the contract to ensure performance breaches are cured.</p>
<p>Interoperability issues with charger and bus results in operational challenges.</p>	<p>Ask charging equipment bidders to provide list of buses that have passed interoperability testing. Include clauses in contract for expected response times for warranty issues. Explore the option of service contracts with vendors to provide ongoing support for several years after project commissioning.</p>
<p>Delays in ENMAX primary feed construction and commissioning.</p>	<p>Ensure early engagement with ENMAX. Complete site investigations as necessary, engage with operations and maintenance staff to understand potential site risks.</p>
<p>Buses ready for delivery/on site before charging infrastructure is commissioned.</p>	<p>Use existing pilot project charging stations at Spring Gardens for bus commissioning activities. Early coordination between bus supplier and contractor to ensure schedules are appropriately aligned.</p>
<p>Costs are higher than estimated due to supply chain or cost escalation.</p>	<p>Use fixed price contracts for bus supply and charging infrastructure. Ongoing and open engagement with vendors to understand price risk for various equipment.</p>
<p>The transition to battery electric buses will significantly alter Calgary Transit service and operations.</p>	<p>A change of this magnitude will require extensive education, training, and change management. To understand best practices of operations pilot projects will be used. Calgary Transit will work with municipalities to learn best practices and strategies for implementation.</p>
<p>December 31, 2025, ZETF Claims Deadline</p>	<p>This timeline has significant risks associated with procuring the Owner's Engineers, Contractors, and bus Supplier.</p> <p>The City is prepared to procure the Owner's Engineer prior to receiving the ZETF approval (estimated in April 2023). The amount of cost at risk to The City would be small but the benefit would be that we would be able to accelerate the investigation work needed for the design. A late Owner's Engineer procurement could mean that the construction/commissioning timeline may extend beyond December 31, 2025, in which case The City would be responsible for all costs after the current ZETF December 31, 2025, completion date.</p> <p>While Infrastructure Canada/ZETF is aware of the challenges, The City will continue to work with them to explain the current Supply Chain challenges being faced by the industry for electrification related material and equipment. Extension of the claims end date related to the charging infrastructure and buses is an important approach to managing this risk.</p>