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MEMORANDUM

NTC-C 2-2026

Subject: Niagara Transit Fleet Electrification Strategy and Implementation Roadmap

Date: February 17, 2026

To: The Niagara Transit Commission

From: Heather Talbot, Corporate Consultant

This memo accompanies the *Niagara Transit Fleet Electrification Strategy and Implementation Front-End Engineering and Design (FEED) Study* completed by WSP in collaboration with Alectra in June 2025. The purpose of this memo is to summarize the key findings, conclusions, and recommendations presented in the study and the accompanying presentation, and to provide context for the detailed technical report.

The study defines the technical requirements, infrastructure needs, and budgetary commitments necessary to support a phased transition of Niagara Transit's revenue and non-revenue fleets to zero-emission vehicles. This includes associated capital investments in fleet procurement, charging systems, electrical infrastructure, and garage retrofits. The implementation strategy builds on prior electrification and hydrogen feasibility studies completed for the former St. Catharines Transit Commission and Niagara Falls Transit Services, and was developed with the objectives of reducing greenhouse gas (GHG) emissions, maintaining operational continuity, and delivering long-term value to residents and taxpayers across Niagara.

The transition roadmap demonstrates that Niagara Transit can achieve up to a 98% reduction in lifecycle GHG emissions over a 12-year period compared to a business-as-usual (BAU) scenario, reducing annual emissions from approximately 16,300 tonnes of CO_2 to under 400 tonnes by Year 12. This reduction is equivalent to removing approximately 3,500 passenger vehicles from the road for one year or offsetting the annual energy use of more than 2,000 Ontario homes. The implementation strategy prioritizes the transition to battery-electric buses (BEBs) at the St. Catharines facility, reflecting the maturity of BEB technology and its widespread adoption by transit agencies across Canada. Hydrogen fuel technology was also assessed and found to require further market maturity and cost reductions before large-scale deployment. However, Niagara Falls' proximity to Atura Power's Niagara Hydrogen Centre presents a strategic advantage for potential future hydrogen implementation once technology readiness and market conditions become more favourable.

At the St. Catharines garage, the transition is planned over a 14-year period, including two years of planning and procurement followed by 12 years of phased BEB deployment. Garage retrofits are proposed in two construction phases: Phase 1 beginning in Year 1 to support BEB deliveries from Years 2 to 6, and Phase 2 completed by Year 5 to enable continued deployment through Year 12. Charger procurement and installation will be phased to align with facility readiness and vehicle delivery, with depot-only charging identified as the preferred strategy for this location. Spare vehicles are introduced beginning in Year 9 to support operational resilience.

For the Niagara Falls garage, retrofit work is recommended to be completed in a single construction phase with operations commencing in Year 6. This later start allows additional time for fuel cell technology to mature while also aligning with service needs and fleet replacement timing. Due to longer routes and heavier duty cycles, Niagara Falls will require a combination of depot charging and on-route charging. Five on-route chargers are proposed to be installed over five years at the Welland Bus Terminal. Both garages will require utility-led electrical service upgrades, distribution system improvements, battery energy storage systems, and standby generators led by Niagara Transit.

Feasibility assessments and operational simulations evaluated multiple charging scenarios under varying temperatures and operating conditions. Results confirm that the proposed charging strategies are technically feasible, provided that service blocks are restructured to allow for mid-day charging and dynamic vehicle assignment. The study highlights the importance of implementing a charging management system to flatten peak electrical demand and reduce electricity costs compared to unmanaged charging scenarios.

From both an emissions and financial perspective, the study confirms that fleet electrification delivers significant greenhouse gas reductions and long-term operating cost savings; however, these benefits come with substantial upfront capital requirements that present a major financial challenge. Compared to a business-as-usual (BAU) scenario, electrification requires significantly higher initial investment, with implementation costs over the 12-year transition period forecast to be approximately 53% higher at St. Catharines and 84% higher at Niagara Falls, equating to a 66% increase across the agency. This represents approximately $208.7 million in additional capital investment, including $153.9 million for zero-emission buses and charging infrastructure and $54.8 million for garage upgrades.

While operating costs are forecast to decrease by approximately $31.4 million over the same period—driven by lower fuel and maintenance expenses—and annual operating savings are expected to exceed $4.1 million once the fleet is fully electrified, the initial capital outlay significantly outweighs near-term financial returns. For the first round of zero-emission bus purchases, the analysis indicates a payback period of approximately 50 years, reflecting the high current cost of vehicles and supporting infrastructure. As a result, despite the substantial emissions savings, the current replacement costs associated with zero-emission buses make a full transition financially difficult to achieve without sustained funding support from other levels of government to offset capital expenditures and reduce long-term financial risk.

In response to these financial constraints, Niagara Transit is evaluating alternative strategies that reduce near-term capital exposure while maintaining progress toward emissions reduction objectives, including the conversion of existing diesel buses through a hydrogen–diesel hybrid pilot project and the exploration of Energy-as-a-Service procurement models that shift capital costs and delivery risks to third-party providers.

Hydrogen – diesel conversion Pilot Project

In parallel with Niagara Transit's long-term fleet electrification roadmap, a hydrogen–diesel hybrid pilot project is being proposed to advance near-term decarbonization while managing cost, risk, and operational continuity. This pilot involves converting existing 2014 New Flyer diesel buses into hydrogen–diesel hybrid vehicles using Canadian-developed technology, providing a practical and cost-effective alternative to up front full fleet replacement. The initiative directly supports federal priorities related to innovation, clean technology adoption, greenhouse gas emission reductions, and sustainable public transit infrastructure, as outlined in the electrification consultant's report (see report NTC 1-2026).

The project aligns with provincial priorities and the federal government's commitment to achieving net-zero emissions by 2050 and reducing transportation-sector emissions by leveraging renewable hydroelectric power and locally produced hydrogen. All project partners—Niagara Transit Commission, MTB Transit Solutions, and Atura Power—are Canadian organizations, ensuring that economic benefits, workforce development, and clean-technology expertise remain within Canada while supporting domestic job creation and the growth of the Canadian hydrogen economy. In addition to emissions reductions, the pilot will generate transferable technical and operational knowledge related to hydrogen integration, fleet retrofitting, and potential fleet-scale deployment. The data and lessons learned will support future funding applications, broader industry adoption, and federal objectives for innovation and commercialization of low-carbon transportation technologies.

The estimated Niagara Transit Commission contribution to the pilot is approximately $2.4 million in combined capital and operating costs between August 2026 and March 2029. These costs include mid-life refurbishment, hydrogen–diesel conversion, installation, data collection, and in-service operational expenses. Following the denial of Niagara Transit’s Zero Emission Transit Fund application from the federal government in late 2025 due to program oversubscription, the project is now being positioned under an alternative federal funding pathway. Specifically, the Hydrogen Innovation Fund (HIF) Stream 2 is expected to support up to 50% of total eligible project costs for projects of up to $4.5 million, significantly reducing the financial burden of the pilot on the Commission.

Advancing the pilot enables Niagara Transit to leverage external funding, extend the useful life of existing fleet assets, and avoid near-term capital replacement pressures while continuing to progress toward emissions reduction targets. Conversely, not proceeding would forgo available federal funding opportunities, delay emissions reductions, limit access to critical operational performance data, and increase long-term pressure on fleet replacement capital budgets. As such, the hydrogen–diesel hybrid pilot represents a strategic, scalable complement to Niagara Transit’s broader electrification strategy, bridging the gap between current fleet realities and future zero-emission transit goals.

Alectra’s Energy-As-A-Service (EaaS) Approach

The Fleet Electrification Strategy and Implementation Roadmap Study references a procurement strategy known as Energy-as-a-Service (EaaS). Through this memo, Alectra Energy Solutions (“Alectra”) is further elaborating on its EaaS solution while highlighting its capabilities as a qualified 3rd party provider of EaaS for Niagara Transit Commission’s consideration.

Part of the study’s findings is that the transition plan will have an overall increase in costs vs business as usual (BAU) since there is a significant capital outlay in 1) battery electric buses (BEBs), 2) facility modifications, and 3) charging infrastructure. Key benefits of the EaaS approach is that certain capital expenditure elements can be shifted to operating expenditures, while shifting material risks to a long-term partner such as Alectra.

Alectra defines Energy-as-a-Service (EaaS) as the turnkey implementation and ongoing management of 1) energy and charging infrastructure, 2) energy services, and 3) bus financing & procurement, under a long-term contract with comprehensive service and performance guarantees. As part of EaaS, Alectra (together with partners) designs, builds, finances, operates and maintains (DBFOM) the required infrastructure necessary to support Niagara Transit's Battery Electric Bus fleet. Alectra's energy services would provide the Commission with optimized energy costs and reliable performance that meet operational needs. In addition, Alectra and partners can fully finance and procure BEBs on behalf of the Commission.

In conclusion, the WSP/Alectra FEED study confirms that fleet electrification is technically feasible, operationally achievable, and environmentally transformative for Niagara Transit. While the transition requires significant capital investment beyond business-as-usual, it delivers substantial GHG reductions, long-term operating cost savings, improved air quality, and alignment with regional, provincial and federal climate and sustainability objectives. The phased roadmap and recommendations outlined in the study, together with complementary pilot initiatives, provide a clear foundation to guide future decision-making, funding strategies, and implementation planning.

The attached appendices should be referenced for detailed technical analysis, costing assumptions, implementation considerations and alternative service delivery options.

Respectfully submitted and signed by

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Corporate Consultant

Appendix 1 - Fleet Electrification Strategy & Implementation Roadmap Study

Appendix 2 - Alectra EaaS Alternative Option

NIAGARA TRANSIT COMMISSION

FLEET ELECTRIFICATION STRATEGY AND IMPLEMENTATION ROADMAP STUDY

Zero-Emission Bus Feasibility and Implementation Planning Report

alectra energy solutions
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FLEET ELECTRIFICATION STRATEGY AND IMPLEMENTATION ROADMAP STUDY

Zero-Emission Bus Feasibility and Implementation Planning Report

NIAGARA TRANSIT COMMISSION

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REVISION HISTORY

FIRST ISSUE

Date	Revision	Prepared by	Reviewed by	Approved by
19 Sep 2025	Revision B	Yutian Zhao Shervin Bakhtiari Saumya Bhavsar	Julian Fernandez-Orjuela	Dominic Giroux
15 Aug 2025	Revision A	Yutian Zhao Kamran Chaudhry Robert Eland Deep Morzaria Reza Sharifi Julian Fernandez-Orjuela	Shervin Bakhtiari	Dominic Giroux

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This limitations statement is considered an integral part of this report

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1 INTRODUCTION

1.1 PROJECT CONTEXT & BACKGROUND

1.1.1 REGIONAL CONTEXT

Niagara Transit (NT) is the regional authority responsible for transit planning, operations and maintenance across the Niagara Region. The formation of NT in January 2023 under By-law No. 2021-96 encompasses previously separate regional transit systems provided by Welland Transit, Fort Erie Transit, St. Catharines Transit and Niagara Falls Transit.

Niagara Transit serves over 9 million riders[1] through a combination of contracted and in-house services operating over 125 routes and 9.2 million revenue vehicle kilometers annually and serves a population of over 500,000[2]. The Niagara Transit fleet consists of 161 conventional buses, 26 paratransit vehicles and 39 non-revenue service vehicles, which are serviced and maintained at three main facilities located within two divisions. The North division facility, located in St. Catharines, maintains 114 vehicles. The South division located in Niagara Falls maintains 112 vehicles. The Welland facility's use will be reduced to administrative purposes in 2025, with operations and maintenance of fixed-route and paratransit services relocated to the Niagara Falls facility.

1.1.2 PREVIOUS ZERO-EMISSIONS TRANSIT STUDIES IN NIAGARA REGION

Prior to the formation of Niagara Transit, St. Catharines Transit Commission (SCTC) and Niagara Falls Transit (NFT) each completed fleet electrification studies to inform capital project / program planning for their (then independently operated) transit bus fleets.

The SCTC conducted a battery electric bus (BEB) feasibility study for its fleet, which involved a preliminary feasibility assessment of BEB deployment on SCTC's operating blocks, as well as a technical evaluation of the required grid architecture and electrical infrastructure. The study also generated recommendations on the planning, kickoff and implementation of a pilot-scale and long-term BEB deployment capital project/program.

NFT completed a Hydrogen Mobility Feasibility Plan for its fleet. It involved a fuel cell electric bus (FCEB) feasibility assessment on NFT's operating blocks, along with a hydrogen supply options assessment based on the resulting demand profile of hydrogen.

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[1] based on 2019 data

[2] Source: niagararegion.ca

1.1.3 PROJECT SCOPE & OBJECTIVES

The formation of the amalgamated transit planning authority in the NT represents an opportunity for more joined up approach to integrated transit planning and system-wide fleet decarbonisation initiatives, and to leverage the findings previous efforts and coordinate regional-level requirements and solutions.

NT is undertaking the *Fleet Electrification Strategy and Implementation FEED Study* to identify the detailed requirements and budgetary commitments associated with the phased deployment of zero-emissions fleet transitioning and infrastructure upgrades. The key objectives of the development of a fleet electrification strategy and implementation plan include demonstrating a reduction in greenhouse gas emissions while ensuring operational continuity and providing value to all regional taxpayers and residents.

In support of these objectives, the project scope encompasses three phases:

- **Phase 1 -** Opportunity assessment and initiation of a funding application process aimed at securing federal funding for a BEB pilot fleet deployment at St. Catharines.
- **Phase 2** includes a comprehensive current state assessment, market scan, zero-emissions transit technology appraisals, detailed electrification feasibility assessments, identification of operational implications & change management aspects, development of facility and infrastructure requirements, costing and preparation of a detailed transition planning roadmap (core study component.)
- **Phase 3** – development of a business case for a 'Secondary Pilot' project involving electrified on-demand transit service.

Phase 2 includes development of the Niagara Transit Fleet Electrification Strategy and Implementation FEED Study (the Study) comprises the essential component of this project, providing the basis for phase 3 and downstream planning, design and budgeting activities. Phase 2 elements include the following:

i. Identifying the feasibility of electrifying regional transit operations. Both battery electric (BEB) and hydrogen fuel cell electric (FCEB) bus technologies were assessed, and battery electric bus technology was identified as the appropriate technology for NT's initial fleet and facility deployment and has been considered for the purposes of all planning and costing in this study.

ii. Defining scenarios, requirements, and associated emission reduction trajectories and capital investment plans for the phased deployment of BEBs and infrastructure upgrades for the newly amalgamated regional transit commission.

1.1.4 EXISTING TRANSIT OPERATIONS OVERVIEW

Niagara Transit operates and maintains a fleet of 210 vehicles, based out of transit facilities each in Niagara Falls and St. Catharines. The Niagara Falls depot houses 101 vehicles, whereas the St. Catharines depot houses 109. The scope of this study excludes the Welland depot from a fleet electrification perspective, although it is noted that planning to redevelop the site for future operations is underway.

Fleet are divided into revenue and non-revenue support vehicles. The revenue fleet comprises 40-ft, 60-ft and paratransit vehicles, whereas the non-revenue fleet consists of hybrid SUVs, pickup trucks and vans. Ownership of WEGO assets were transferred to the Niagara Transit Commission and these are part of the Niagara Falls core 40-ft and 60-ft fleet. The following figures break down a) the asset inventory by depot and vehicle type b) total fleet by vehicle types.

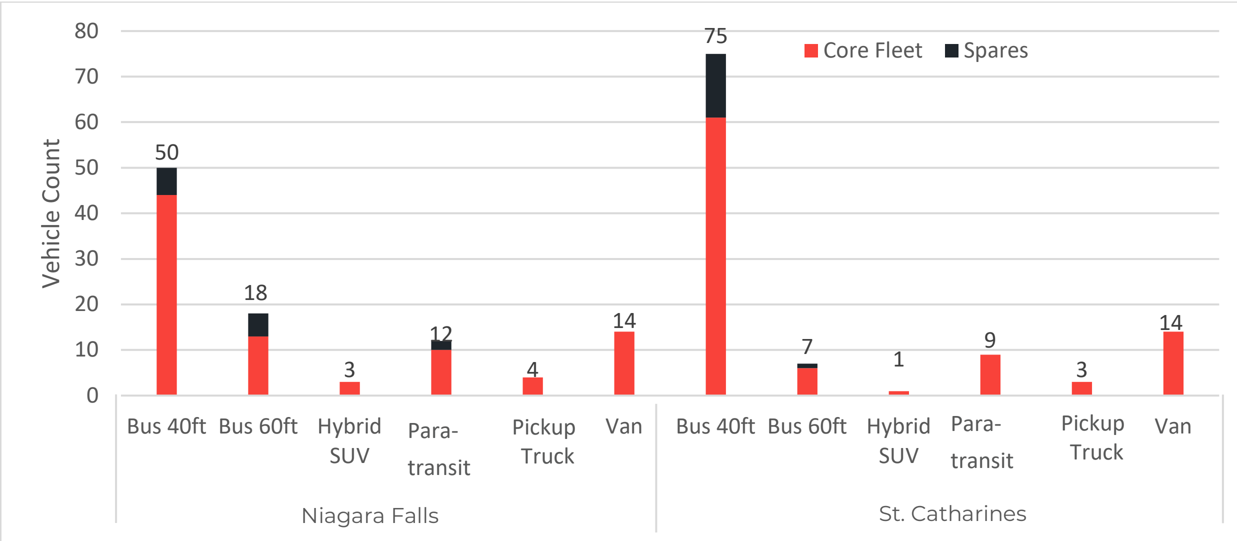

Figure 1-1. Niagara Transit Fleet Asset Distribution.

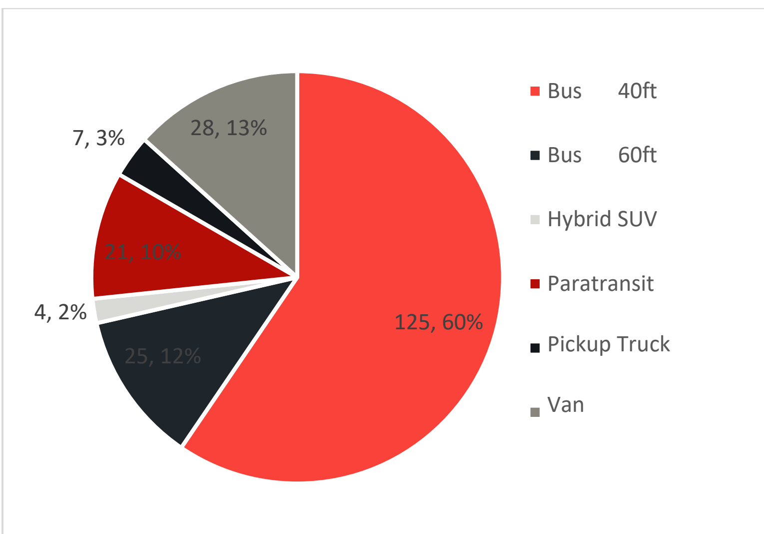

Figure 1-2. Fleet Composition by Vehicle Type.

Diesel remains the predominant fuel requiring displacement from Niagara Transit operations. The Niagara Falls and St. Catharines facilities house 70 and 85 diesel vehicles respectively. Niagara Transit fleet fuel consumption statistics are shown below.

Table 1-1. Baseline Annual Fuel Usage – Overall Fleet (2023-09-10 to 2024-09-10)

Vehicle Type	Diesel (L)	Diesel (%)	Unleaded Gasoline (L)	Unleaded Gasoline (%)
Bus 40-ft	4,093,985	87.35%	0	0.00%
Bus 60-ft	573,400	12.23%	0	0.00%
Paratransit vehicle	10,211	0.22%	180,923	74.16%
Hybrid SUV	0	0.00%	2,346	0.96%
Pickup Truck	7,599	0.16%	2,331	0.96%
Van	1,442	0.03%	58,353	23.92%
Total	**4,686,636**	**100.00%**	**243,952**	**100.00%**

1.2 PURPOSE AND STRUCTURE OF THIS REPORT

This *Zero-Emission Bus Feasibility and Implementation Planning Report* builds upon the detailed feasibility planning work presented in the preceding *Charging Strategy Analysis Report*, which established the overall requirements for an electrified fleet e.g. how many of each type of battery electric bus are required at each garage, peak power requirements at each garage, fleet refueling (charging) strategies, bus parking requirements and charging equipment requirements for both garages.

These findings were applied to develop the physical layouts, infrastructure sizing and equipment design requirements for each transit garage and combined with fleet replacement planning information from NT to define annual requirements for vehicle purchase / deployment, charging equipment and other infrastructure associated with the multi-year program of electrification of NT's transit operations.

The application of these components culminates in the preparation of the costed Implementation Plan, setting out a detailed roadmap of activities and annual costs NT can use to guide future fleet electrification planning and decision making.

In addition to this introduction, the *ZEB Feasibility and Implementation Planning Report* documents insights from Phase 2, subtasks 3, 4 and 5 of the second phase of the project. The report includes the following sections:

- **Transit Operations and Maintenance Facility Modifications** – this section describes in detail the cross-disciplinary design requirements associated with the facility upgrades at St. Catharines Garage and Niagara Falls Garage. Construction phasing strategies and considerations are included for St. Catharines, and capital cost estimates for the facility retrofits are summarised.
- **NT Fleet & Facilities Transition Roadmap** – this section describes the required quantities and timing of fleet, infrastructure and facility transition for each garage, creating the basis for the costed implementation plan.
- **Costs & GHG Emissions Analysis** – provides a detailed picture of capital and operational costs, together with all important factors and assumptions, along with presenting the GHG emissions reductions associated with the transition timeframe.
- **Conclusions and Recommendations** – summarises key findings and recommended next steps.

2 TRANIT OPERATIONS AND MAINTENANCE FACILITY MODIFICATIONS

This section describes the proposed facility modifications and charging infrastructure arrangements required for fleet electrification at each of the two transit facilities included in the study:

1. St. Catharines Bus Storage and Maintenance Facility located at 2012 First St Louth, St. Catharines, ON L2S 3V9
2. Niagara Falls facility located at 8208 Heartland Forest Rd, Niagara Falls, ON L2H 0L7

Welland Transit Facility is excluded from the assessment as NT will determine future planning for this site separately.

Facility retrofit design layouts and high-level requirements have been developed to enable Class D cost estimates and construction phasing considerations were developed to inform the Implementation Plan.

Technical disciplined involved in defining the facility requirements include architecture, electrical, structural, and civil engineering, HVAC / Fire Protection. The requirements for each are presented below.

Capex estimates for the facility retrofit work are presented in Section 4.

2.1 ST. CATHARINES GARAGE

The *Industry Scan, Current State Assessment and BEB Feasibility Analysis Report* identified the existing conditions at St. Catharines facility including bus storage capacity, space utilisation, parking arrangements, access and egress / circulation and other space program features. The existing base electrical load and spare capacity, existing electrical equipment & infrastructure and backup power generation systems were assessed.

The *Charging Strategy Analysis Report* identified the future-state fleet and charging requirements at each garage, which underpins the proposed facility retrofits and recommended implementation planning presented herein.

The previous study tasks identified the preferred BEB parking / charging arrangements will utilise overhead pantograph charging technology to maximise the utility of the available floor space.

Transit service electrification feasibility and charging simulation work showed charging can be fully depot-based at St. Catharines without the need for on-route chargers outside the depot[3].

[3] Simulation work is based on Q3 2024 transit operations and does not account for service changes / growth since this time.

2.1.1 ARCHITECTURE

The St. Catharines Bus Storage and Maintenance Facility, consisting of an original garage storage building and a more recently built garage extension unit, **will be used to store ninety (90) 40’ BEBs (67 Core + 23 Spares), eleven (11) 60’ BEBs (9 Core + 2 Spares), and twelve (12) paratransit vehicles (10 Core + 2 Spares).** Refer to Table 2-1 below.

Refer to Figure 2-1 and Appendix A for the proposed site layout drawings.

Table 2-1: Proposed Fleet Makeup at St. Catharines Garage

	Core Fleet	Spares	Total
40’ BEB	67	23	90
60’ BEB	9	2	11
Paratransit Vehicle	10	2	12

Both indoor and outdoor spaces of the site are proposed to serve the function of storage for the fleet and provide charging locations for all core buses and select spare buses.

The original Garage Storage area in the facility measures 3012 square meters (SQM) and currently consists of ten (10) bus lanes, with five (5) overhead doors on the east, and two (2) overhead doors on the south side. One (1) bus lane on the northmost side (Grid G), will be fenced off for electrical sub panels and charging cabinets. This building can accommodate forty-five (45) 40’ BEBs, with roof mounted pantographs for each.

The lanes will require new line painting, signage, and new coiling for the overhead doors on the east as pantograph interferes with door storage when open (5 total). Overhead door width to be confirmed.

The additional garage storage building has an approximate area of 1127 SQM. The building has four (4) overhead doors, two (2) on the east, and two (2) on the west sides, with a total of four (4) bus lanes. One (1) bus lane on the northmost side (Grid L) will be fenced off for the main electrical panel, the subpanels, charging cabinets, and the auxiliary transformer. The remaining three (3) lanes will be used to store the nine (9) core 60’ BEBs, with roof mounted pantographs for each.

The lanes will require new line painting, signage, and new coiling for the overhead doors on the east as pantograph interferes with door storage when open (2 total). Overhead door width to be confirmed.

Adjacent to the exterior southern wall of the additional garage storage area, is a suitable location for the remaining charging cabinets, which will supply the exterior gantry pantographs, for twenty-four (24) 40’ BEBs (22 core + 2 spares). A new island to be installed south of the outdoor storage is recommended to protect the gantry pantograph structures and to direct traffic. A minimum distance of six (6) metres from paved island to pavement edge is required for fire route.

Site fencing will be required around the electrical yard adjacent to building. New Bollards (1.2m) to be installed every 3m around perimeter of fenced area. Likewise, Site fencing will be required around the Battery Energy Storage System (BESS) and Generator Area (refer to Electrical section below). New Bollards (1.2m) to be installed every 3m around perimeter of fenced area.

The core paratransit vehicle fleet will be stored and charged to the southeast of the site. There will be three charging cabinets for the paratransit vehicles, each connected to four charging dispensers. These cabinets and dispensers will have dedicated concrete mounting pads. The remaining spare buses for 60’ BEBs, 40’ BEBs and paratransit vehicles will have parking north-east and in the maintenance bay.

It is recommended that maintenance bay is used for maintenance purposes only, as there will be only one (1) mobile charger in the facility.

Landscape and paving areas are to be repaired where new duct banks are installed. It is recommended to increase the paved area to support new bus parking, as indicated on the site plan. New concrete curbs and landscaping for island separating charging and south circulation route will be required. Note that civil works are excluded from the cost estimates.

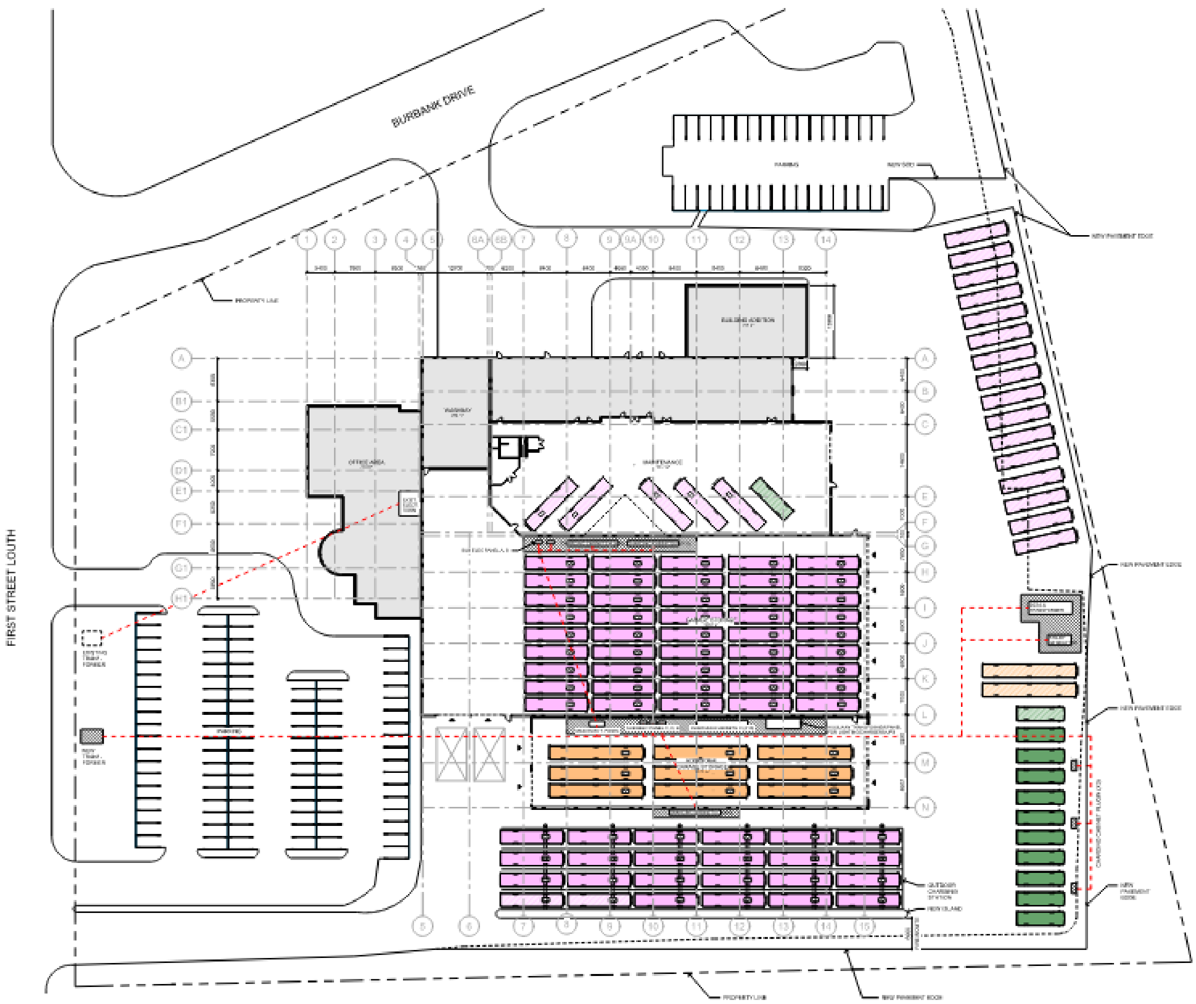

Figure 2-1: St. Catharines Facility Site Plan (Conceptual Only).

LEGEND:

Core buses: 60’ BEB (Orange); 40’ BEB (Pink), Paratransit Vehicle (Green).

Spare buses are represented in a diagonal hatch pattern.

2.1.2 ELECTRICAL

The proposed electrical design provides new infrastructure to support Niagara Transit's fleet electrification initiative at the St. Catharines garage. This project enables charging of the transit fleet through a network of pantograph and plug-in chargers, backed by a utility-supplied transformer, a robust distribution system, auxiliary services, BESS, and a standby generator for emergency scenarios. The facility will accommodate present and future charging needs with adequate spare provisions and system flexibility.

The distribution system considering a diversity factor of 60% begins at a new utility-fed 6000 kVA pad-mounted transformer and connects to an 8000A-rated main Switchgear at 480Y/277V. Downstream subpanels A through E distribute power to charging cabinets and auxiliary systems. The design includes intelligent Energy Management System (EMS) coordination with BESS and standby generator integration to balance load and maintain operational reliability during peak and outage conditions.

The design includes a layered metering and protection scheme using SEL protective relays:

- SEL-735: Used for advanced metering of the incoming utility supply, providing precise energy usage data and power quality monitoring.
- SEL-751: Provides feeder protection and is integrated with CTs and PTs to monitor current and voltage levels at the subpanel inputs.
- SEL-700G: Installed at the generator panel to ensure reliable generator protection and synchronization during emergency operations.

A SCADA/DMS RTU/PLC system is integrated via Ethernet and Modbus communication protocols, enabling centralized monitoring, control, and diagnostics:

- The EMS intelligently coordinates between the utility source, BESS, and standby generator, optimizing load profiles and demand during peak usage or grid outages.
- The system provides real-time visibility and control of the charging network, facilitating automated scheduling, load shedding, and fault response.

A single line diagram together with a description of the core components of the electrical design is included in Appendix A.

2.1.2.1 *STAND-BY GENERATOR AND PANEL*

A 2000 kVA, 480V standby natural gas generator is suggested to support critical systems during utility outages. Load will be controlled through EMS to ensure safe operation and prevent overload. The generator supplies only essential systems and a limited number of charging cabinets under backup scenarios.

2.1.2.2 *BATTERY ENERGY STORAGE SYSTEM (BESS)*

A 2 MW / 4 MWh BESS is suggested to support peak shaving, global adjustment reduction, and load balancing in conjunction with the EMS. The system is not intended for continuous full-load operation but responds dynamically based on facility demand and grid status.

2.1.2.3 *DESIGN CRITERIA*

The design criteria include the following:

- Applicable Codes: CEC Part I, CSA C22.2 standards, utility provider requirements
- Ambient Temperature: 30°C design
- Voltage Drop Target: < 3% on feeders
- Conductor Type: Copper, RW90 insulation
- Conduit Fill & Derating: Considered per CEC 2021 requirements

2.1.2.4 *FUTURE PROVISIONS*

For future provisions consider:

- 1 spare 5" EMT conduit from main transformer to main switchboard for future expansion
- Load feeders designed with moderate margin to accommodate future charging cabinets
- EMS-integrated flexibility with BESS allows load balancing without reconfiguration
- Spare breaker slots allocated in the main switchboard

2.1.2.5 *METERING AND PROTECTION*

For metering and protection consider the following (for specific reference refer to Appendix A)

- Main Metering: utility-grade metering at the service entrance
- BESS Protection: breaker with protective relays with CT/PT metering
- Generator Protection: breaker with protective relays with CT/PT metering and alarms
- Protection Coordination: Conducted across panels using LSI or LSIG breakers, aligned with fault current levels and time-current characteristics

2.1.3 *STRUCTURAL*

Based on the site visit and review of drawings provided, the building structure consists of steel deck on steel open web joists supported by steel trusses and steel beams on steel columns.

The base building structural drawings provided by NT include the structural tender set consisting of drawings S1 to S8 prepared by Marshall Macklin Monaghan Limited and dated January 15, 1990. No base building structural drawings for the expansions were provided by NT.

With respect to the proposed electrification requirements, the following structural changes are noted:

Original Bus Storage and Expansion Building Areas (Interior Charging Areas)

1. Roof mounted supports for proposed interior pantographs: proposed structural support for the interior pantographs consists of two (2) new steel beams W200x25 for each pantograph connected to the existing building structure as shown in Figure 2-2
2. Each pantograph is to be hung from new steel beams by four (4) threaded rods.

Figure 2-2. Roof Framing Plan – Structural Support for Interior Pantographs.

Outdoor Charging Area

1. Gantry for exterior pantographs: A freestanding gantry structure to be designed to support the exterior pantographs. The structural support for the gantry consists of steel framing supported by steel columns on concrete pedestals and foundations as shown in Figure 2-3 and Figure 2-4.
2. The steel framing consists of two (2) steel beams W200x27 for each pantograph connected to primary steel beams W460x60 supported by perimeter beams W460x97.
3. foundation to be supported by 4 helical piles (refer to Figure 2-4).
4. The structure is laterally supported by steel x-bracings on one direction and moment frames on the other direction.

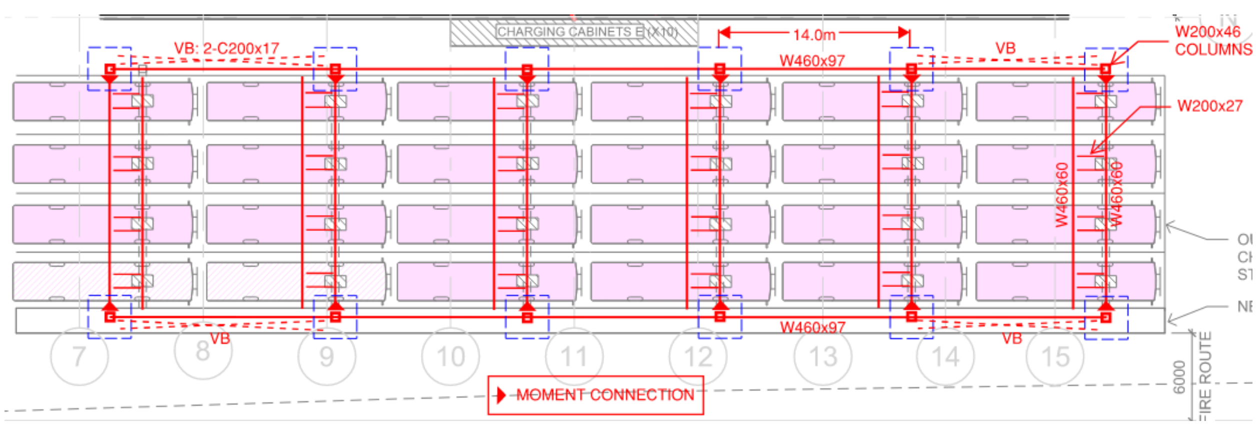

Figure 2-3. Gantry Framing Plan – Structural Support for Exterior Pantographs.

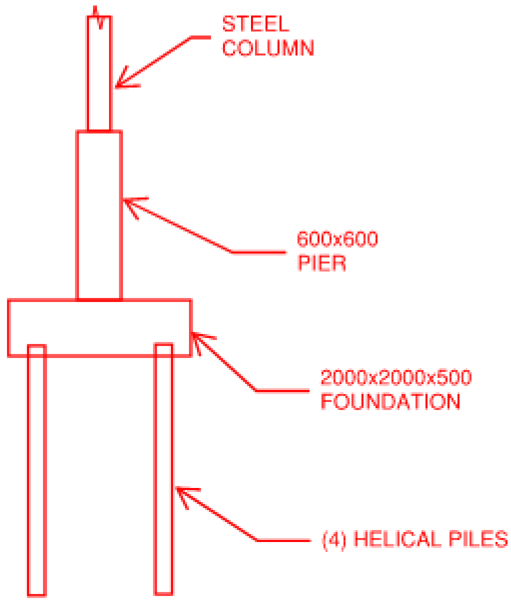

Figure 2-4. Typical Foundation Detail – Proposed Outdoor Gantry.

2.1.4 HVAC

The bus storage area shown in Figure 2-5 and Figure 2-6 is being served by a combination of make-up air units (MAU-01, 02, 03), exhaust fans and gas fired unit heaters, shown in Figure 2-7.

Information regarding make-up air unit, exhaust fans, and gas fire unit heaters are not available on drawings or Condition Report Assessment provided by Englobe Corp. dated 10th August 2023. However, the condition assessment report identifies 2039 as the recommended action year for replacement of these units.

As-builts are not available for the additional storage area highlighted in yellow. Based on pictures from site visit (Figure 2-8 and Figure 2-9), this area is being heated by unit heaters. Information regarding gas detection system is not available. It must be verified if this area complies with OBC 6.2.2.3 Ventilation of Storage and Repair Garages based on detailed site investigations and as-builts.

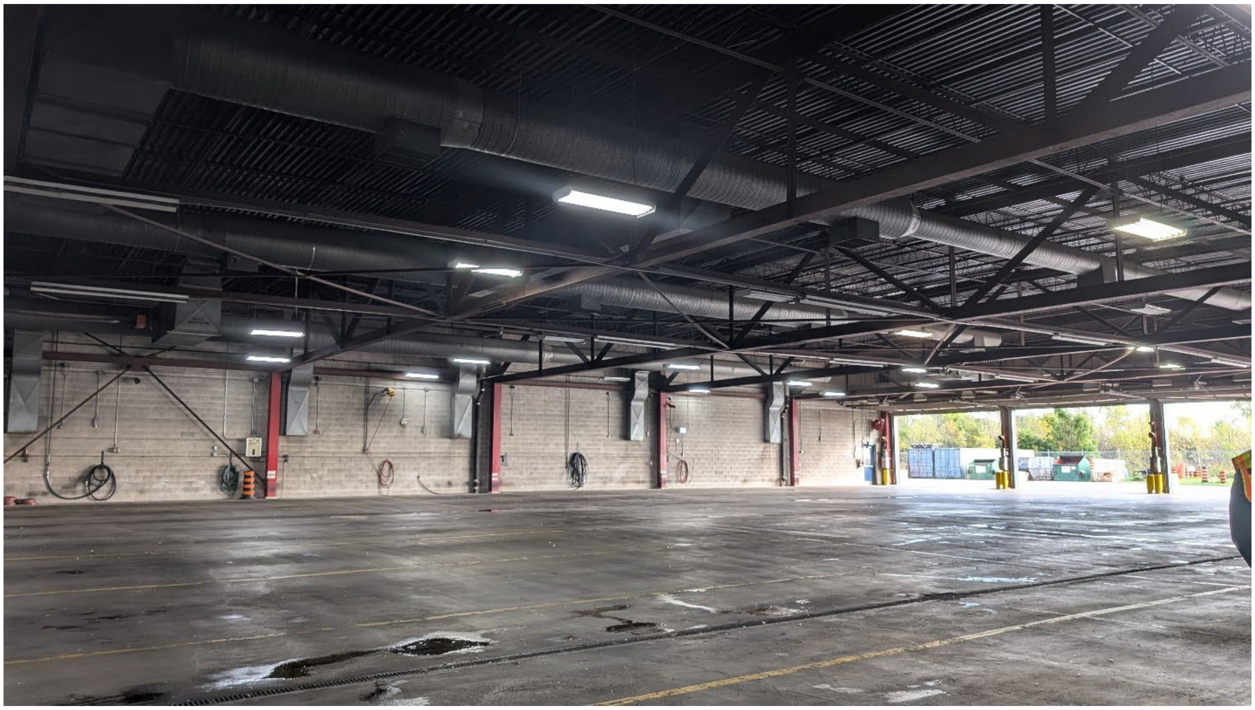

Figure 2-5: Ducting in Original Bus Storage Area.

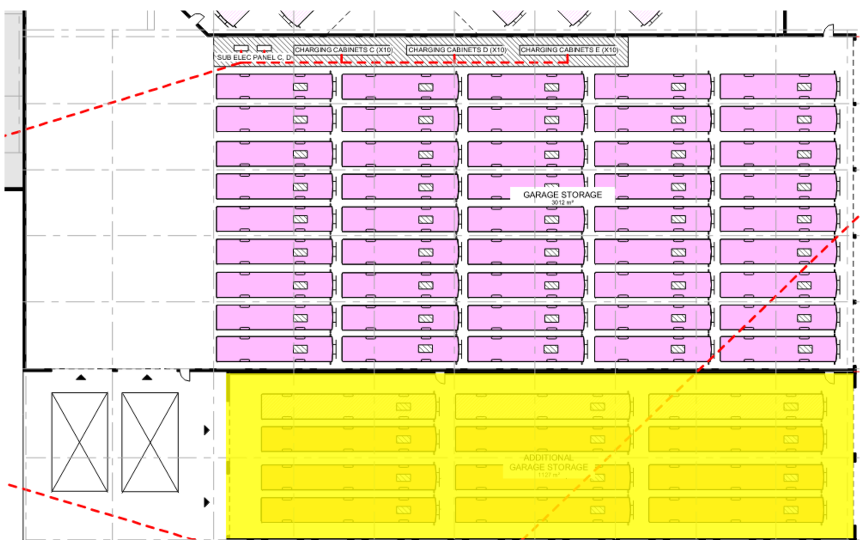

Figure 2-6. Additional Garage Storage Area.

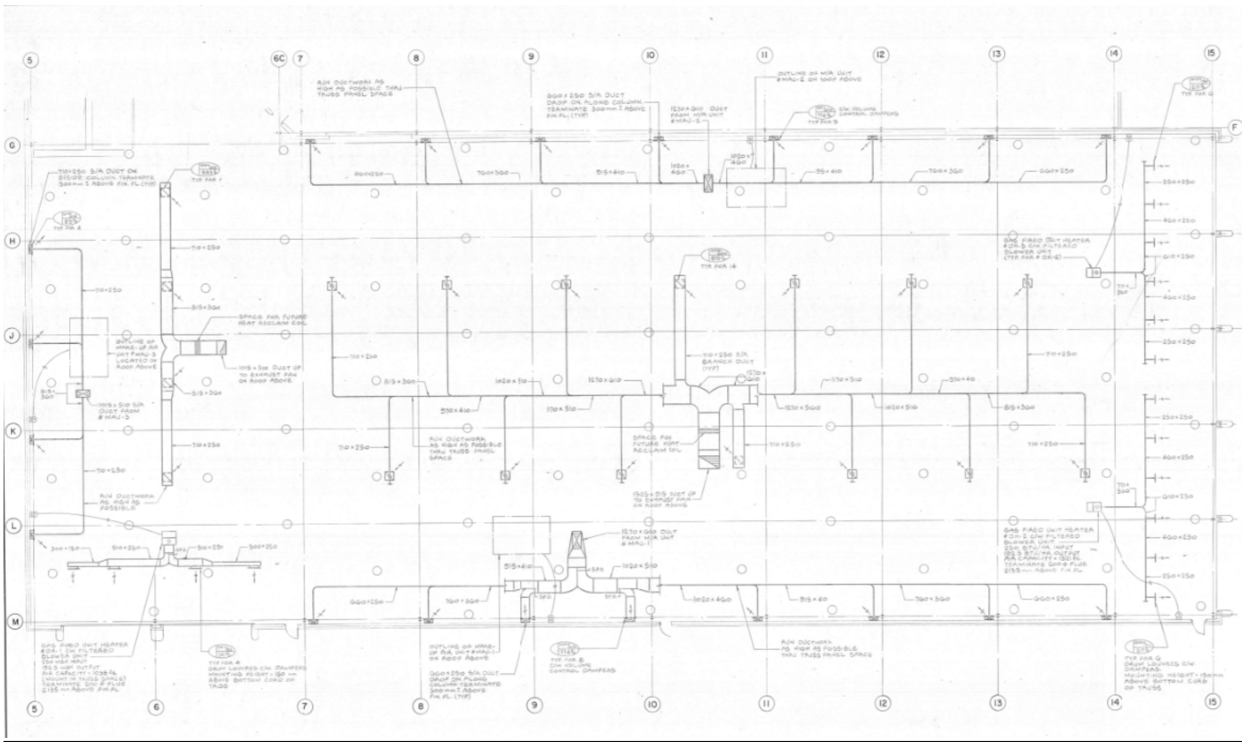

Figure 2-7. Block "A" Heating & Ventilation Plan.

Additional Garage Storage Area – view 1

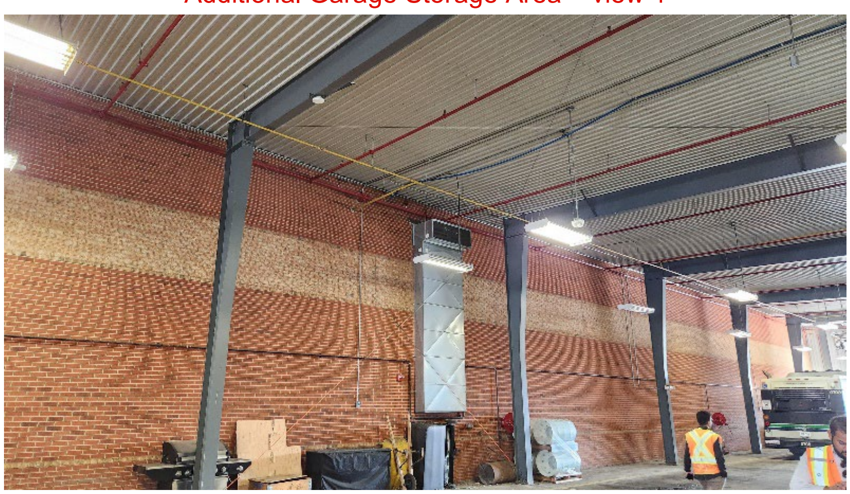

Figure 2-8. Additional Garage Storage Area – view 1.

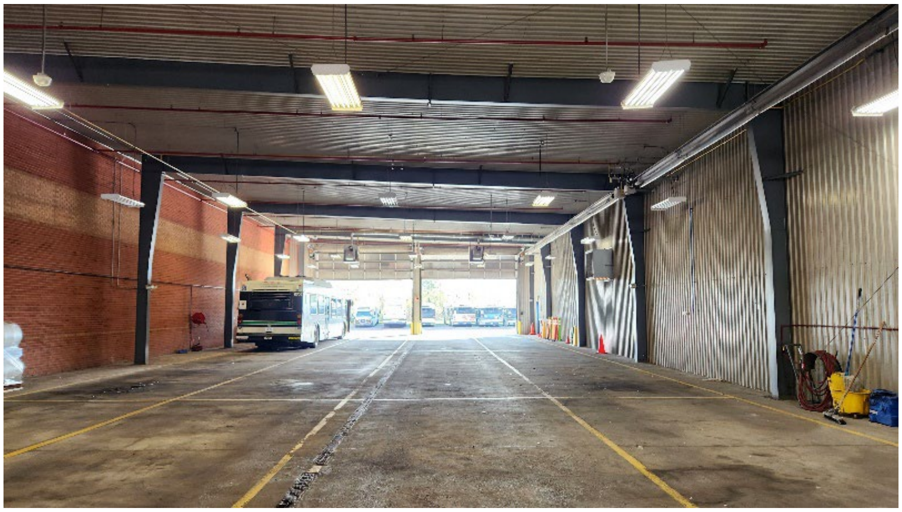

Figure 2-9. Additional Garage Storage Area – view 2.

It is suggested that the garage storage area currently served by a make-up air unit and exhaust fan be replaced with a heat recovery unit. This change will enhance efficiency and lower energy consumption in the bus storage area.

As for main electrical panel, sub electrical panel and charging cabinets, they are proposed to be located along in the wall in the Additional Garage Storage Area shown in Figure 2-8 and Figure 2-9. Provisions for HVAC system will have to be provided for this area to main optimum temperature conditions based on the operating conditions of electrical equipment. If temperatures as high as 40 C is permissible, forced air ventilation through heat recovery unit or exhaust fans can be considered as well. This shall be determined during detailed design stage.

To support the charging infrastructure, a 2000 kVA outdoor natural gas generator is being proposed by the electrical team. This will most likely need an upgrade in gas infrastructure, but detailed investigations must be carried out during design stage. A dedicated gas line, manual valve, overpressure protection device shall be required for the new generator in accordance with CSA 282.

Alternatively, a diesel generator can also be considered. Fuel storage and handling for outdoor diesel generator shall be designed in accordance with CSA B139 and TSSA. This will include design of key components including but not limited to fuel storage tank (single or double-walled, sized appropriately for autonomy), a fill pipe with spill containment and a secure cap, a vent pipe, fuel supply and return piping, fuel monitoring, and potentially leak detection and secondary containment depending on tank size and location.

2.1.4.1 *FIRE PROTECTION*

Currently there is a 6” incoming fire-main entering the facility. The sprinkler system is a wet system as shown in Figure 2-10.

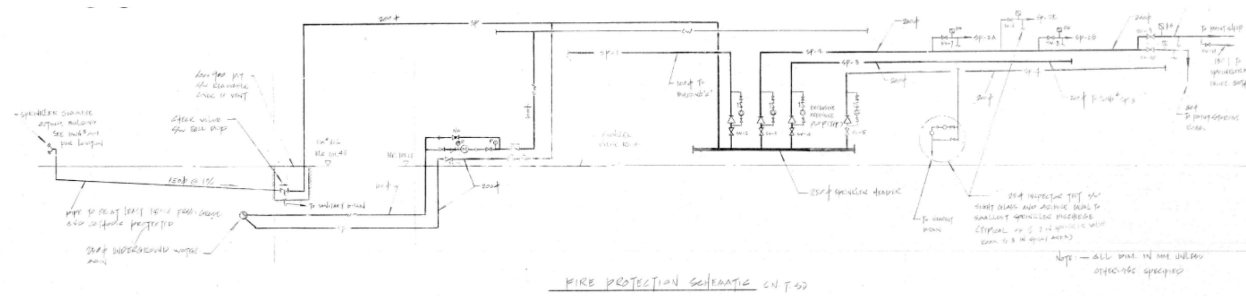

Figure 2-10. Sprinkler Header Diagram.

NFPA 13 recommended Ordinary Hazard Group II is sufficient, based on experience from previous projects. It is not uncommon for AHJ (authorities having jurisdiction) to request higher level of hazard classification, that is Extra Hazard I/II. This is primarily because current versions Ontario Building Code and Electrical Safety Code do not provide explicit guidance on installation of new charging systems and energy storage systems in new and existing building extensions. Hence, it must be determined through close coordination with Code Consultant and AHJ if hazard classification needs to be upgraded. If upgraded, detailed hydraulic calculations, designed and sealed by Professional Engineer (engaged by the successful mechanical contractor) in accordance with NFPA 13 and 14, Ontario Building and Ontario Fire Code and as per requirements of AHJ. Based on the hydraulic calculations and hydrant flow test reports, it will be determined if a fire pump, jockey pump, sprinkler pipe and head upgrades shall be required. In summary, it must be determined in coordination with AHJ and Code Consultant if higher levels of fire protection are required.

A fire hydrant shall be provided to support firefighting operations for exterior standby gas generators and battery energy storage systems. While the Ontario Building Code (OBC) does not explicitly mandate hydrants for these systems, the design shall align with the intent of OBC Division B, Part 3, which references NFPA 14 for standpipe and hose system design. NFPA 14 requires that fire department connections and water supplies be capable of delivering adequate flow and pressure to support firefighting efforts. In accordance with these principles, and consistent with best practices for sprinklered structures, a fire hydrant shall be located within 90 metres of the equipment along an unobstructed path. The final location of the hydrant shall be coordinated with the civil engineering discipline during the detailed design phase to ensure compliance with access and flow requirements.

2.1.5 CONSTRUCTION PHASING CONSIDERATIONS

The construction phasing strategy has been developed to ensure the delivery of the first BEBs coincides with the completion of the initial construction phase of St. Catharines garage. The construction and installation of chargers is planned to be split into two phases for St. Catharines depot.

St. Catharines Phase 1 considers the planning, procurement and construction activities associated with the first five years of BEB deliveries - namely:

1. Detailed Design and Early Works Package – a nominal two-year period (shown as Planning Years 1 & 2 on the graphic below) which entails budgeting, detailed / issued-for-construction (IFC) design, permitting and procurement activities associated with the Phase 1 facility retrofit and the procurement and implementation of long-lead items such as the electrical service upgrade (e.g. upstream electrical substation, mains panels / switchgear, standby generator, civil trenching works and BESS.) This period could equally be

considered for engagement with energy-as-a service (EaaS) provider(s), should this delivery model be preferred.

A refined duration for this detailed design & early works should be confirmed as part of the next stages of design.

2. Provision of charging infrastructure to cover the first 5 years of BEB deliveries (i.e. 52 no. 40' BEB's, 6 no. 60; BEBs and 10 no. paratransit vehicles.)
3. Installation of charging cabinets, pantographs and dispensers to accommodate the BEBs (i.e., 23 no. 150 kW charging cabinets with 54 associated pantograph dispensers and 54 no. 200 kW charging cabinets with 10 associated plug-in dispensers.)
4. Futureproofing for Phase 2: "roughed in" conduit routing for the Phase 2 chargers, pantographs and dispensers will also be installed in Phase 1 to simplify construction of Phase 2.

Phase 2 consists of implementation of charging equipment to cover the remainder of the BEB deliveries in years 6 though 12.

- A 2-year procurement planning period is nominally provided in Years 3 and 4,
- 28 no. 40' BEBs, 5 no. 60' BEBs and 12 no. paratransit vehicles,
- Gantry works & associated electrical work for external BEB parking / storage and charging,
- Installation of charging cabinets, pantographs and dispensers to accommodate the BEBs (i.e., 15 no. 150 kW charging cabinets with 22 associated pantograph dispensers)

Refer to Section 0 for a detailed breakdown of the fleet and charging infrastructure transition plan for St. Catharines.

The **physical extents of the St. Catharines construction phases are illustrated in Figure 2-11** and the associated **BEB procurement / delivery and facility construction schedule is discussed in Section 3.3.1**.

Phasing Approaches for Chargers, Pantographs and Dispensers: within each construction phase, NT has the option to construct and install all the charging cabinets, pantographs and dispensers in a single-year construction event / package, or to spread the construction over years within the "phase" according to BEB delivery schedule.

Implementing all the chargers, pantographs and dispensers in a single year is efficient from a schedule and operational continuity perspective but can result in underutilisation of equipment during the warranty period before the corresponding BEBs are received. Alternatively, installing the charging equipment according to the receipt of BEBs requires additional procurement and administrative effort and presents operational complexity each year. The preferred approach should be evaluated during the detailed design development process based on available budget, capacity and operational requirements.

Long-Lead Items & Early Works

The following table identifies the infrastructure components which are subject to relatively long procurement lead times. These could potentially be broken out from the main construction package(s) as one or more early works packages.

Table 2-2. List of Long-Lead Procurement Components

ITEM	DESCRIPTION	ESTIMATED LEAD TIME
Long-Lead Procurement Items		
Utility Transformer	6000 kVA, 13.8 kV–480/277 V pad mount	12–18 months
Main Electrical Panel	8000 A, 480 V switchgear	10–14 months
Sub Electrical Panels	Multiple panels rated at 2000 A / 1200 A	8–12 months
BESS Switchgear	3000 A, 480 V switchgear and circuit breakers	10–14 months
Battery Energy Storage System (BESS)	2000 kW / 4000 kWh system containerized	12–14 months
Standby Generator	480 V, 1200 A with dedicated panel and controls	10–12 months
Main Package		
Charging Cabinets	150–200 kW DC fast charging cabinets (40+ units)	8–10 months
Dispenser Units	Pantograph and CCS1 plug-in connectors	6–8 months
Auxiliary Transformer	100 kVA, 480–120/208 V for lighting/control loads	6–8 months
Protection Relays & Meters	SEL-751, SEL-735 for monitoring & protection	6–8 months

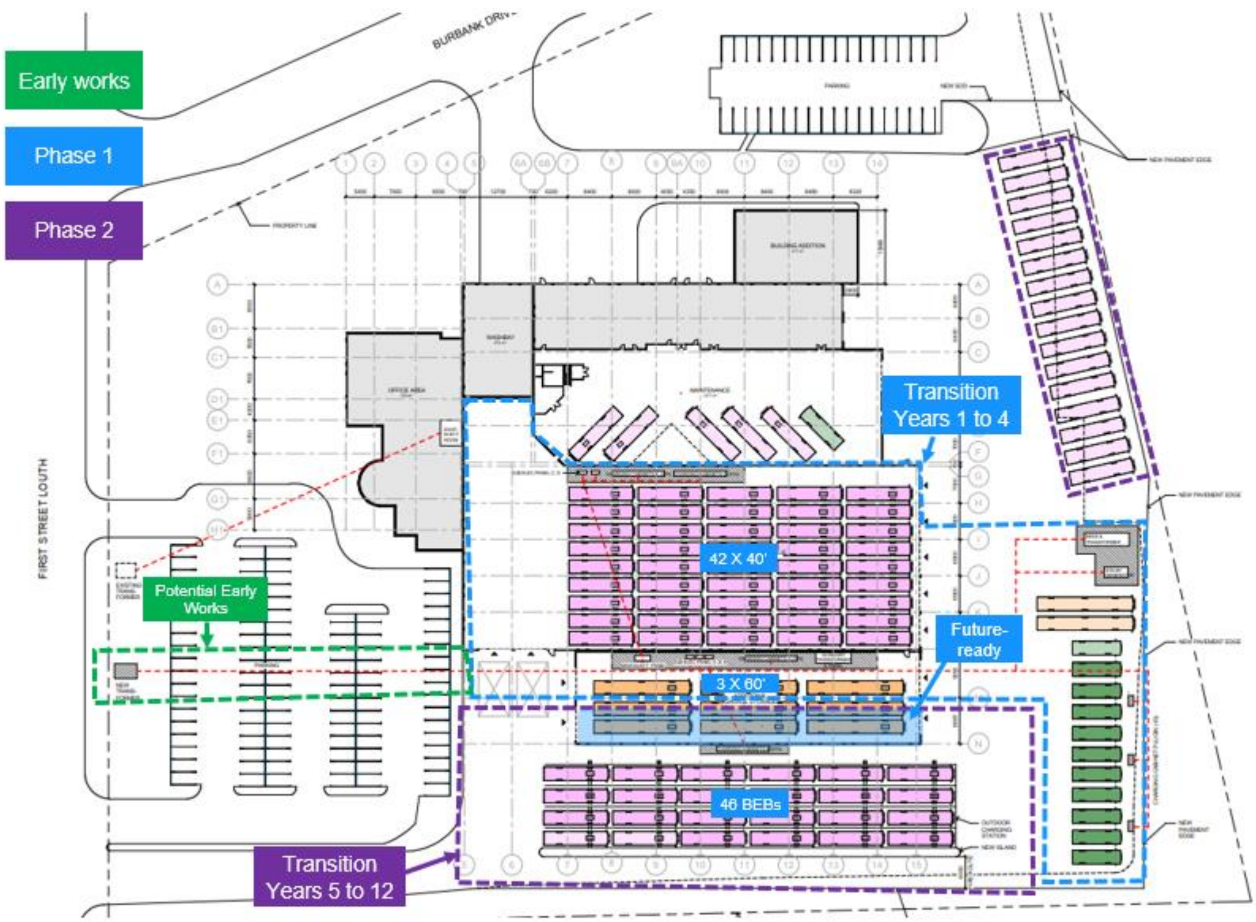

Figure 2-11: St. Catharines Phasing Diagram.

2.2 NIAGARA FALLS FACILITY

The *Industry Scan, Current State Assessment and BEB Feasibility Analysis Report* identified the existing conditions at Niagara Falls Garage including bus storage capacity, space utilisation, parking arrangements, access and egress / circulation and other space program features. The existing base electrical load and spare capacity, existing electrical equipment & infrastructure and backup power generation systems were assessed.

The *Charging Strategy Analysis Report* identified the future-state fleet and charging requirements at each garage, which underpins the proposed facility retrofits and recommended implementation planning presented herein.

Niagara Falls Garage hosts Metrolinx GO buses under a long-term lease arrangement that entails the allocation of two of its indoor storage lanes to these vehicles, in addition to providing certain driver facilities within the building. These lanes are excluded from the NT electrification scope and will be preserved for the use of Metrolinx GO regional transit vehicles.

As at St. Catharines, the preferred charging technology within the garage will be overhead pantographs rather than plug-in chargers.

Service and charging simulations indicated that due to the heavier duty cycles of the longer distance intermunicipal services operating out of Niagara Falls, there is a need for on-route chargers outside the depot. Five on-route chargers are proposed at Welland Bus Terminal so buses are able to top up their state of charge while performing layovers there.

With the Niagara Falls facility being relatively newer than St. Catharines, it's proposed to implement the retrofits at this site after the majority of the work at St. Catharines is completed. This approach provides NT with time to consider the development of low and zero-emissions transit technologies (and fuel costs) as they emerge or mature in the coming years. For example, the business case for hydrogen fuel cell electric bus operations may improve over time and warrant reconsideration.

2.2.1 ARCHITECTURE

The Niagara Bus Storage and Maintenance Facility, consisting of an existing garage storage building, exterior lanes/parking, and a maintenance bay, will be used to store forty-nine (49) 40' BEBs (41 Core + 8 Spares), twenty-four (24) 60' BEBs (20 Core + 4 Spares), and fourteen (14) paratransit vehicles (11 Core + 3 Spares). Both indoor and outdoor spaces of the site will be serving the function of storage for the fleet and provide charging locations for all core buses and select spare buses. Refer to Table 2-3.

Refer to Figure 2-12 and Appendix A for drawings.

Table 2-3: Proposed Fleet Makeup at Niagara Falls Garage

	Core Fleet	Spares	Total
40' BEB	71	8	49
60' BEB	20	4	24
Paratransit Vehicles	11	3	14

The Garage Storage area in the facility measures up to 2280 square meters (SQM) and currently consists of six (6) bus lanes, with three (3) overhead doors on the east, and two (2) overhead doors on the south side. As of now, two (2) out of six (6) indoor bus lanes are reserved for GO Buses.

The two (2) north lanes reserved for GO Buses will remain as is. The remaining lanes in the garage can be used for charging sixteen (16) out of twenty-four (24) 60’ BEBs with roof mounted pantographs for each. The lanes will require new line painting, signage, and new coiling for the overhead doors on the east as pantograph interferes with door storage when open (3 total). Overhead door width to be confirmed.

Currently, there are eight (8) exterior lanes south of the garage storage. For the purpose of charging the indoor and outdoor stored buses, one (1) bus lane on the northmost side (closest to the building) will be fenced off for the main electrical panel, the subpanels, and charging cabinets. The remaining seven (7) lanes plus one (1) new lane, will be used to charge the four (4) remaining 60’ core BEBs, as well as forty-two (42) 40’ BEBs (41 core + 1 spare).

This outdoor charging area will be comprised of six (6) rows of exterior gantry pantograph structures for the 40’ buses, and two (2) independent gantry pantograph structures for the 60’ BEBs. The lanes will require new line painting and signage.

A new island to be installed south of the outdoor storage is recommended to protect the gantry pantograph structures and to direct traffic. A minimum distance of six (6) metres from paved island to pavement edge is required for fire route.

Site fencing will be required around the electrical yard adjacent to building. New Bollards (1.2m) to be installed every 3m around perimeter of fenced area. Likewise, Site fencing will be required around the Battery Energy Storage System (BESS) and Generator Area. New Bollards (1.2m) to be installed every 3m around perimeter of fenced area.

The core paratransit vehicles will be parked in the southeast end of the site. There will be three charging cabinets for the paratransit vehicles, each connected to four charging dispensers. These cabinets and dispensers will have dedicated concrete mounting pads. The remaining spare buses for 60’ BEBs, 40’ BEBs and paratransit vehicles will have parking north-east and in the maintenance bay.

It is recommended that maintenance bay is used for maintenance purposes only, as there will be only one (1) mobile charger in the facility. An island to separate transverse traffic between the north lanes is recommended. Minimum distance of 6m is required for fire code.

Landscape and paving areas are to be repaired where new duct banks are installed. It is recommended to increase the paved area to support new bus parking, as indicated on the site plan. New concrete curbs and landscaping for island separating charging and south circulation route will be required.

2.2.1.1 *FUTURE SITE EXPANSION POTENTIAL*

NT is considering the potential for acquisition of additional land surrounding the Niagara Falls transit garage to accommodate future service growth.

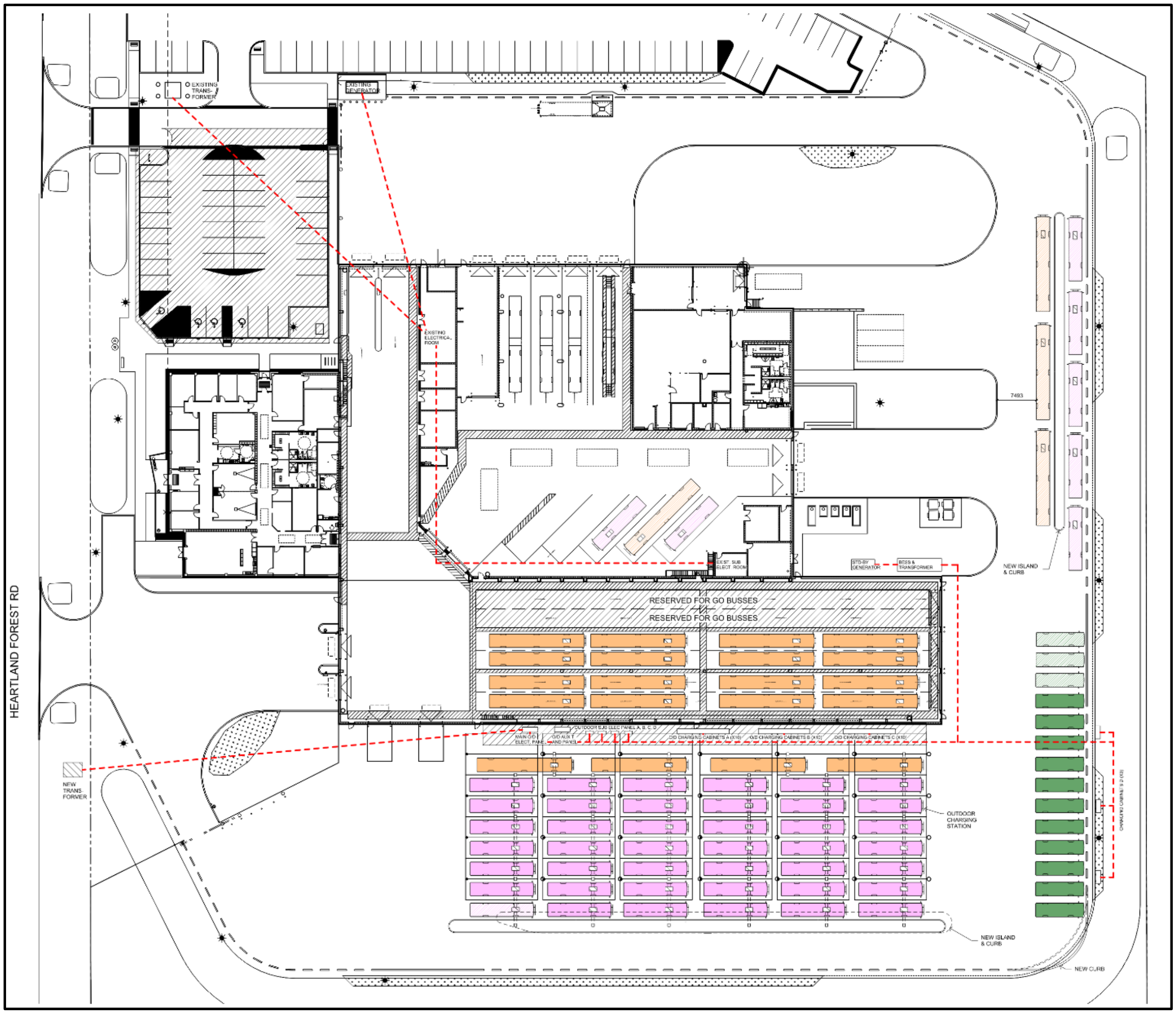

Figure 2-12: Niagara Facility Site Plan (Conceptual Only).

LEGEND:
Core buses: 60’ BEB (Orange); 40’ BEB (Pink), Paratransit Vehicle (Green).
Spare buses are represented in a diagonal hatch pattern.

2.2.2 ELECTRICAL

The proposed electrical design provides new infrastructure to support Niagara Transit's fleet electrification initiative at the Niagara Falls garage. This project enables charging of the transit fleet through a network of pantograph and plug-in chargers, backed by a utility-supplied transformer, a robust distribution system, auxiliary services, BESS, and a standby generator for emergency scenarios. The facility will accommodate present and future charging needs with adequate spare provisions and system flexibility.

The distribution system considering a diversity factor of 60% begins at a new utility-fed 6000 kVA pad-mounted transformer and connects to an 8000A-rated main Switchgear at 480Y/277V. Downstream subpanels A through D distribute power to charging cabinets and auxiliary systems. The design includes intelligent Energy Management System (EMS) coordination with BESS and standby generator integration to balance load and maintain operational reliability during peak and outage conditions.

The design includes a layered metering and protection scheme using SEL protective relays:

- SEL-735: Used for advanced metering of the incoming utility supply, providing precise energy usage data and power quality monitoring.
- SEL-751: Provides feeder protection and is integrated with CTs and PTs to monitor current and voltage levels at the subpanel inputs.
- SEL-700G: Installed at the generator panel to ensure reliable generator protection and synchronization during emergency operations.

A SCADA/DMS RTU/PLC system is integrated via Ethernet and Modbus communication protocols, enabling centralized monitoring, control, and diagnostics:

- The EMS intelligently coordinates between the utility source, BESS, and standby generator, optimizing load profiles and demand during peak usage or grid outages.
- The system provides real-time visibility and control of the charging network, facilitating automated scheduling, load shedding, and fault response.

A single line diagram together with a description of the core components of the electrical design is included in Appendix A.

2.2.2.1 *STAND-BY GENERATOR AND PANEL*

A **2000 kVA, 480V** standby natural gas generator is suggested to support critical systems during utility outages. Load will be controlled through EMS to ensure safe operation and prevent overload. The generator supplies only essential systems and a limited number of charging cabinets under backup scenarios.

2.2.2.2 *BATTERY ENERGY STORAGE SYSTEM (BESS)*

One **2 MW / 4 MWh BESS** is suggested to support peak shaving, global adjustment reduction, and load balancing in conjunction with the EMS. The system is not intended for continuous full-load operation but responds dynamically based on facility demand and grid status.

2.2.3 *STRUCTURAL*

Based on the site visit and review of drawings provided, the building structure consists of steel deck on steel open web joists supported by steel trusses and steel beams on steel columns.

With respect to the proposed electrification requirements, the following structural changes are noted:

Interior Charging Area

1. To accommodate roof mounted supports for interior pantographs: proposed structural support for the interior pantographs consists of two (2) new steel beams W200x25 for each pantograph connected to the existing building structure as shown in Figure 2-13.
2. Each pantograph to be hung from new steel beams by four (4) threaded rods.

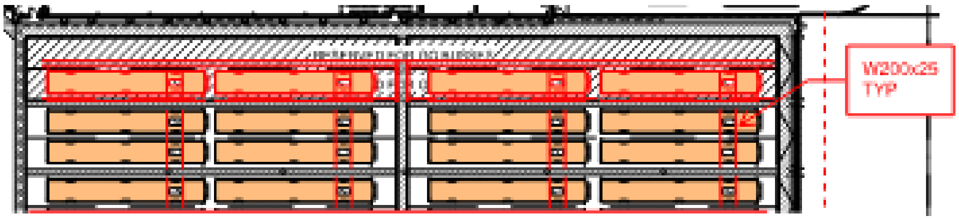

Figure 2-13 Roof Framing Plan – Structural Support for Interior Pantographs.

Outdoor Charging Area

1. Gantry for exterior pantographs: A freestanding gantry structure to be designed to support the exterior pantographs. The structural support for the gantry consists of steel framing supported by steel columns on concrete pedestals and foundations as shown in Figure 2-14 and Figure 2-15.
2. The steel framing consists of two (2) steel beams W200x27 for each pantograph connected to primary steel beams 460x60.
3. Each foundation to be supported by 4 helical piles.
4. The structure is laterally supported by steel x-bracings on one direction and moment frames on the other direction.

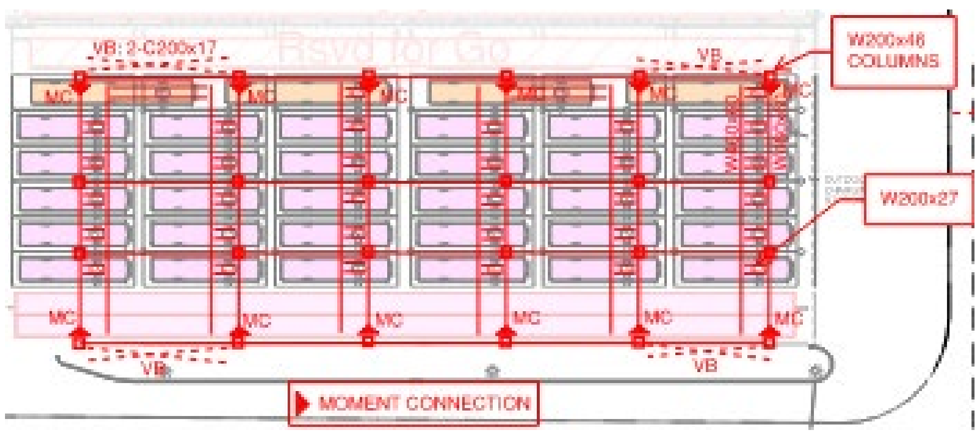

Figure 2-14. Gantry Framing Plan – Structural Support for Exterior Pantographs.

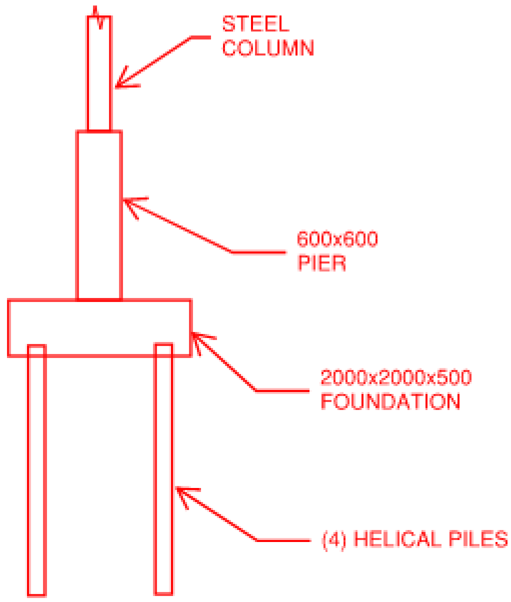

Figure 2-15. Typical Foundation detail of new gantry.

2.2.4 HVAC

The exiting vehicle storage space is currently ventilated using two (2) roof mounted, indirect fired gas fired, 100% outdoor air handling units each 9400 l/s (20,000. CFM) Supply & 9165 l/s (19420 cfm) Exhaust/ Return. This equates to a total of approximately 2 x 20,000 CFM. Air handling units currently operate based on sensing the air quality within the space via CO and NO2 sensors.

Based on proposed 33 electrical buses with heat dissipation of 1.5 kW each, the total charging load would be 30 kW in existing bus storage, therefore the air is required to maintain the Max. inside space temperature, in summer, of 35˚C, only 13,200 cfm. Hence, the existing out air handling units should be sufficient to maintain a temperature of 35˚C.The supply and return air ducting runs at ceiling level. Based on the proposed charging infrastructure within the facility, the ducts may need to be rerouted within the existing trusses to allow for mounting of bus charging pantographs. As for the air handling units themselves, the units are in good condition and not due for replacement until 2039 based on the Condition Assessment Report provided by Englobe Corp. dated 10^{th} August, 2023.

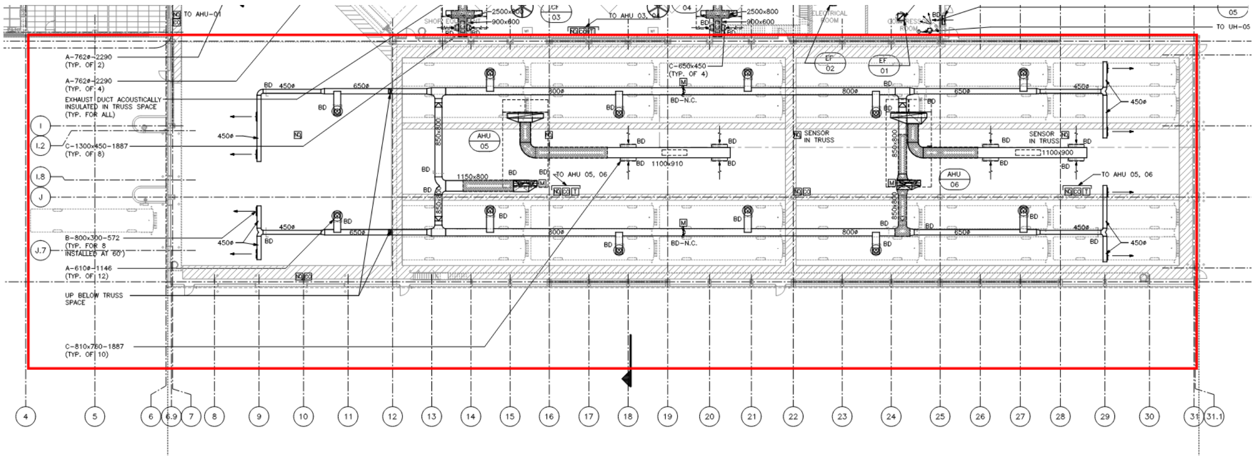

Figure 2-16. HVAC Garage - Ground Floor.

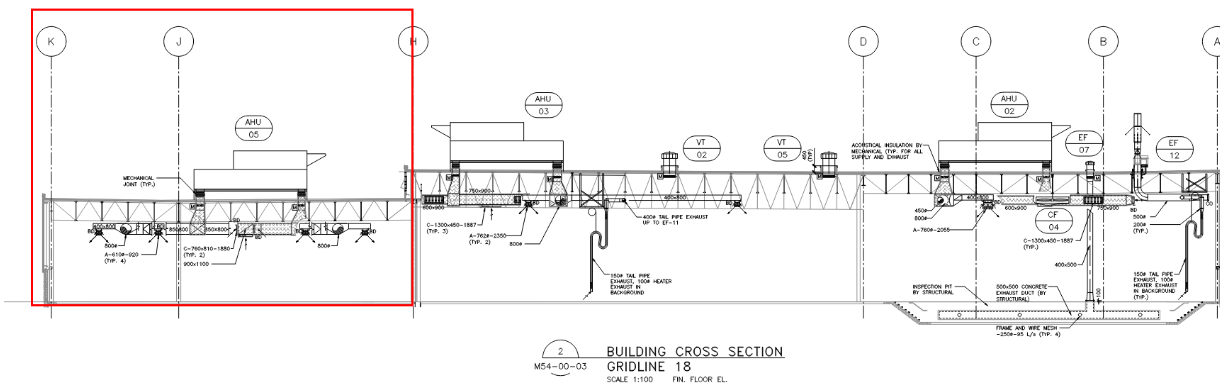

Figure 2-17. Building Cross Section Gridline 18.

As for main electrical panel, sub electrical panel and charging cabinets, they are proposed to be located outside the garage. Hence, no provisions for HVAC system are deemed necessary.

To support the charging infrastructure, a 2000 kVA outdoor natural gas generator is proposed. This will most likely need an upgrade of the site gas supply infrastructure but detailed investigations must be carried out during design stage. A dedicated gas line, manual valve, overpressure protection device shall be required for the new generator in accordance with CSA 282.

Alternatively, a 2000 KVA outdoor diesel generator can also be considered. Fuel storage and handling for outdoor diesel generator shall be designed in accordance with CSA B139 and TSSA. This will include design of key components including but not limited to fuel storage tank (single or double-walled, sized appropriately for autonomy), a fill pipe with spill containment and a secure cap, a vent pipe, fuel supply and return piping, fuel monitoring, and potentially leak detection and secondary containment depending on tank size and location.

2.2.4.1 *FIRE PROTECTION*

With reference to the existing building provisions, an 8” incoming fire main enters the facility in the sprinkler and water meter room.

The sprinkler system is a combination of wet and dry sprinkler system as shown in Figure 2-18. Hazard classification of various zones is identified in Figure 2-19. The bus storage area and circulation areas are being served by a wet sprinkler system, classified as ordinary hazard group II.

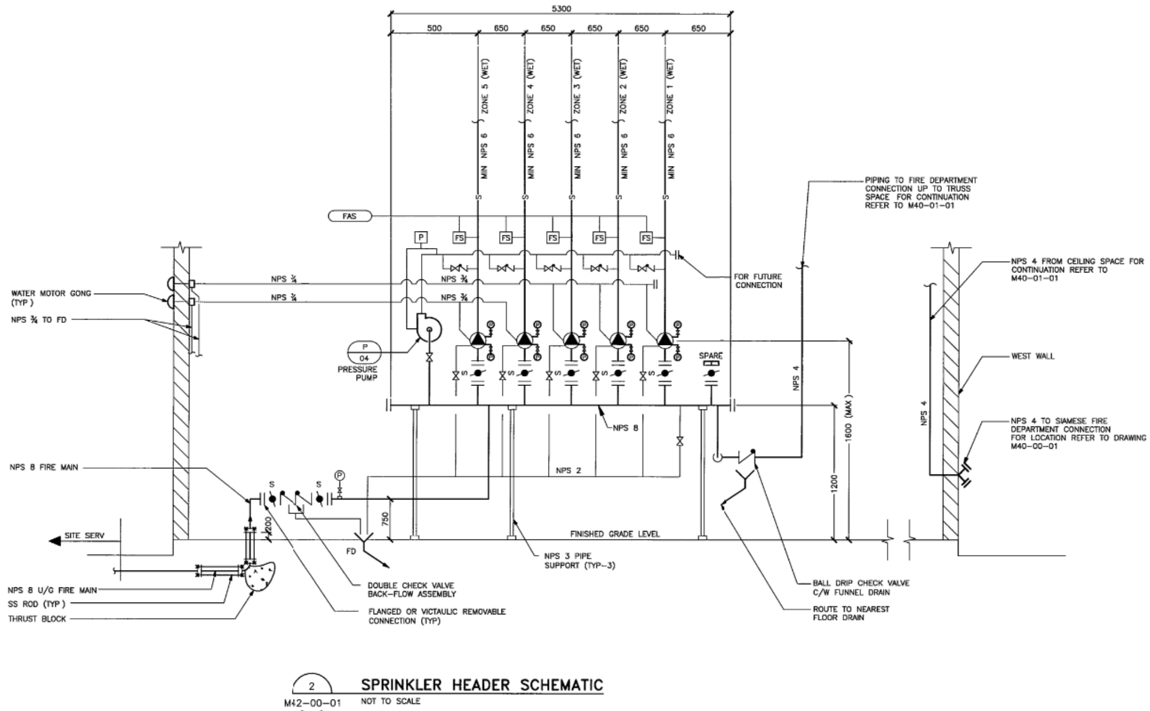

Figure 2-18. Sprinkler Header Schematic.

SUMMARY OF FIRE PROTECTION ZONES

ZONE	SUBZONE	AREA DESTINATION	HAZARD CLASS PER NFPA 13	TYPE OF FP SYSTEM	WATER COVERAGE IMPERIAL USGPM/SQ FT /SQ FT	WATER COVERAGE METRIC L/MIN/SQ M	AREA SQ.M (SQ.FT.)	SUGESTED SPRINKLER HEAD	ORIFICE TEMP NPS °C(°F)
1	–	ADMINISTRATION OFFICES	LIGHT HAZARD	WET	0 10/1500	4,05/140	1,218 (13,276)	PENDENT	NPS 1/2 68 C (155 F)
2	–	BUS CIRCULATION & SERVICE LANES	ORDINARY HAZARD GROUP II	WET	0 20/1500	4,05/140	1,020 (11,000)	UPRIGHT	NPS 3/4 141 C (286 F)
	2A	NORTH ENTRANCE	ORDINARY HAZARD GROUP II	DRY	0 20/2000	8 1/140	132 * (1,439)	UPRIGHT	NPS 3/4 141°C (286 F)
	2B	SOUTH & SOUTHWEST ENTRANCE	ORDINARY HAZARD GROUP II	DRY	0 20/2000	8 1/140	132 * (1,439)	UPRIGHT	NPS 3/4 141°C (286°F)
3	–	BUS STORAGE	ORDINARY HAZARD GROUP II	WET	0 20/1500	8 1/140	3,600 (33,000)	UPRIGHT	NPS 3/4 141 C (286°F)
	3A	EAST STORAGE ENTRANCE	ORDINARY HAZARD GROUP II	DRY	0 20/2000	8 1/140	275 5 * (2,964)	UPRIGHT	NPS 3/4 141 C (286 F)
4	–	REPAIR	ORDINARY HAZARD GROUP II	WET	0 20/1500	8 1/140	3,323 (36,000)	UPRIGHT	NPS 3/4 141 C (286 F)
	4A	HIGH RACK INSIDE PART STORAGE	ORDINARY HAZARD GROUP II	WET	MOST REMOTE HEADS AT 15 PSI				NPS 3/4 141 C (286°F)
5	–	PART STORAGE	EXTRA HAZARD GROUP II	WET	0 50/2000	20/230	542 (5,800)	UPRIGHT	NPS 3/4 141 C (286 F)
	5A	TIRE STORAGE	EXTRA HAZARD GROUP I	WET	0 30/2500	12/232	94 (1,010)	UPRIGHT	NPS 3/4 141 C (286 F)
6	–	SPARE							

NOTE

SUBZONES AREAS MARKED WITH * ARE INCLUDED IN THE ASSOCIATED ZONE AREAS

Figure 2-19. Fire Protection Zone Summary.

For the proposed scope of work, the area highlighted in yellow in Figure 2-20 corresponds to the area of interest that will be used to charge and store BEBs. While NFPA 13 recommends Ordinary Hazard Group II as sufficient, based on WSP's past project experience, it is not uncommon for the Authority Having Jurisdiction (AHJ) to request higher level of hazard classification, that is Extra Hazard I/II. This is primarily because current versions Ontario Building Code and Electrical Safety Code do not provide explicit guidance on installation of new charging systems and energy storage systems in new and existing building extensions. The consultant responsible for the detailed design & application of codes must therefore coordinate with the AHJ to determine whether hazard classification needs to be upgraded. If upgraded, detailed hydraulic calculations, designed and sealed by Professional Engineer (engaged by the successful mechanical contractor) in accordance with NFPA 13 and 14, Ontario Building and Ontario Fire Code and as per requirements of Authorities Having Jurisdiction. Based on the hydraulic calculations and hydrant flow test reports, it will be determined if a fire pump, jockey pump, sprinkler pipe and head upgrades shall be required. In summary, it must be determined in coordination with AHJ and Code Consultant if higher levels of fire protection are required.

A fire hydrant shall be provided to support firefighting operations for exterior standby gas generators and battery energy storage systems. While the Ontario Building Code (OBC) does not explicitly mandate hydrants for these systems, the design shall align with the intent of OBC Division B, Part 3, which references NFPA 14 for standpipe and hose system design. NFPA 14 requires that fire department connections and water supplies be capable of delivering adequate flow and pressure to support firefighting efforts. In accordance with these principles, and consistent with best practices for sprinklered structures, a fire hydrant shall be located within 90 metres of the equipment along an unobstructed path. The final location of the hydrant shall be coordinated with the civil engineering discipline during the detailed design phase to ensure compliance with access and flow requirements.

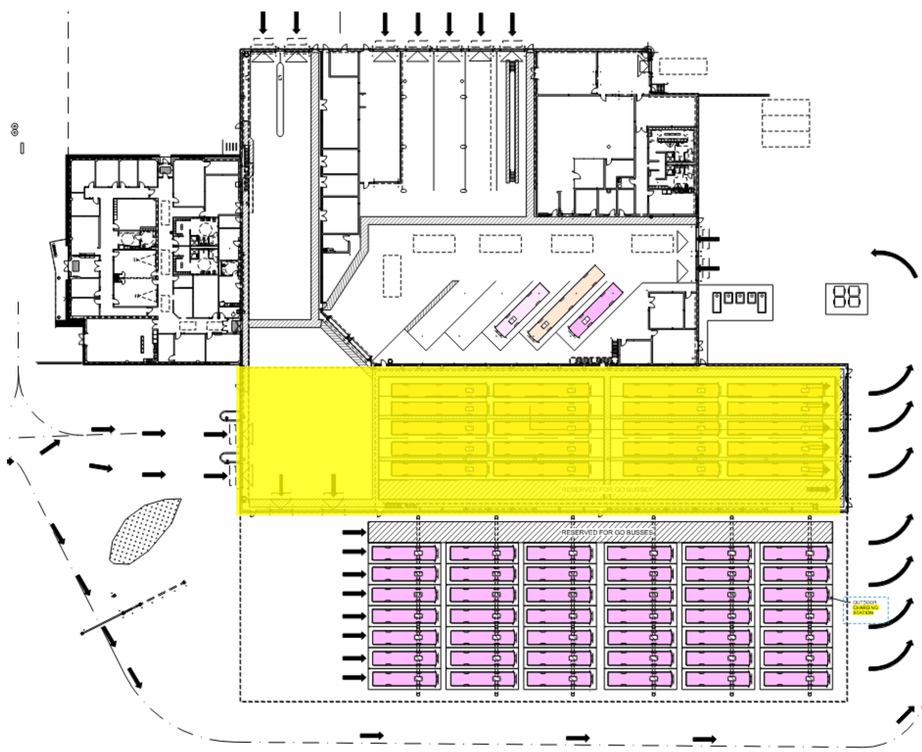

Figure 2-20 Scope of Fire Protection Work.

2.2.5 CONSTRUCTION PHASING CONSIDERATIONS

The retrofits for the Niagara Falls garage are envisaged to be completed in a single construction phase, in addition to a potential early works package to increase the capacity of the electrical service at the site. The charger installation schedule for Niagara Falls garage and Welland Bus Terminal is included in Section 3.3.2.

On-route chargers are required to provide top-up charging for services operated from Niagara Falls garage. There is a total of 5 no. on-route chargers planned at Welland Bus Terminal, estimated to be implemented over a period of five years. This may change in case of service expansions or other changes to facilities in the future. Refer to Figure 2-21.

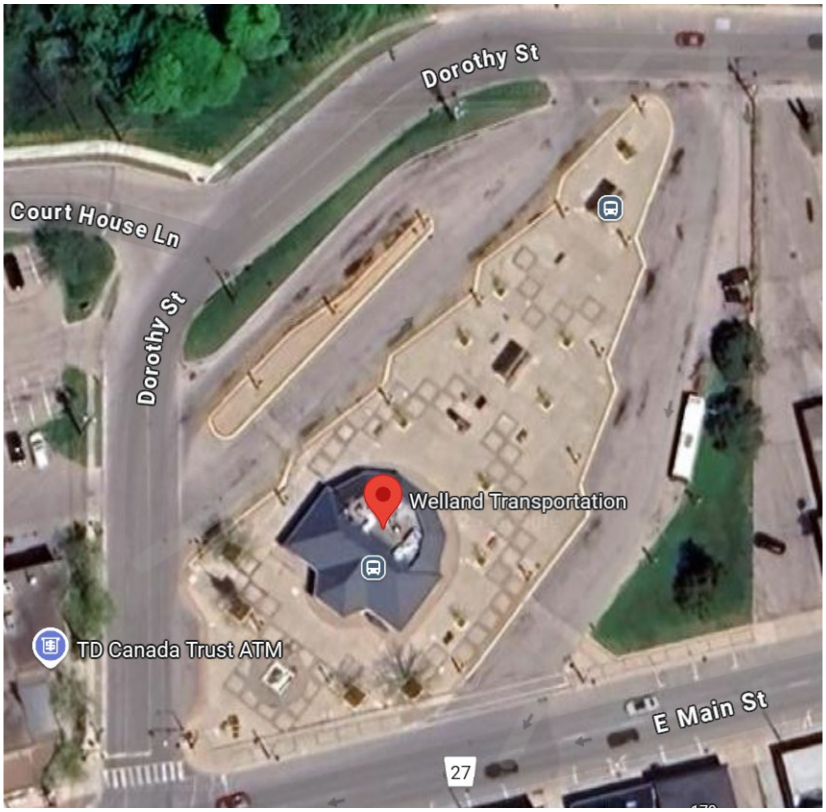

Figure 2-21. Satellite view of Welland Bus Terminal.

A suggested list of items to include in the early works package for Niagara Falls Garage is as follows:

- As with St. Catharines, a two-year period (in Years 4 and 5) has been allowed to accommodate planning, budgeting, detailed / issued-for-construction (IFC) design, permitting and procurement activities associated with facility retrofit and the procurement and implementation of long-lead items such as the electrical service upgrade if required (e.g. upstream electrical substation, mains panels / switchgear, standby generator, civil trenching works and BESS).
- A refined duration for this detailed design & early works should be confirmed as part of the next stages of design. An Opening Day in Year 6 is anticipated to align with the delivery of the BEBs as noted below.

- Provision of charging infrastructure to cover the first all BEB deliveries required for Niagara Falls. Installation of charging cabinets, pantographs and dispensers to accommodate the BEBs.
- BEB procurement will also begin in Year 4, with first delivery occurring in Year 6.

Refer to Section 0 for a detailed breakdown of the fleet and charging infrastructure transition plan for Niagara Falls.

The **BEB procurement / delivery and facility construction schedule for Niagara Falls is discussed in Section 3.3.2 below.**

As with St. Catharines, there are options for the installation of **Chargers, Pantographs and Dispensers**: NT can either construct and install all the charging cabinets, pantographs and dispensers in a single-year construction event / package, or to spread the construction over years within the "phase" according to BEB delivery schedule.

Implementing all the chargers, pantographs and dispensers in a single year is efficient from a schedule and operational continuity perspective but can result in underutilisation of equipment during the warranty period before the corresponding BEBs are received. Alternatively, installing the charging equipment according to the receipt of BEBs requires additional procurement and administrative effort and presents operational complexity each year. The preferred approach should be evaluated during the detailed design development process based on available budget, capacity and operational requirements.

Long-Lead Items & Early Works

The following table identifies the infrastructure components which are subject to relatively long procurement lead times. These could potentially be broken out from the main construction package(s) as one or more early works packages.

Table 2-4. List of Long-Lead Procurement Components

ITEM	DESCRIPTION	ESTIMATED LEAD TIME
Long-Lead Procurement Items		
Utility Transformer	6000 kVA, 13.8 kV–480/277 V pad mount	12–18 months
Main Electrical Panel	8000 A, 480 V switchgear	10–14 months
Sub Electrical Panels	Multiple panels rated at 2000 A / 1200 A	8–12 months
BESS Switchgear	3000 A, 480 V switchgear and circuit breakers	10–14 months
Battery Energy Storage System (BESS)	2000 kW / 4000 kWh system containerized	12–14 months
Standby Generator	480 V, 1200 A with dedicated panel and controls	10–12 months
Main Package		
Charging Cabinets	150–200 kW DC fast charging cabinets (40+ units)	8–10 months
Dispenser Units	Pantograph and CCS1 plug-in connectors	6–8 months
Auxiliary Transformer	100 kVA, 480–120/208 V for lighting/control loads	6–8 months
Protection Relays & Meters	SEL-751, SEL-735 for monitoring & protection	6–8 months

3 NT FLEET & FACILITIES TRANSITION ROADMAP

3.1 TRANSITION ROADMAP PLANNING PRINCIPLES

NT's transition plan has been developed by bringing together the analyses and findings of the preceding project tasks and reporting, particularly the *Industry Scan, Current State Assessment and BEB Feasibility Analysis Report*, and the *Charging Strategy Analysis Report* as well as through numerous engagement meetings with NT and Niagara Region stakeholders. The approach is presented according to fleet and facility / infrastructure considerations in the following sections.

The fleet deployment is planned to take 12 years, corresponding the expected lifespan of 40-ft and 60-ft buses. This period begins upon the receipt of the first delivery of BEBs and coincides with the opening of the first facility infrastructure retrofits.

Two years preceding the start of BEB operations is allowed for planning / budgeting, detailed design, procurement, and facility construction (referred to as Planning Years 1 and 2) brings the total estimated timeline to 14 years.

3.1.1 FLEET

The pre-transition NT fleet consists of a mix of diesel and gasoline-fuelled 40-ft, 60-ft, and paratransit vehicles, which can operate assigned daily transit services (blocks) without the need for midday refueling.

Transit service energy consumption and charging simulation results included in the *Charging Strategy Analysis Report* indicate that converting from diesel-fuelled buses to BEBs poses challenges to longer block completion due to battery size / range limitations of BEB technology. To overcome this, a higher number of 40-ft and 60-ft BEBs are required to replace legacy ICE buses, resulting in a BEB to ICE fleet replacement ratio greater than 1. In contrast, electric paratransit vehicles can replace their ICE counterparts on a one-to-one basis because of their shorter daily service distances.

Figure 3-1 compares at each garage the number of existing ICE buses to the simulated minimum number of BEBs needed to replace them. The percentage of electric spare buses is 20% of the core value, as discussed with NT. This spare percentage is less than that of the legacy ICE fleet, which includes a high number of relatively old units.

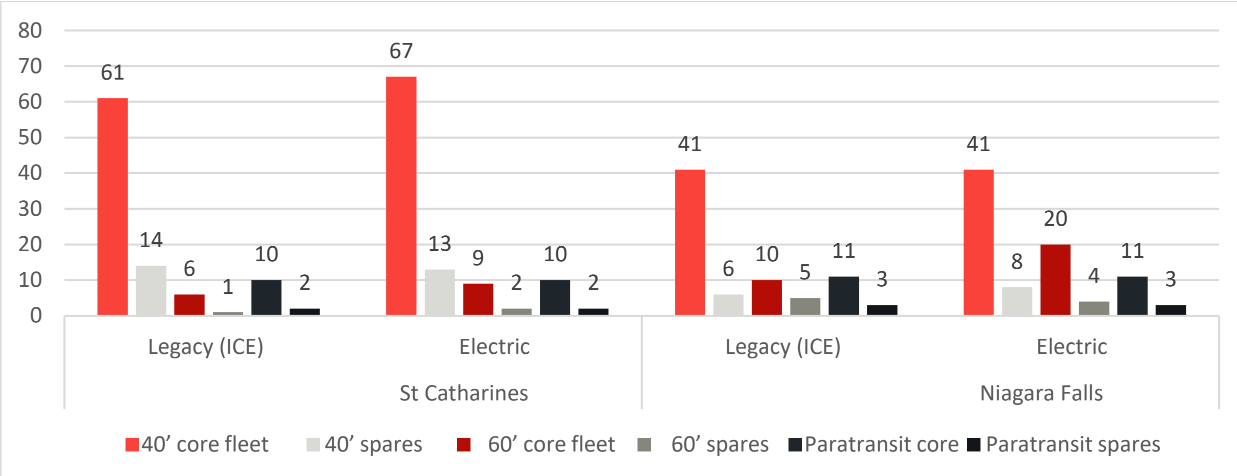

Figure 3-1: Comparison of ICE vs BEB Fleet Composition.

The strategy for fleet replacement is aligned with the NT’s ‘business as usual’ Vehicle Replacement Schedule which covers the first 8 years of ZEB operations and covers both St. Catharines and Niagara Falls garages. This is summarised in Table 3-1 below.

Table 3-1: NT ‘Business as Usual’ (Internal Combustion) Fleet Replacement Plan

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	TOTAL
40' Buses	8	13	11	10	10	9	10	10	82
60' Buses	1	1	1	0	3	4	4	2	16
Paratransit Vehicles	3	5	3	2	1	4	4	4	26
Total	**12**	**19**	**15**	**12**	**14**	**18**	**18**	**16**	**124**

In the final 4 years (Years 9 to 12), BEBs are scheduled to be deployed (while ICE buses are retired) evenly to meet the required total number of core and spare units at each garage as identified by the feasibility modelling. Refer to Figure 3-1. The breakdown and rationale for the roll-out of each bus type is listed below:

- **40-foot buses:** On average, 10 core 40-foot buses are replaced annually between Year 1 and Year 10. The remaining 47 units, assumed to be spare buses, are scheduled for replacement evenly over the final two years of the transition (Years 11 and 12). This approach ensures that spare units are deployed once the core BEB fleet has stabilized operationally. Given the 12-year lifespan of conventional diesel buses, no BEB replacements are expected within the transition period.
- **60-foot buses:** Deployment is more gradual in the early years, with fewer replacements (1 per year) during Years 1 to 3 to prioritize the 40-foot transition. However, the replacement rate increases starting Year 5, continuing through Year 10. Similar to the 40-foot buses, the last two years (Years 11 and 12) are used to deploy spare units. No BEB replacements are required during the transition period due to the 12-year life cycle of the 60-foot diesel fleet.
- **Paratransit Vehicle:** BEB deployment for paratransit vehicles is spread relatively evenly across the 12-year transition, averaging about 3 units per year. However, due to the shorter 8-year useful life of these vehicles, the units deployed in the early years will begin reaching end-of-life by Year 9. Consequently, from Year 9 onward, new BEB paratransit

vehicles are deployed both to replace retiring electric units and to fulfill remaining core and spare requirements.

The transition to BEBs requires an additional seven 40-foot BEBs and thirteen 60-foot BEBs compared to the BAU scenario. Figure 3-2 illustrates the vehicle purchase plan for Year 9 to Year 12. The numbers of 40-ft and 60-ft buses are evenly distributed across these years. No additional paratransit vehicles are purchased in Years 9 to 12.

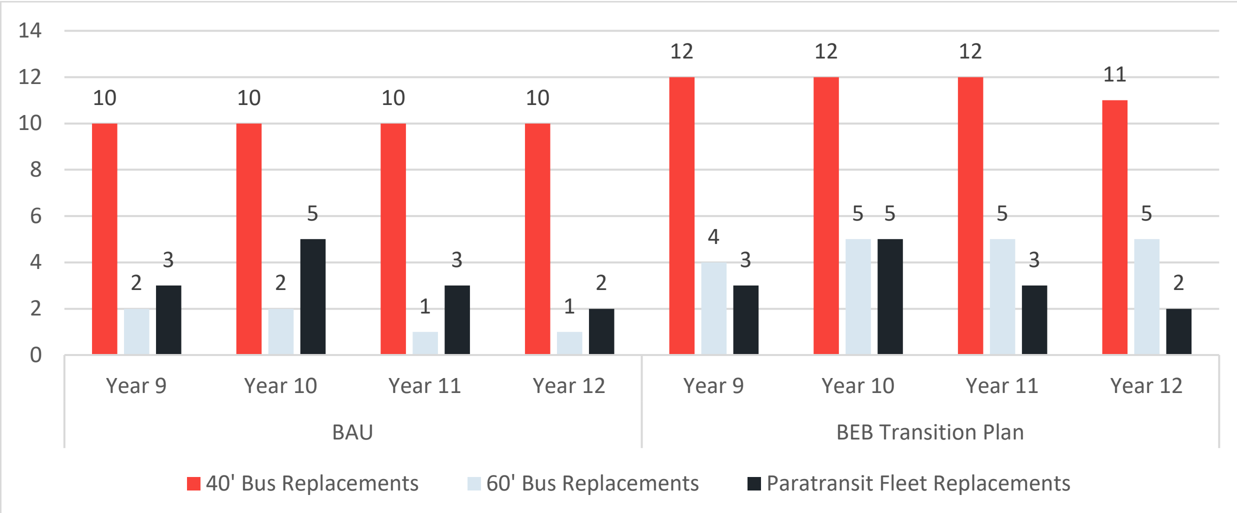

Figure 3-2: Comparison of BAU vs BEB Vehicle Purchase Plan for Years 9 to 12.

It is recommended that NT begins to phase out the oldest existing ICE fleet units first as they take delivery of new BEBs in Year 1 of the Transition Plan.

The proposed BEB fleet quantities presented are based on transition feasibility modelling undertaken for NT transit services operating as of Q3 2024 and do not allow for future service growth.

3.2 OPERATIONS AND MAINTENANCE GARAGES

3.2.1 ST. CATHARINES GARAGE

The electrification schedule prioritizes improvements at St. Catharines garage, the older of the two facilities, because it aligns with NT's existing budgeted plans to redevelop the site in the short-to-medium term.

With St. Catharines being the larger of the two facilities and housing a higher number of buses, it is proposed to redevelop in two construction phases. A description of the facility components included in each constriction phase is included in Section 2.1.

The core fleet for Phase 1 are received in Years 1 to 4 and in Years 5,6 and 7 in Phase 2. Spare BEBs will be added in Years 11 and 12, following the complete electrification of Niagara Falls' core fleet. Figure 3-3 illustrates the fleet transition at St. Catharines garage from Years 1 to 12.

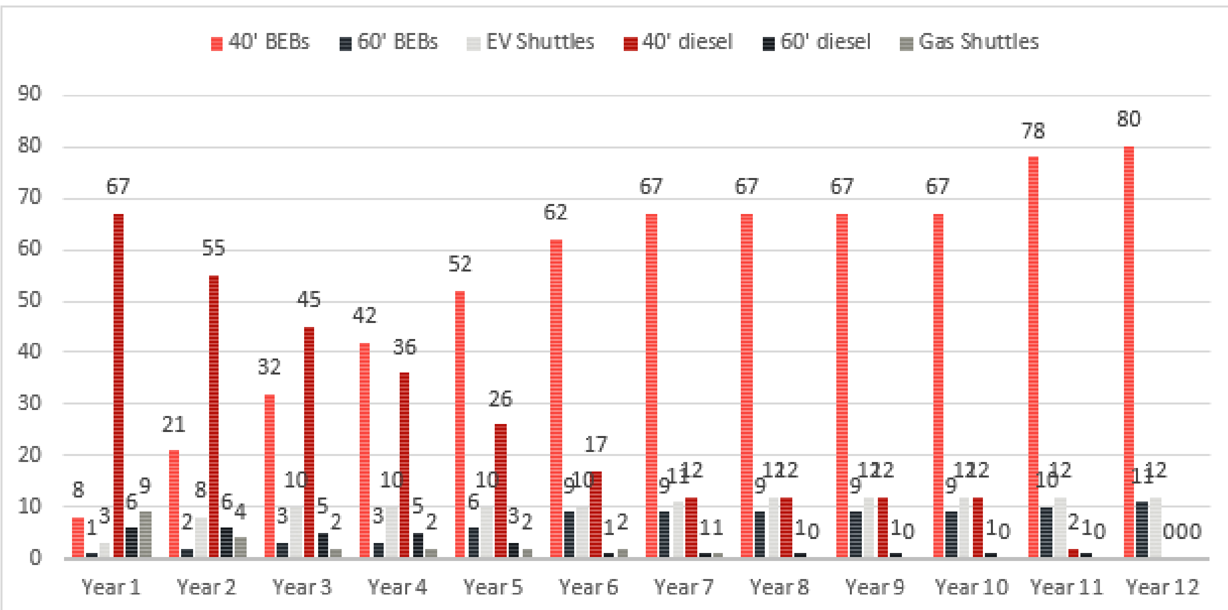

Figure 3-3. Proposed Fleet Deployment Schedule at St. Catharines Garage.

Figure 3-4 shows the corresponding number of chargers to be installed at the depot each year. 23 no. 150kW chargers and 3 no. 200kW chargers are installed in Phase 1 (Years 1 to 4) while an additional 15 no. 150kW chargers are installed in Phase 2 and completed by Year 7.

In addition, four chargers for 40-ft and 60-ft spare buses are deployed in Years 11 and 12 and chargers for spare paratransit vehicles are deployed in Years 7 and 8.

The spare BEBs do not require additional dedicated chargers, and they will use the core fleet's chargers when core fleet are in service.

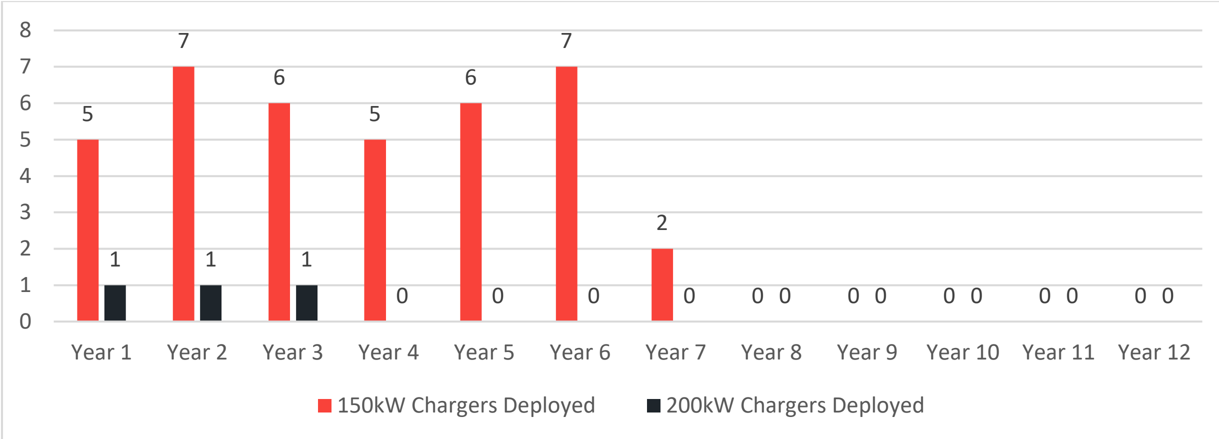

Figure 3-4. Proposed Charger Deployment Schedule at St. Catharines.

3.2.1.1 *PLANNING, DESIGN, PROCUREMENT AND CONSTRUCTION*

Planning, design, procurement, construction and enabling work activities need to be structured to achieve operational readiness and support the delivery of BEBs expected at St. Catharines Garage from Year 1 for its Phase 1 construction package, and again in Year 5 for the second phase.

Detailed design & early enabling works for St. Catharines Phase 1 should start as a priority in Planning Year 1, anticipating the need to tender early works packages for long lead items identified above (e.g. the substation for the service capacity upgrade, associated switchgear, BESS and potentially chargers). Assume up to a 2-year lead time, then the enabling works package should be ordered in the early part of Planning Year 1.

Detailed design work will also confirm the construction schedule and cost for the St. Catharines Phase 1 Package, and potentially for Phase 2. Considering an estimated 12 to 18-month construction timeframe, and the need for the facility to be operations ready in Year 1, the award timeline for the Phase 1 construction package should be in mid Planning Year 1.

The construction packaging for the 2nd phase at St. Catharines garage will depend on the design approach, although a 1-year construction timeline and a Year 5 opening day suggests award some time in late Year 4 or early Year 5.

3.2.2 *NIAGARA FALLS GARAGE AND WELLAND BUS TERMINAL ON-ROUTE CHARGERS*

The deployment of BEBs and chargers at Niagara Falls garage will begin in Year 6 following the core fleet deployment at St. Catharines and is planned to overlap with St. Catharines Phase 2. Electric paratransit vehicles will initiate their transition earlier in Year 3. The entire Niagara Falls fleet is projected to complete their transition by Year 12, whereas the deployment of the electric paratransit vehicles will finalize by Year 8. Refer to Figure 3-5:.

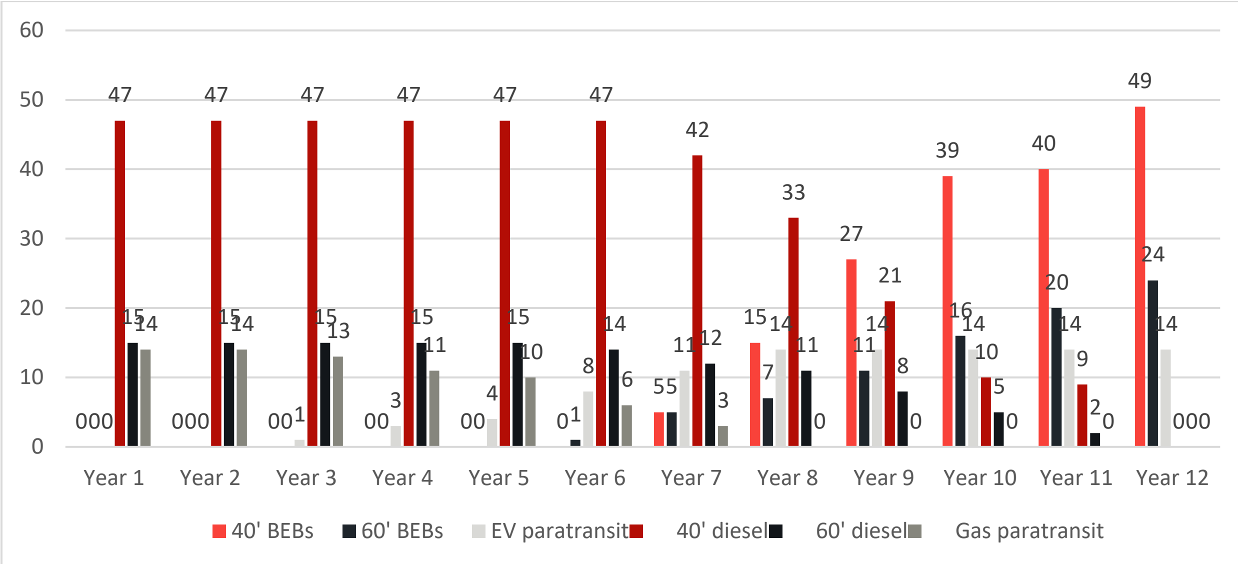

Figure 3-5: Proposed Fleet Deployment Schedule at Niagara Falls Garage.

Figure 3-6 shows the number of depot chargers to be installed each year at Niagara Falls garage and the number of on-route chargers installed at Welland Bus Terminal.

The first depot charger is to be installed at Niagara Falls garage in Year 3 for the electric paratransit vehicles, as they have the earliest transition schedule due to their shorter useful life.

The first chargers for the 40-ft and 60-ft BEBs need to be operational by Year 6

Operational on-route chargers at Welland Terminal are required by Year 7. One on-route charger is required each year thereafter until all 5 are deployed by Year 11.

As at St. Catharines, spare buses do not require additional dedicated chargers as they will use the core fleet's units while out in service.

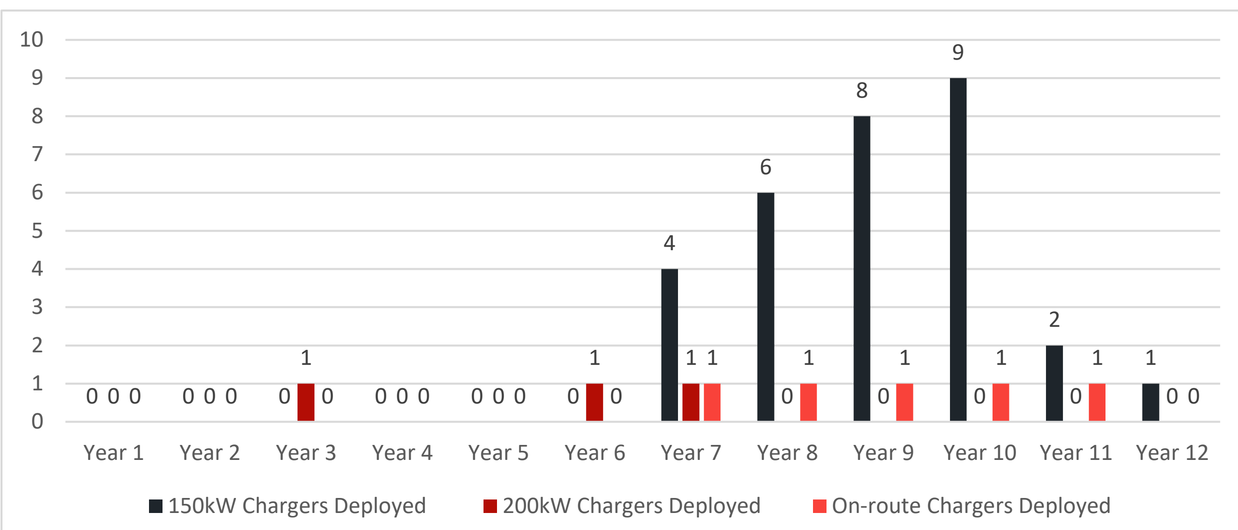

Figure 3-6: Proposed Charger Deployment Schedule at Niagara Falls Garage.

3.2.2.1 *PLANNING, DESIGN, PROCUREMENT AND CONSTRUCTION*

All planning, design, procurement, and construction activities must be coordinated to ensure the facility is operationally ready ahead of BEB deliveries, which begin in Year 5 and continue through Year 12. Detailed design, utility coordination (including EAAS considerations), and charger procurement are scheduled to begin in Year 4, with early tendering of long-lead items, such as substations, switchgear, BESS, and chargers being a key priority to mitigate delivery risks.

The main construction package is expected to commence by mid-Year 4, allowing sufficient time for installation, testing, and commissioning activities to take place in Year 5. Charging equipment installation is phased from Year 5 to Year 9, aligning with the gradual deployment of BEBs over the remaining years of the transition period.

The garage is delivered in a single phase, with all supporting infrastructure in place to enable a smooth ramp-up of operations beginning in Year 5 and continuing through to the end of the transition in Year 12.

3.3 ROADMAP SUMMARY

The following sections summarize the fleet and facility transition roadmap activities.

3.3.1 ST. CATHARINES

The transition at the St. Catharines garage spans two planning years followed by a twelve-year implementation period. Planning and procurement activities occur in year 1 and 2 of the planning with Phase 1 construction begins in mid-Year 1 Planning and supports BEB deployment from Year 2 through Year 6 of implementation. Phase 2 planning begins in Year 3, with construction and garage readiness completed by Year 5. This enables continued deployment of BEBs through to Year 12. Charger procurement and installation are phased across Years 1 to 7 to align with garage readiness and vehicle delivery. Spare vehicles are introduced in Year 9 to supplement the core fleet.

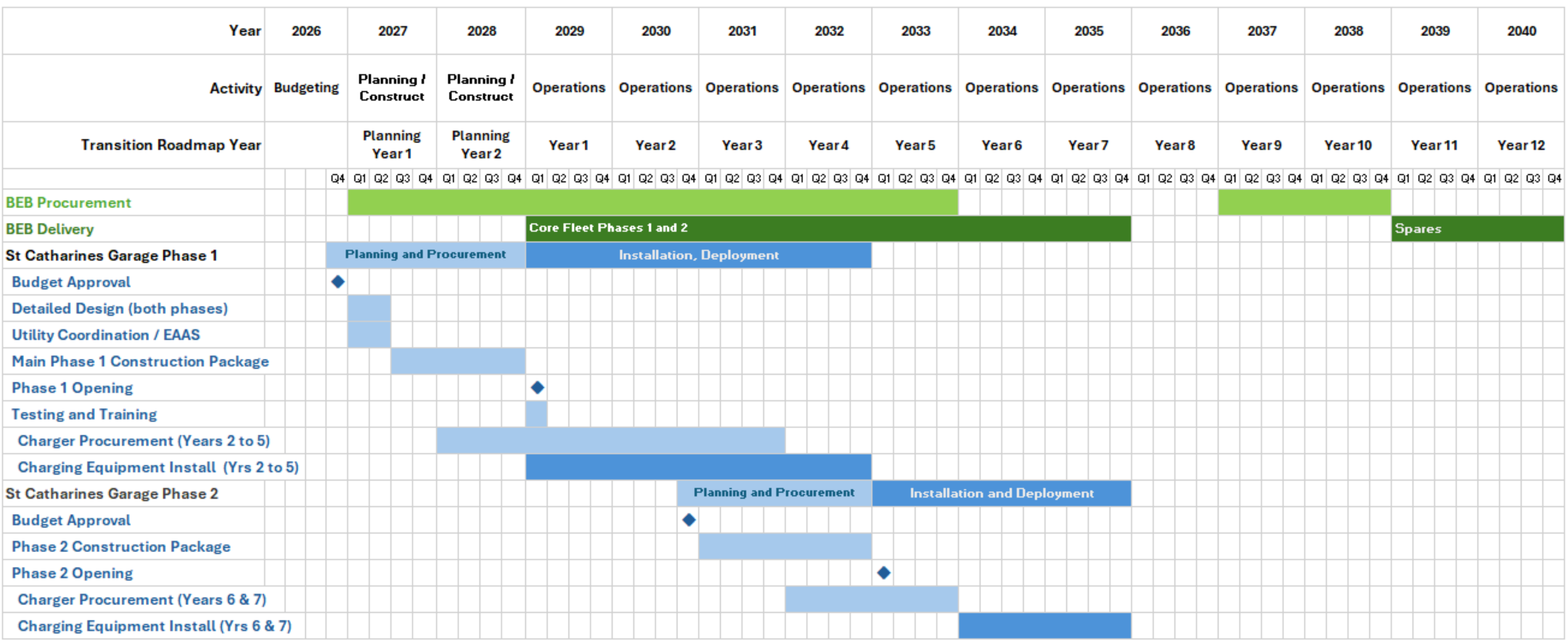

Figure 3-7. Phasing Schedule for St. Catharines Depot.

3.3.2 NIAGARA FALLS

The Niagara Falls garage follows a single-phase transition with planning and procurement to be completed over years 3 and 4. Facility construction activities begin in mid-Year 4 and are completed by the end of Year 5 before opening. This enables BEB delivery and deployment starting in Year 6. Testing and training activities takes place at the beginning of Year 6 to support operational readiness. Charger procurement and installation are scheduled between Years 5 and 12 to align with infrastructure commissioning and vehicle roll-out.

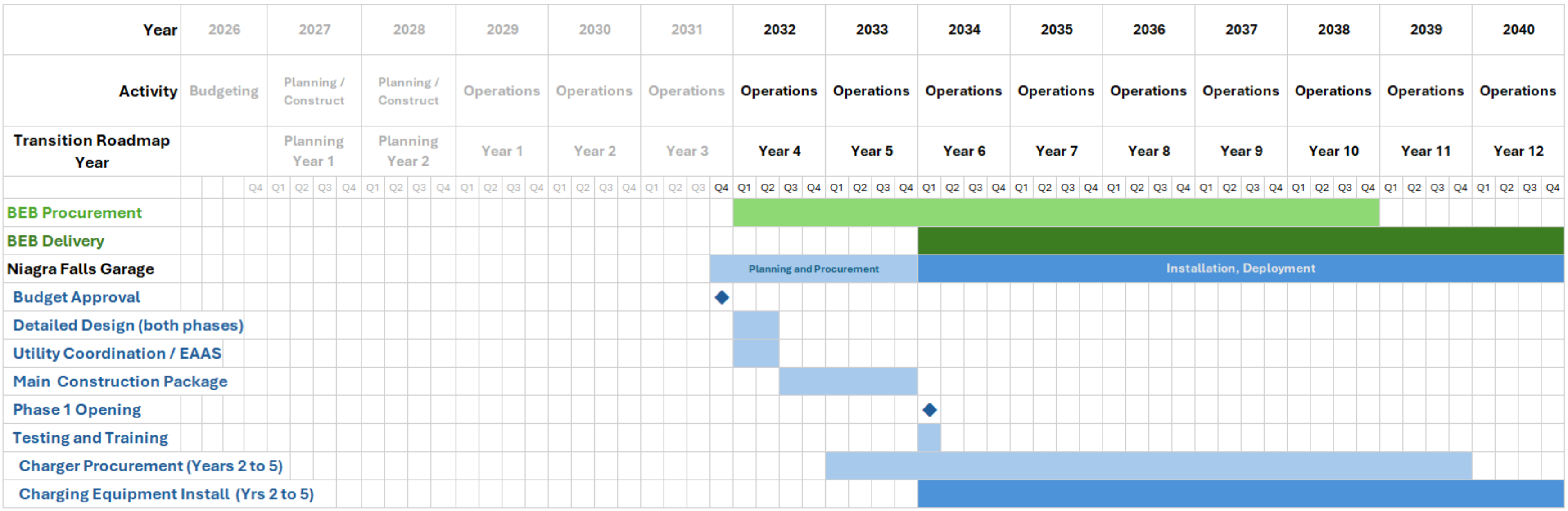

Figure 3-8: Niagara Falls Implementation Schedule.

4 COST AND GHG EMISSIONS ANALYSIS

This section presents cost considerations associated with the Fleet and Facilities Transition Planning Roadmap discussed in Section 3 and consists of two key areas:

- Section 4.2 provides capital costs (CAPEX) for fleet and facility retrofits, and operations and maintenance costs (OPEX) over the 14-year transition timeline, and total cost of ownership (TCO) resulting from the implementation of the transition roadmap.
- The GHG emissions analysis, in Section 0, outlining the lifecycle GHG emissions savings expected thanks to the gradual implementation of the transition roadmap.

4.1 ASSUMPTIONS

The main assumptions underpinning the feasibility analysis are summarized in Table 4-1, while a more complete list of technical and unit cost assumptions impacting the analyses, e.g. vehicle and charger pricing, utility and fuel rates, maintenance unit costs, mileage and energy efficiencies by vehicle sizes, and lifecycle GHG emission factors, are included in Appendix C.

Table 4-1 General Assumptions for the Feasibility Analysis

ITEM	ASSUMPTION
1	Costs are presented as **net present value**, without adjustment for inflation.
2	OPEX and GHG emission calculations are **based on revenue transit service operations** and exclude non-revenue mileage.
3	Electricity demand calculations assume the presence of a **charging management system** to flatten peak demand and reduce the demand charge component in electricity billing costs.
4	**St. Catharines garage will operate a daily 18-hour daily charging window**. This results in the distribution of charging power over the 18 hours, presented as St. Catharines Strategy 3 during the 2nd technical workshop on March 6th 2025.
5	**Niagara Falls depot has a 12-hour daily charging window**, presented as Niagara Falls Strategy 1 during the 2nd technical workshop on March 6th 2025.
6	For Niagara Falls, it is assumed 80% electricity usage (kWh) is consumed during off-peak hours while 10% usage is consumed during both mid-peak and on-peak hours.
7	**Maintenance costs for one BEB is 44.1% lower than one ICE bus.**[4]
8	Charger maintenance is based on the number of charger cabinets, not the number of pantographs or plug-in dispensers.
9	All depot chargers have the same maintenance cost per unit per year.
10	All types of chargers have the same efficiency of 94%.

[4] Leslie Eudy and Matthew Jeffers. "Zero-Emission Bus Evaluation Results: King County Metro Battery Electric Buses", Federal Transit Administration. February 2018.

11	The lifecycle greenhouse gas emission factors for diesel and gasoline remain constant from the Year 1 to 12.
12	The fuel and energy efficiency remains the same for all buses from Year 1 to 12.
13	GHG emission factor of Ontario electricity generation from year 2026 to 2037 is applied for Year 1 to 12 in the calculation.
14	Payments for BEBs are upon the year of their delivery

4.2 COST ANALYSIS

4.2.1 INTRODUCTION

Total costs are calculated based on projected capital and operational expenses (CAPEX and OPEX) associated with transitioning the fleet and facilities over a 14-year period. This timeline includes 12 years for replacing the fleet and chargers, plus an additional two years for planning, design, and construction to ensure the garages are ready before the first battery electric buses (BEBs) are delivered.

The main cost components include:

- CAPEX (Capital Expenditures): Costs related to facility construction or retrofits, purchasing BEBs, chargers, cabinets, and dispensers.
- OPEX (Operational Expenditures): Ongoing costs such as fuel (diesel), electricity, maintenance, and staff labour.

All costs are reported as net present value (NPV) without factoring in future price escalations.

CAPEX and OPEX components are reported in aggregate and separately below. They are also reported for both garages together and then individually for St. Catharines and Niagara Falls garages. This Cost Analysis section is structured as follows:

a) An overview and breakdown of total costs, showing CAPEX and OPEX for both garages combined and for each garage separately.

b) Detailed CAPEX overview and breakdown.

c) Detailed OPEX overview and breakdown.

“Business as Usual” (BAU) costs associated with forecasted un-transitioned fleet and operations scenario are calculated based on data provided by NT and shown alongside the transition costs for reference.

4.2.2 TOTAL COST

Figure 4-1 presents the total CAPEX and OPEX for the NT fleet and facility transition plan including the costs of facility construction, BEBs, chargers / cabinets and dispensers, as well as the costs of operating and maintaining both diesel and electric fleets throughout the transition period.

The annual average cost for transition plan is approximately $31,725,000 over the 14 years, compared to the annual average total cost of $22,251,000 for the BAU scenario.

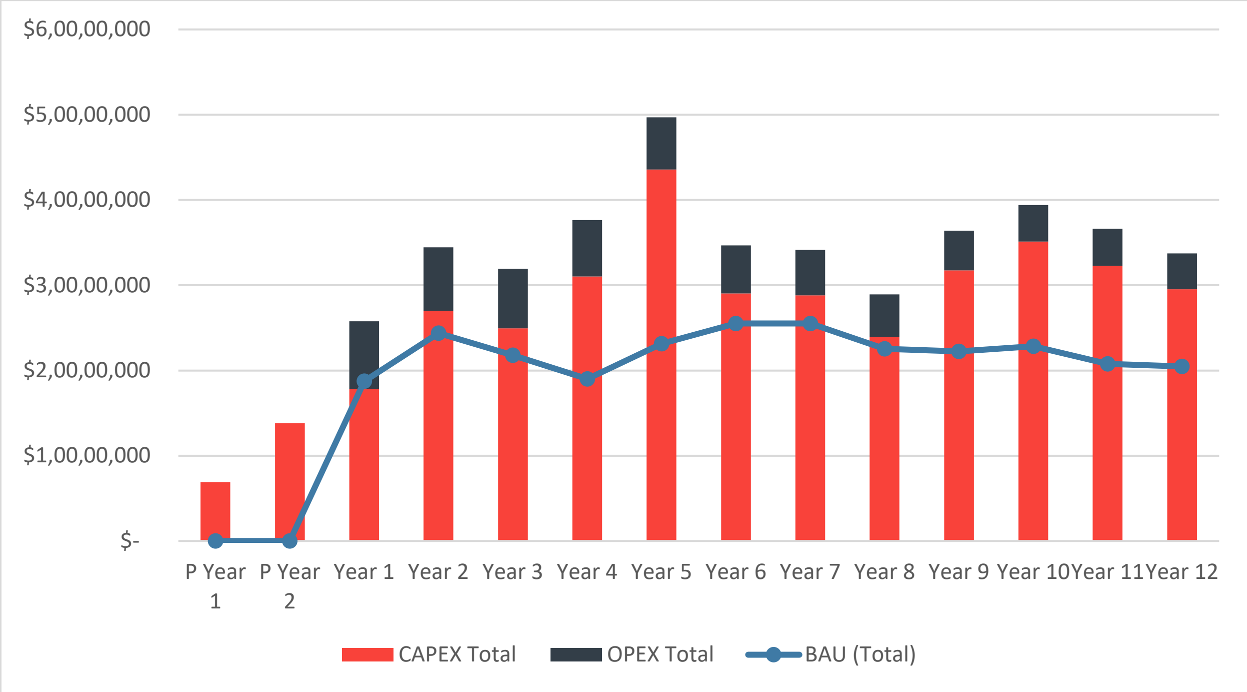

Figure 4-1: Total Cost: CAPEX & OPEX for Both Garages.

Figure 4-2 and Figure 4-3 show total CAPEX and OPEX costs for St. Catharines and Niagara Falls depots. At the St. Catharines site, years 8, 9, 10, and 12 have lower costs than BAU due to fewer BEB purchases and the operation of a large electric fleet. OPEX savings outweigh CAPEX, since by Year 7 over 95% of the fleet is electric and purchase volumes are low. The fleet CAPEX rises in Year 11 as BEBs reach end-of life and require replacement.

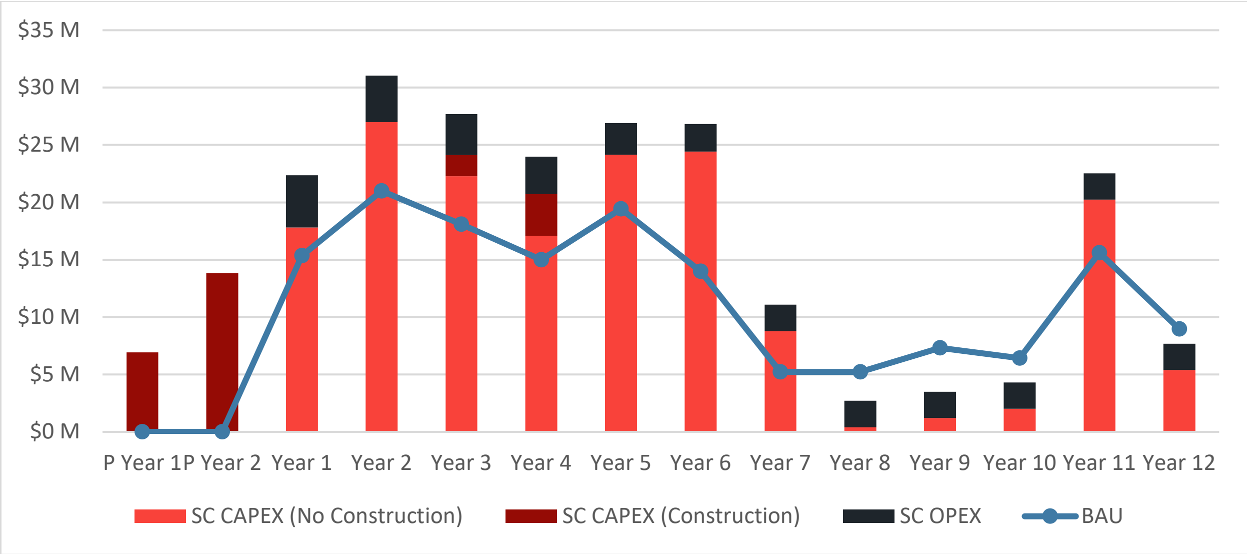

Figure 4-2: Total Cost for St. Catharines Garage.

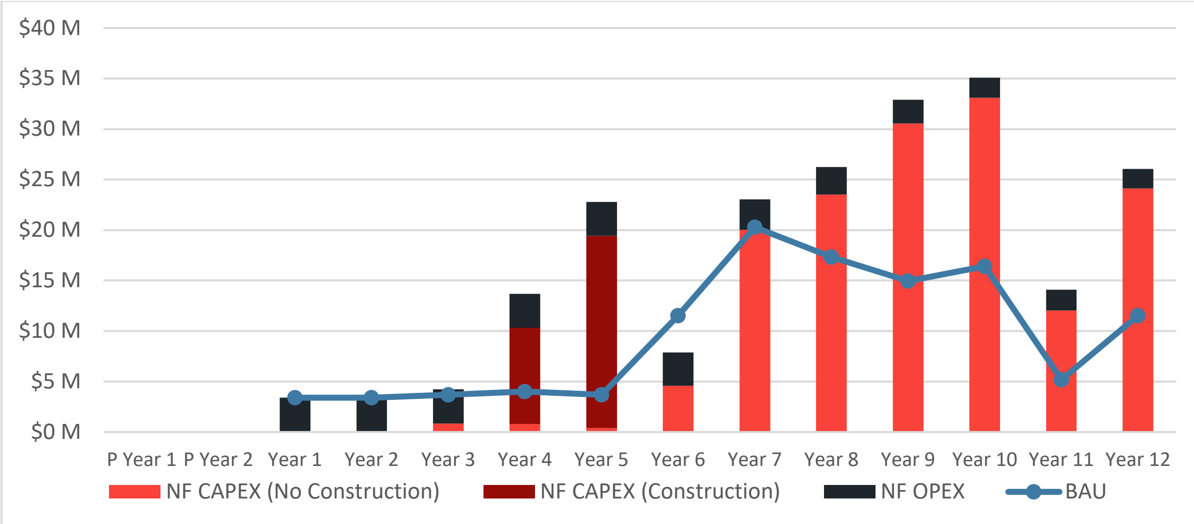

Figure 4-3. Total Cost for Niagara Falls Depot.

Table 4-2 compares a tabulated summary of total transition and BAU cost components by facility. Key insights include:

- The capital expenses required by the transition plan for the St. Catharines facility is 113% more than the BAU scenario.
- The capital expenses required by the transition plan for the Niagara Falls' facility is 139% more than the BAU scenario.
- The savings in operational expenses accrued through the implementation of the transition plan for the St. Catharines facility is equivalent to 42% of the operational expenses incurred within the BAU scenario.
- The savings in operational expenses accrued through the implementation of the transition plan for the Niagara Falls facility is equivalent to 16% of the operational expenses incurred within the BAU scenario.
- The OPEX savings for the Niagara Falls facility are lower compared to the St. Catharines site due to the late implementation of the transition and the operation of on-route chargers. As the replacement is delayed to approximately the second half of the project timeline, the OPEX savings are delayed and limited, as well to a shorter timeframe. On-route chargers have more maintenance cost than depot chargers.
- The transition plan for the St. Catharines facility is 53% more than the BAU. At Niagara Falls the increase is 84%.
- Accounting for both facilities and the overall fleet to be owned by NT, the total cost for the implementation of the transition plan will be 66% higher compared to the to the BAU.

Table 4-2: Total Costs Summary: Transition vs BAU

	BAU	BAU	TRANSITION PLAN	TRANSITION PLAN
	St. Catharines	Niagara Falls	St. Catharines	Niagara Falls
CAPEX Fleet	$ 92,394,500	$ 74,566,900	$ 158,581,700	$ 137,715,100
CAPEX Construction	$ -	$ -	$ 26,252,700	$ 28,524,400
CAPEX Charging Equipment	$ -	$ -	$ 12,160,000	$ 12,260,000
OPEX Fleet - Electricity	$ -	$ -	$ 4,728,100	$ 3,040,800
OPEX Fleet - Fuel	$ 33,298,800	$ 26,679,600	$ 7,350,000	$ 17,257,800
OPEX Fleet - Maintenance ICEs	$ 25,942,800	$ 14,127,600	$ 5,579,200	$ 8,968,300
OPEX Fleet - Maintenance BEBs	$ -	$ -	$ 12,599,600	$ 3,264,300
OPEX Fleet - Maintenance Chargers	$ -	$ -	$ 4,121,900	$ 1,743,100
Totals	$151,636,100	$115,374,100	$ 231,373,200	$ 212,773,800

	BAU	TRANSITION PLAN
Total	**$267,010,200**	**$444,147,000**

4.2.3 CAPEX: OVERVIEW

Figure 4-4 presents the combined capital costs including facility construction, fleet and charger / cabinet costs for both garages.

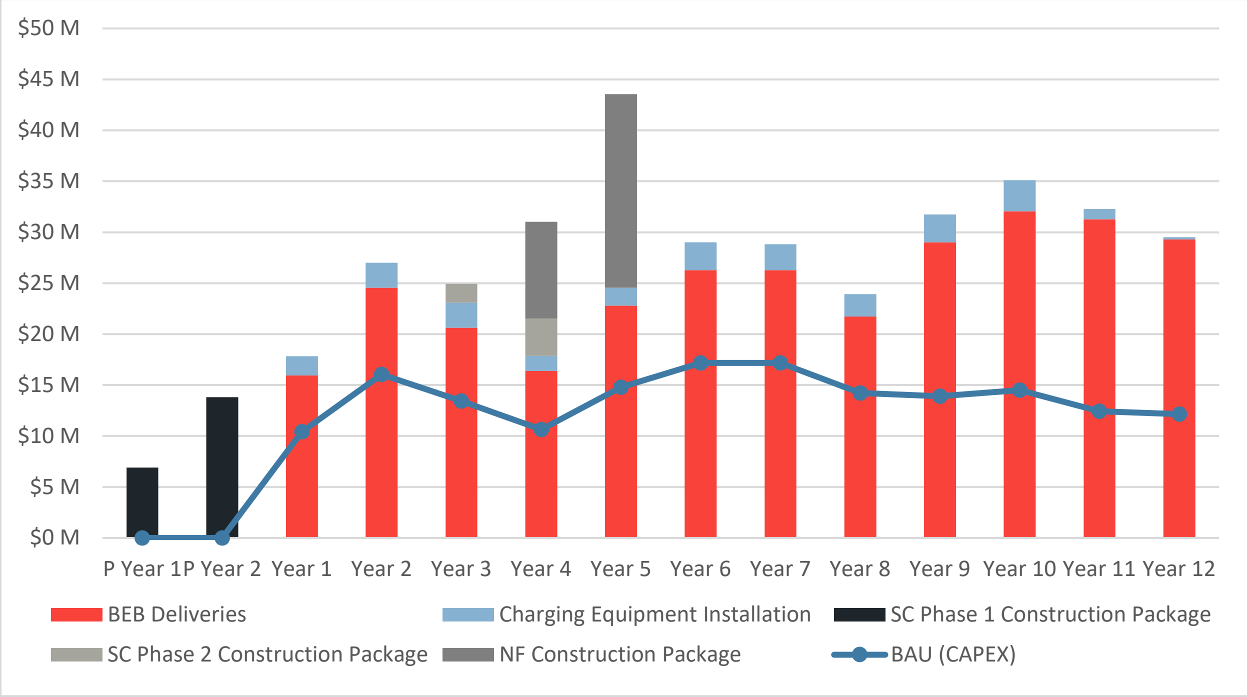

Figure 4-4: Total CAPEX (Fleet, Facility Construction, Chargers / Cabinets / Dispensers) for Both Garages.

4.2.4 CAPEX: TRANSIT GARAGE MODIFICATIONS

Class D construction cost estimates for each facility are summarised below. Detailed cost schedules including, basis of estimates, exclusions, scope of work and assumptions are provided in Appendix B.

St. Catharines

The estimated total construction cost **without chargers** for St Cathrines Option 1 Phase 1 (excluding HST & Soft/Project Costs) = **$20,741,831**

The estimated total construction cost budget **without chargers** for St Cathrines Option 1 Phase 2 (excluding HST & Soft/Project Costs) = **$5,510,866**

Niagara Falls

The estimated total construction cost budget without chargers for Niagara Falls Option 2 (excluding HST & Soft/Project Costs) = **$28,524,445**[5]

[5] Note that on-route charger construction costs are not included.

4.2.5 *CAPEX: FLEET & CHARGERS*

Figure 4-5 compares the capital investment for fleet and charging infrastructure transition with BAU (ICE buses only) at St. Catharines and Niagara Falls. The transition plan's average annual CAPEX is about $26,726,000, versus $13,913,000 for BAU - a 92% increase. This includes costs for core and spare fleets, depot chargers, and on-route chargers (the latter for Niagara Falls only).

(Facility retrofit construction costs are not included in this graph.)

Unit cost assumptions for vehicles and equipment are detailed in Appendix C.

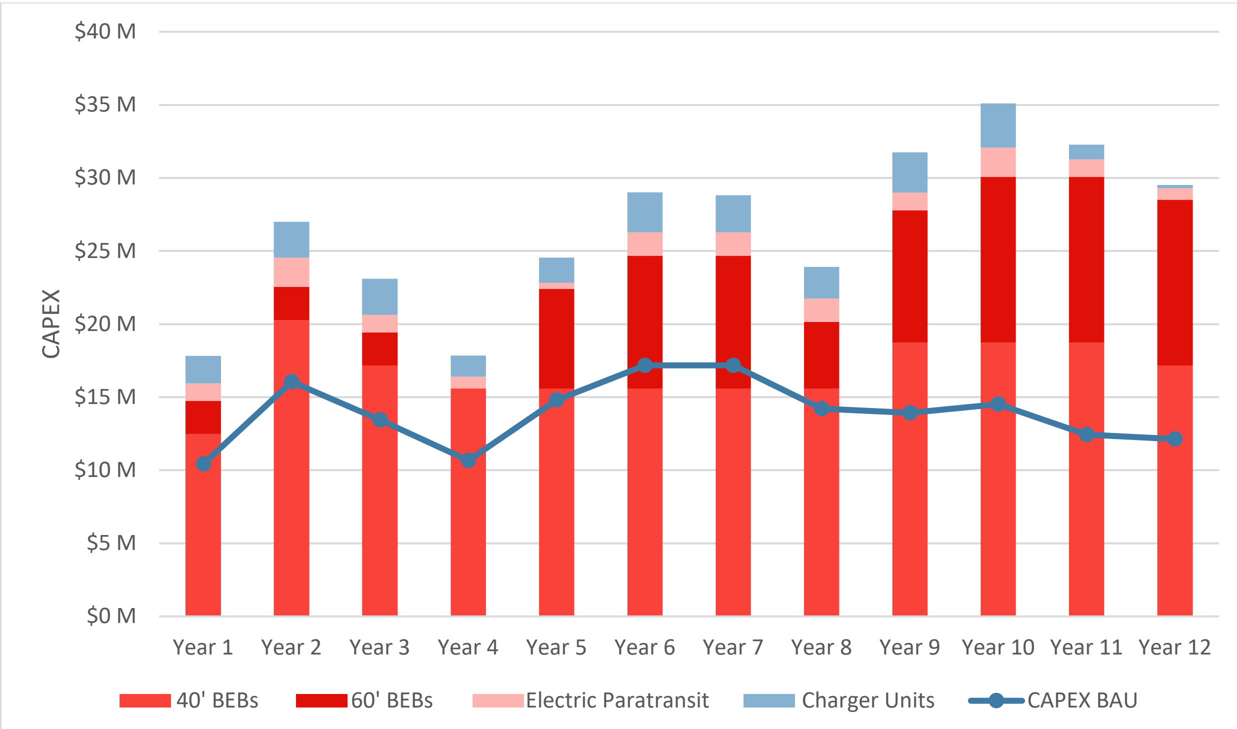

Figure 4-5: Combined Fleet and Charger CAPEX for St. Catharines and Niagara Falls Garages.

4.2.5.1 *CAPEX: FLEET & CHARGERS FOR ST. CATHARINES*

Figure 4-6 shows the comparison of the transition plan against the BAU.

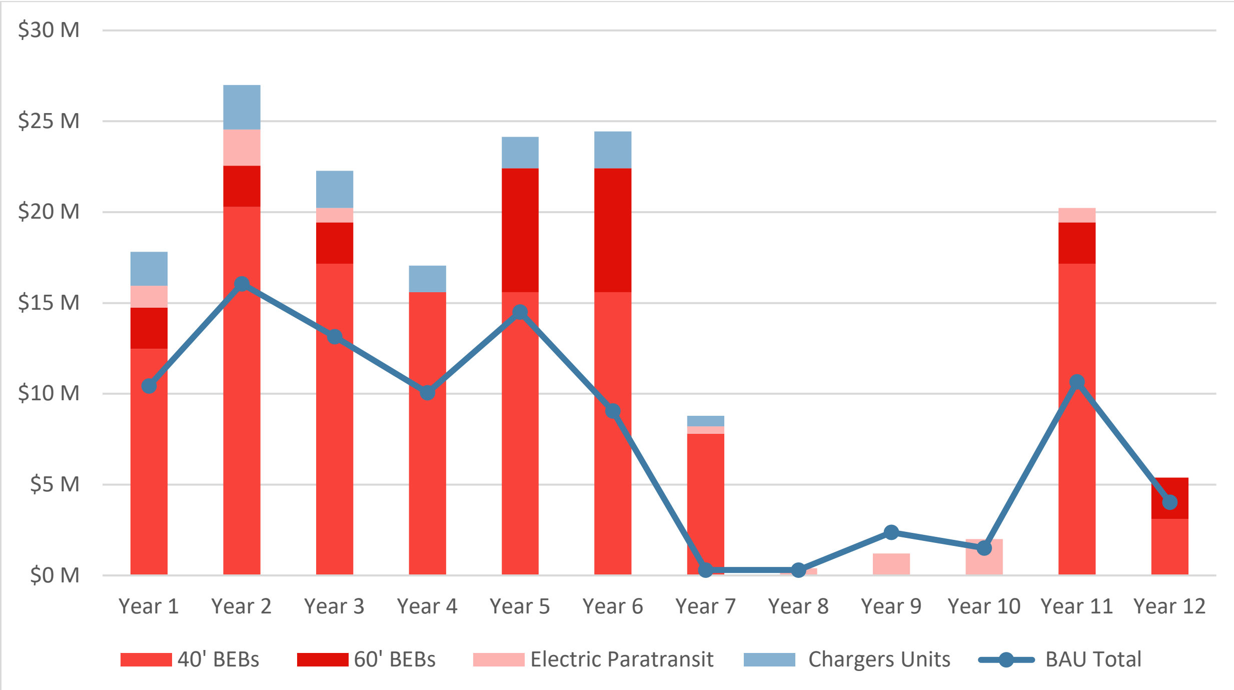

Figure 4-6: Fleet and Charger CAPEX at St. Catharines Depot.

At St. Catharines depot, all charging is depot-based. The annual average CAPEX for the transition plan is about $14.23 million - an 85% increase over the $7.7 million BAU figure - mainly due to purchasing 40-ft BEBs. In contrast, electric paratransit vehicles and chargers account for a small portion of costs. **(Facility retrofit construction costs are excluded here).**

CAPEX peaks in Year Two to accommodate charger and dispenser procurement prior to BEB acquisition. Fleet-related CAPEX decreases in Years 8 -10 as core deliveries finish by Year 7, with remaining payments for spares in Years 11 and 12. NT may use this period of lower CAPEX to prepare for Niagara Falls garage's transition.

4.2.5.2 *CAPEX: FLEET & CHARGERS FOR NIAGARA FALLS*

Figure 4-7 shows that Niagara Falls' average annual CAPEX for BEBs and chargers from Year 1 to 12 is about $12,498,000 - 101% higher than the BAU figure of $6,214,000. This difference stems from a higher BEB-to-diesel bus replacement ratio and the need for on-route chargers in Niagara Falls. However, total CAPEX for Niagara Falls is less than St. Catharines due to a smaller fleet size. Notably, capital investments at the Niagara Falls garage are much lower in Years 1–6, as retrofits occur after St. Catharines and BEBs are procured later in the process. **(Facility retrofit construction costs are excluded here).**

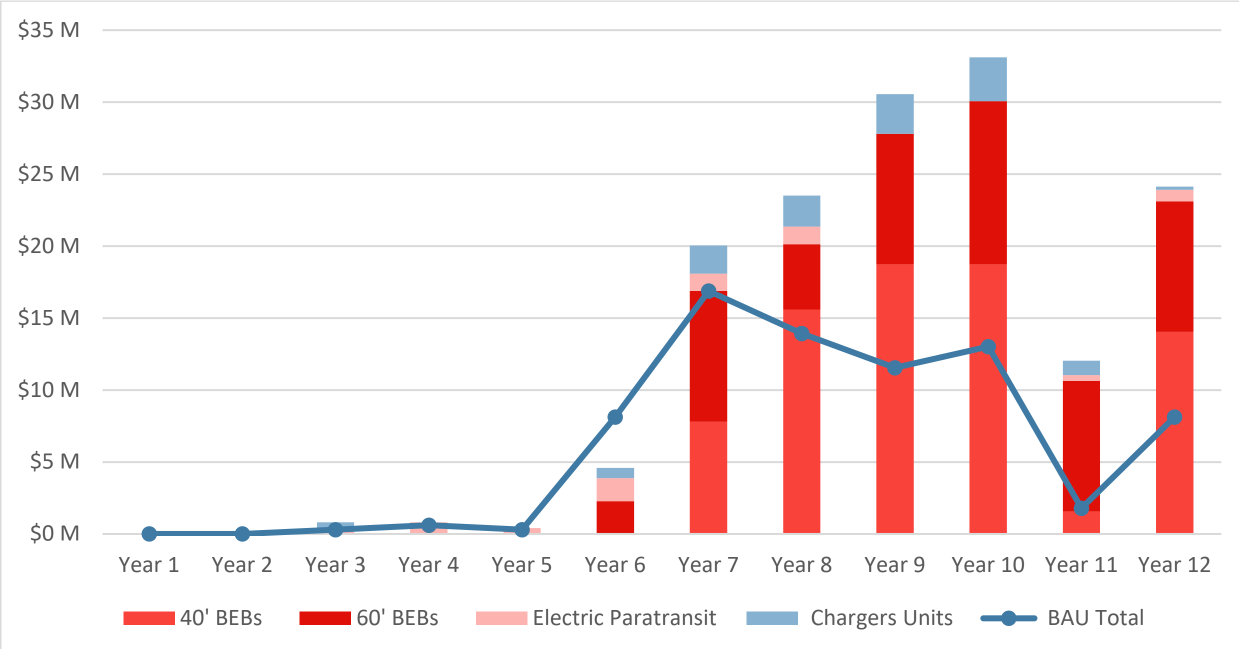

Figure 4-7: Fleet and Charger CAPEX at Niagara Falls Garage.

4.2.6 OPEX: OVERVIEW

This section presents projections of operational expenses. The OPEX calculations reflect only the core fleet, since the expenses related to spare fleet activity are comparatively minor. Fuel and maintenance cost assumptions are included in Appendix C.

Figure 4-8 shows the total OPEX for **fuel, electricity and maintenance** for the transition roadmap at both St. Catharines and Niagara Falls garages.

OPEX forecasts for the St. Catharines and Niagara Falls sites are presented separately below.

OPEX savings increase each year as electrification advances and stabilize by Year 10. The average annual OPEX across Years 1 to 12 is estimated at approximately $5,721,000 under the transition plan, compared to $8,337,000 for business-as-usual (BAU), representing an average annual savings of about $2,616,000. By Year 12, when both fleets are fully electric, the annual OPEX savings are projected to reach approximately $4,115,000, indicating a 50% reduction in operational expenses.

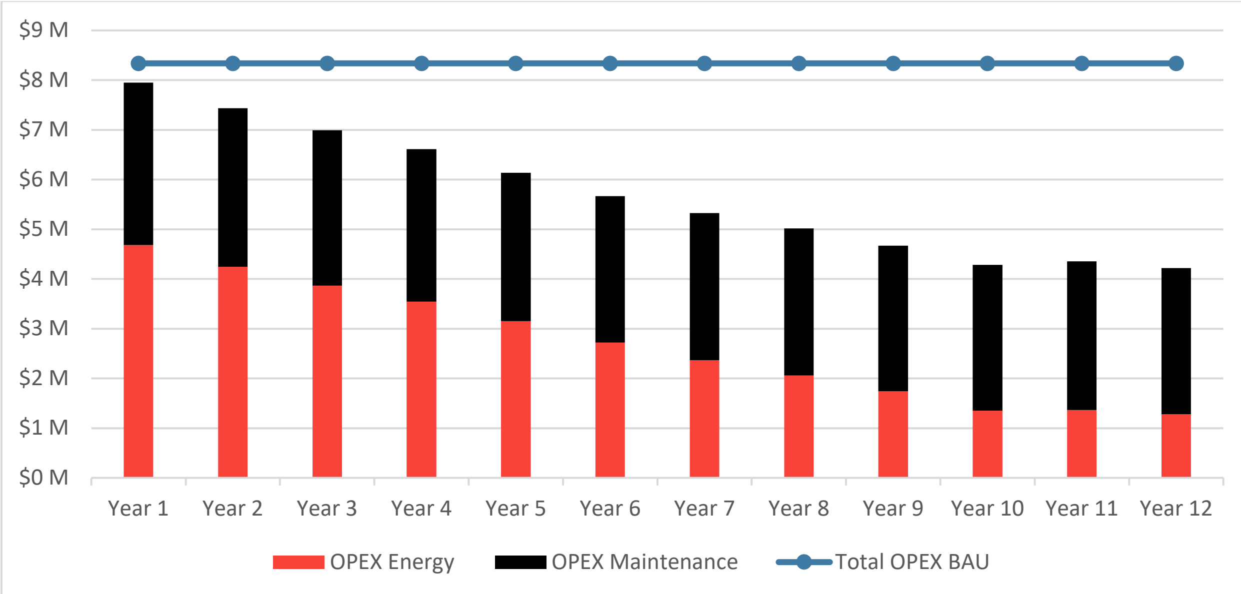

Figure 4-8: Total OPEX (Fuel, Electricity and Maintenance) for Both Depots.

Electricity and Fuel

Figure 4-9 illustrates combined OPEX for the transition plan, covering electricity and fuel. BAU costs remain flat as inflation is excluded, while transition plan expenses decline until Year 10, when over 95% of the ICE fleet is replaced, leading to stable costs thereafter. Prior to Year 10, annual operational costs average $2,698,000 for the transition plan versus $4,998,000 for BAU, a 46% reduction in fuel costs. By Year 12, full electrification brings annual savings of about $3,720,000.

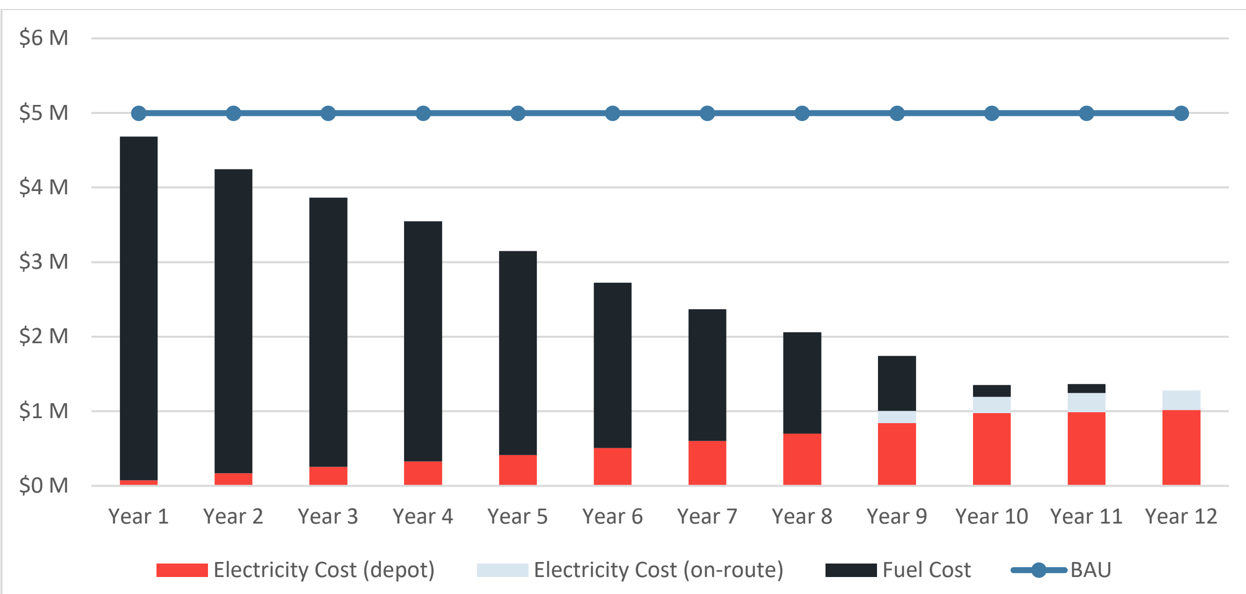

Figure 4-9. OPEX: Electricity and Fuel for Both Garages.

Maintenance Costs

Figure 4-10 shows the maintenance cost for the transition plan against the BAU scenario. While the maintenance cost of a single BEB is lower than a diesel bus[6], the total maintenance cost for the vehicle and the charger by Year 12 is about 15% lower compared to diesel buses. During the transition period (Year 1 to Year 12), the average annual maintenance cost for the transition plan is approximately $3,023,000, compared to $3,339,000 for the BAU, which is an 12% reduction in maintenance cost.

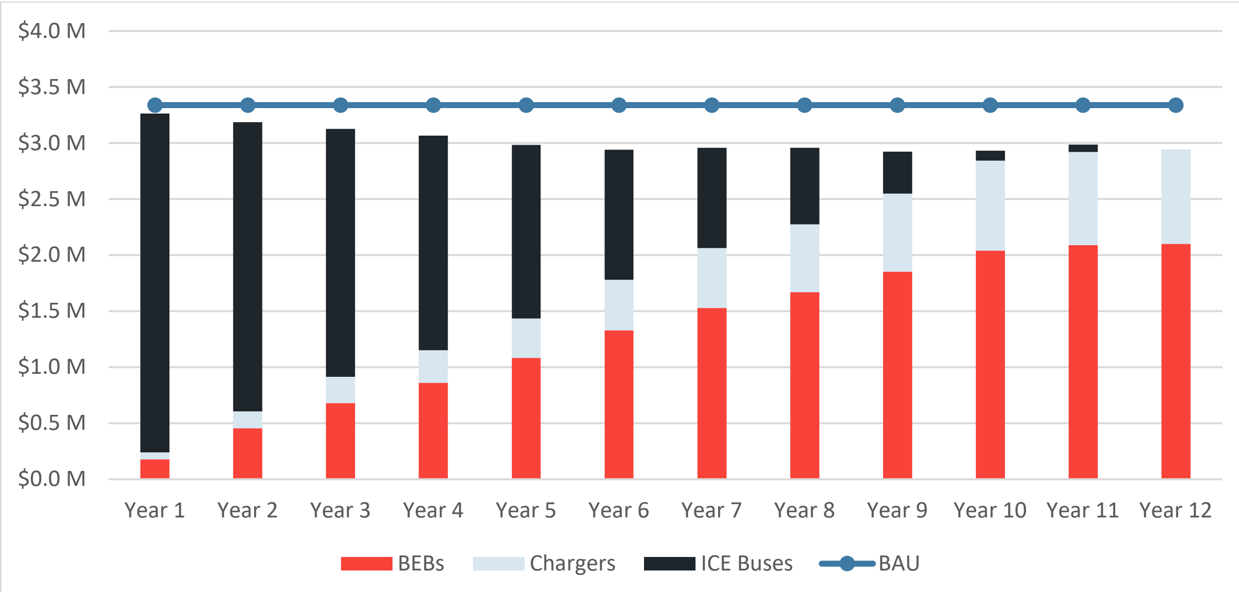

Figure 4-10: OPEX: Vehicle and Charger Maintenance Costs for Both Garages.

4.2.6.1 *OPEX FOR ST. CATHARINES FLEET*

Total OPEX

Figure 4-11 shows the total OPEX for the St. Catharines depot. Since its transition begins earlier, OPEX savings start in year 1. Average annual savings are about $2,072,000, which is higher than those at the Niagara Falls depot.

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[6] By 46%, see maintenance cost assumptions in Appendix C

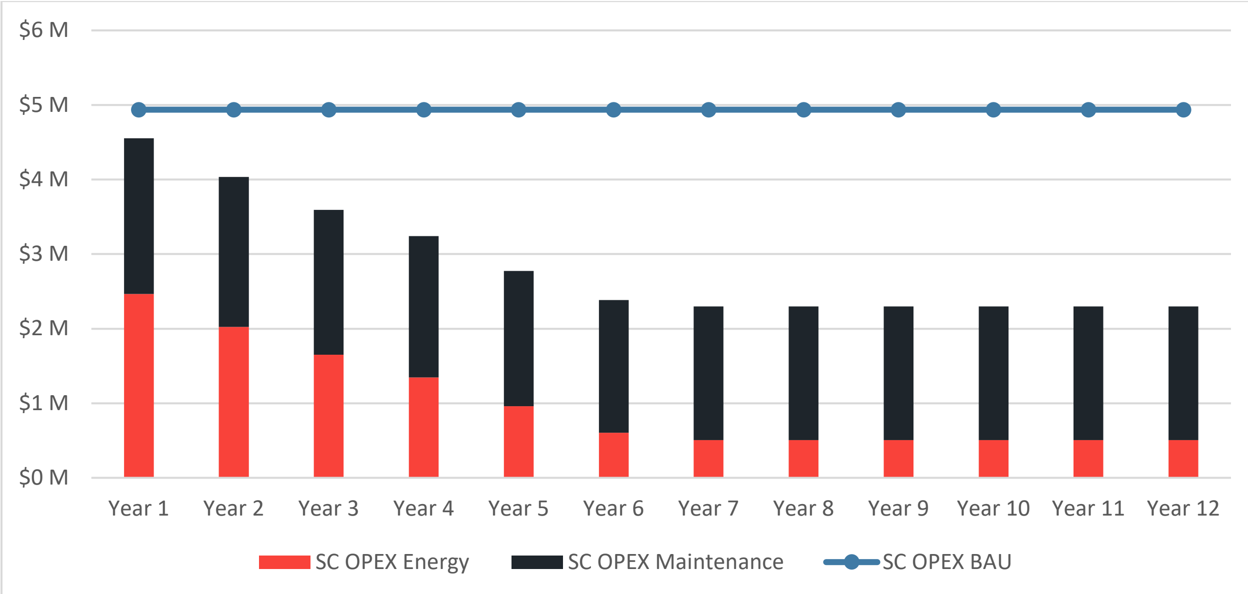

Figure 4-11: Total OPEX for St. Catharines Depot.

Fuel and Electricity

Figure 4-12 shows the electricity and fuel costs of the transition plan at St. Catharines depot against the BAU. Most of the OPEX savings from year 1 to 6 are expected to come from the BEB operation from St. Catharines, as this facilities' fleet is planned to be electrified first. The average annual electricity and fuel cost for the transition plan is approximately $1,007,000 vs $2,775,000, only 36% of the BAU OPEX at St. Catharines depot.

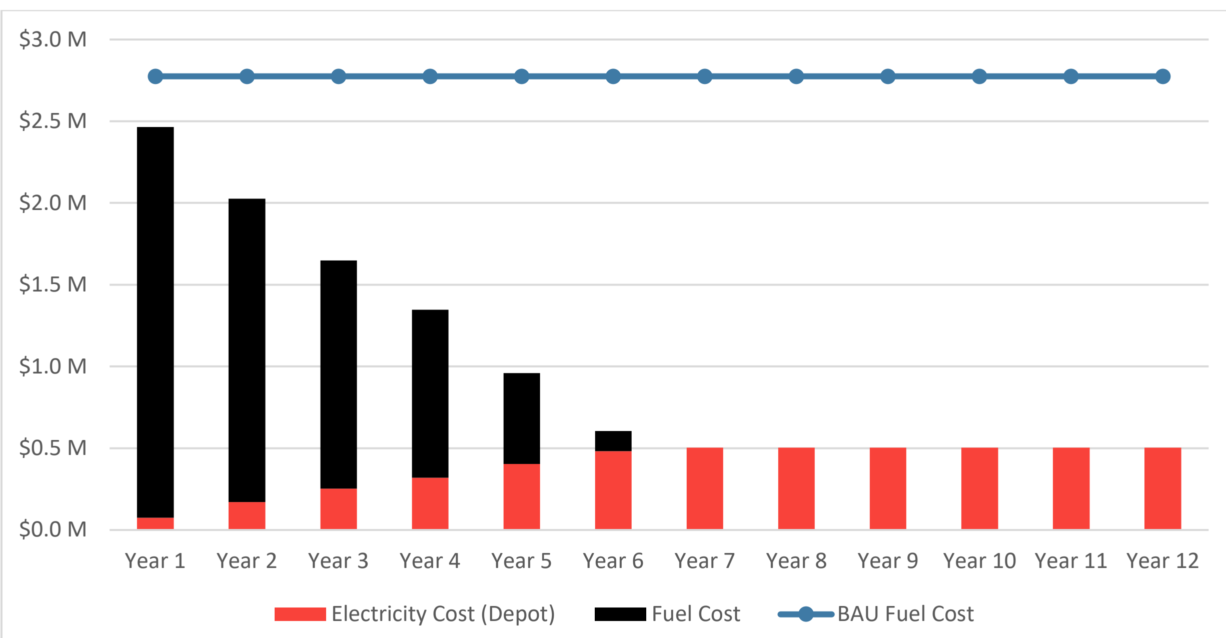

Figure 4-12: OPEX: Electricity and Fuel for St. Catharines Depot.

Maintenance

Figure 4-13 shows that vehicle and charger maintenance costs at St. Catharines are slightly lower under the transition plan. The average annual maintenance OPEX during the transition is $1,858,000, compared to $2,162,000 for BAU, a 14% reduction.

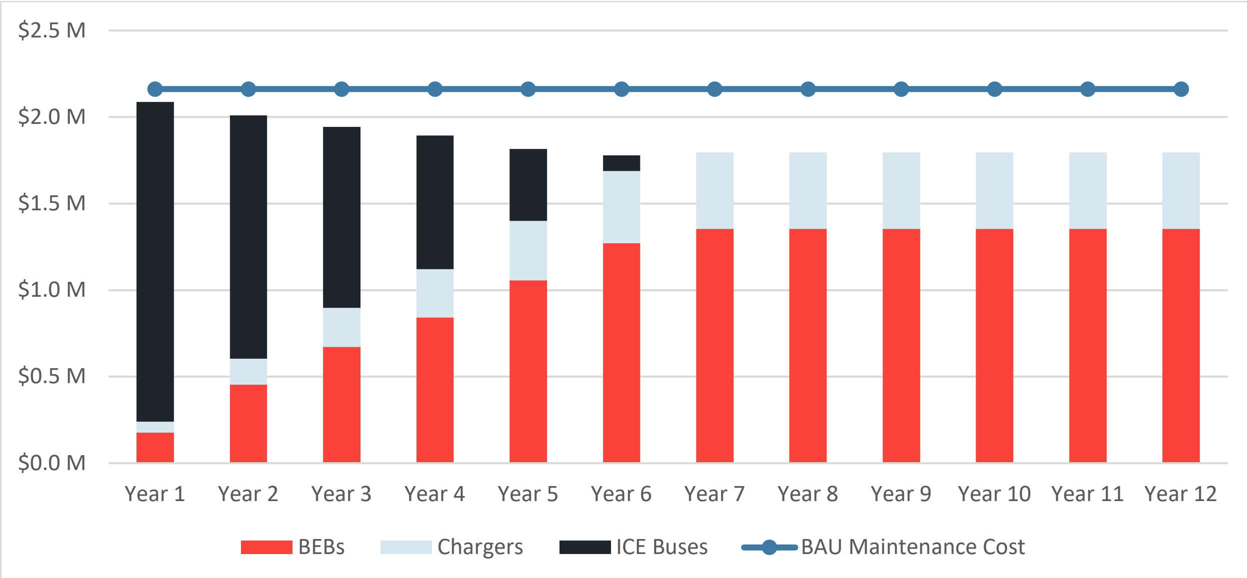

Figure 4-13: OPEX: Vehicle and Charger Maintenance Costs at St. Catharines Depot.

4.2.6.2 *OPEX FOR NIAGARA FALLS FLEET*

Total OPEX

Figure 4-14 shows the total OPEX cost for Niagara Falls garage. As expected, major savings start from Year 7 onwards due to delayed start of electrification. Following the complete electrification by Year 12, the annual savings are expected to sit at approximately $1,477,000, which represents a 43% reduction compared to the BAU.

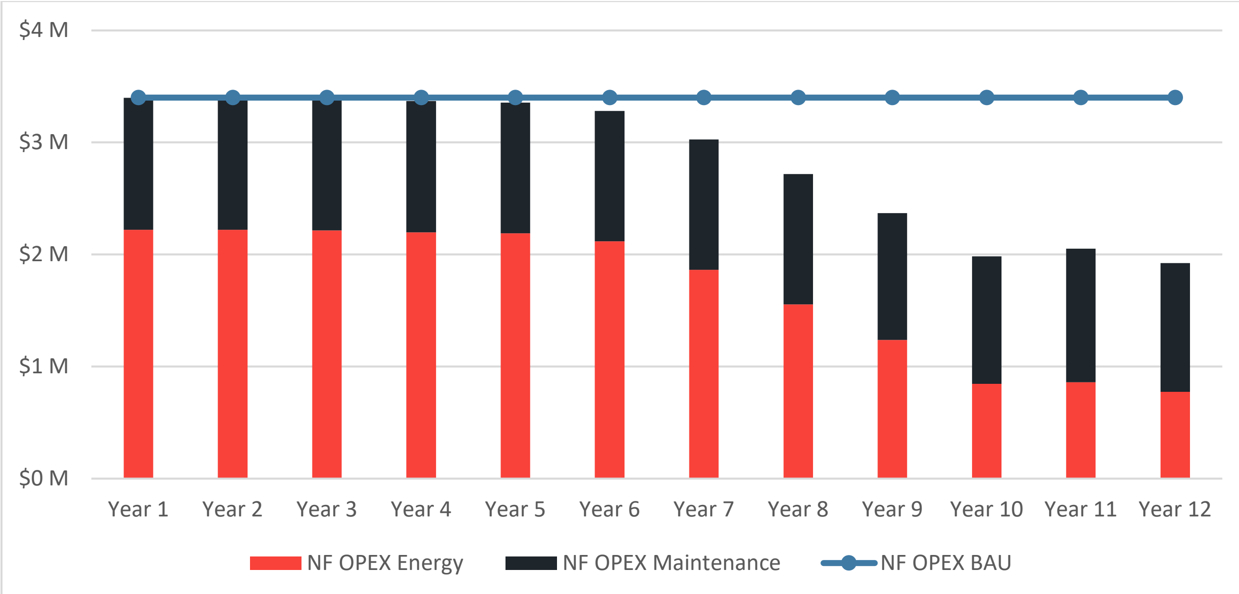

Figure 4-14: Total OPEX for Niagara Falls Depot.

Fuel and Electricity

As shown in Figure 4-16**,** the fuel savings start from year 5, which coincides with the acquisition of the first BEB at the Niagara Falls site. By Year 12, annual savings in electricity and fuel costs is close to 1.5 million dollars, which is 65% less compared to the BAU's fuel cost. From Year 1 to 12, the transition's average annual electricity and fuel cost is approximately $1,692,000, compared to $2,223,000 for BAU. This is, approximately, average savings of 24%.

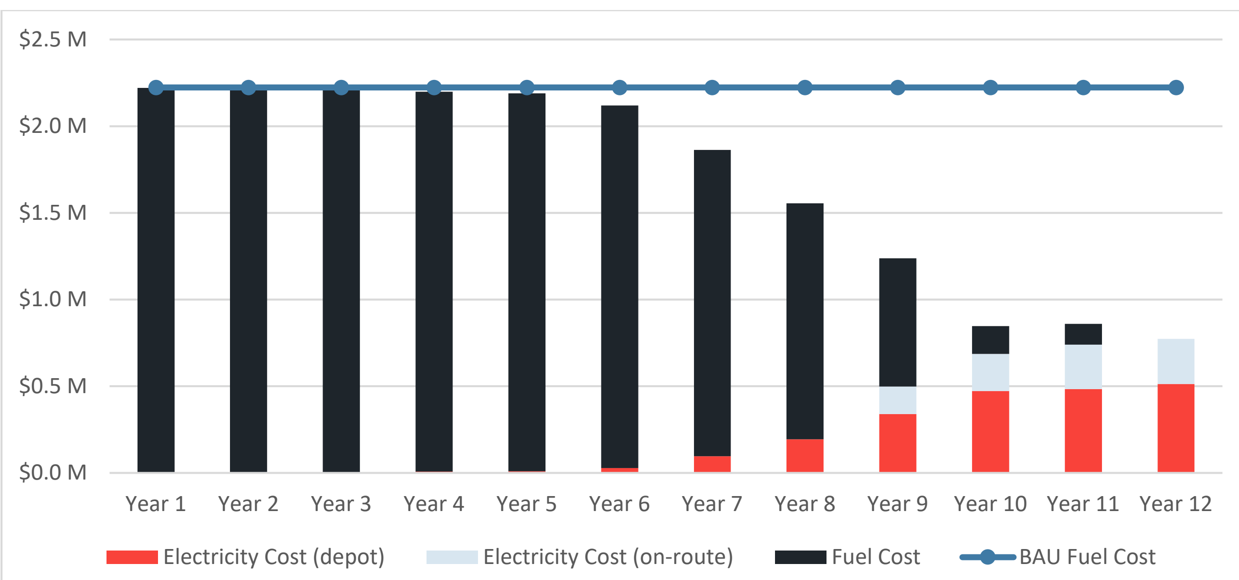

Figure 4-15. OPEX: Electricity and Fuel Costs at Niagara Falls Depot.

Maintenance

Figure 4-16 shows vehicle and charger maintenance costs at Niagara Falls. The transition plan's maintenance costs are approximately equal to the BAU plan throughout the 12-year timeframe. This is mainly due to two factors: the high maintenance cost of five on-route chargers, and the higher number of BEBs compared to diesel buses. From Year 1 to 12, the average annual maintenance cost is $1,165,000 for the transition plan compared to $1,177,000 for the BAU. This represents a % reduction. On Year 12, once the fleet is 100% electrified, the savings are expected to sit at 2%.

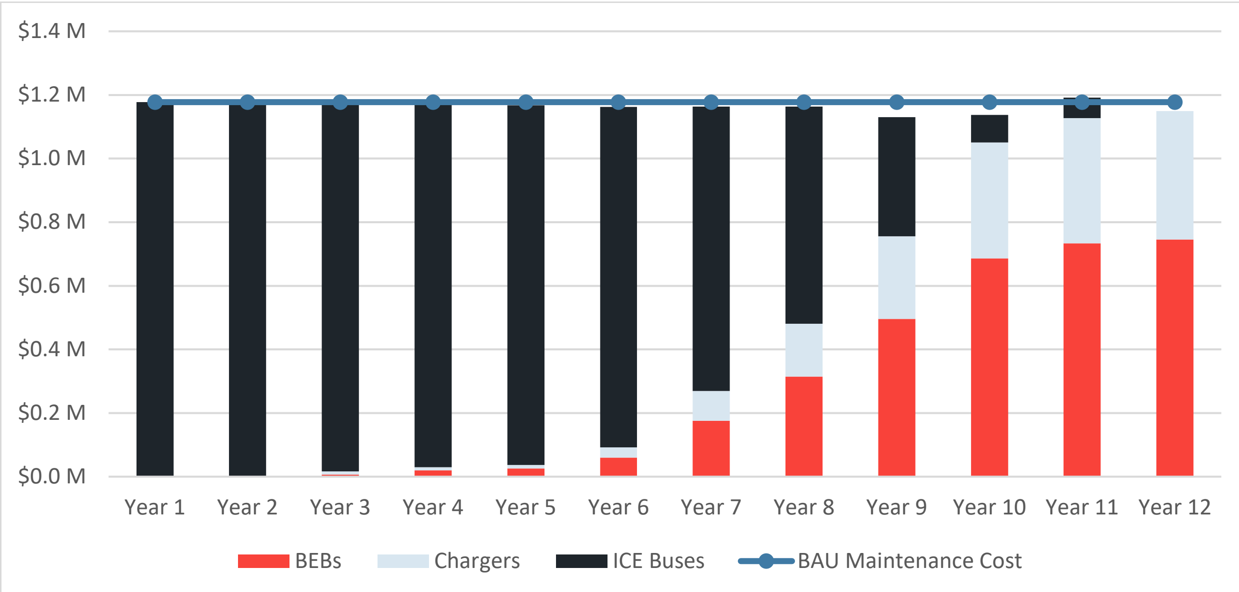

Figure 4-16: OPEX: Vehicle and Charger Maintenance Costs at Niagara Falls Depot.

4.3 GHG EMISSIONS ANALYSIS

Determining the GHG emissions savings is the main driver for transit agencies when considering fleet electrification. Ontario's grid is one of the cleanest among the provinces and territories in Canada. Therefore, electrification of the transportation segment in Ontario can bring significant GHG emissions reductions. GHG emission calculations are based only on the core fleet.

4.3.1 OVERALL GHG EMISSIONS

Figure 4-17 presents the lifecycle GHG emissions for the transition plan against the GHG emissions for the BAU scenarios. The GHG emissions illustrated include both facilities. BAU lifecycle GHG emissions remain constant over the years, while the future implementation of transition plan shows a continuous decrease from Year 1 to 12. By Year 12, BEBs can reduce GHG emissions by 98% compared to the BAU scenario. Further reductions are expected as Ontario's grid becomes cleaner. All assumptions related to the GHG emission factors, fuel economies (for ICEs), and energy efficiencies are included in Appendix C.

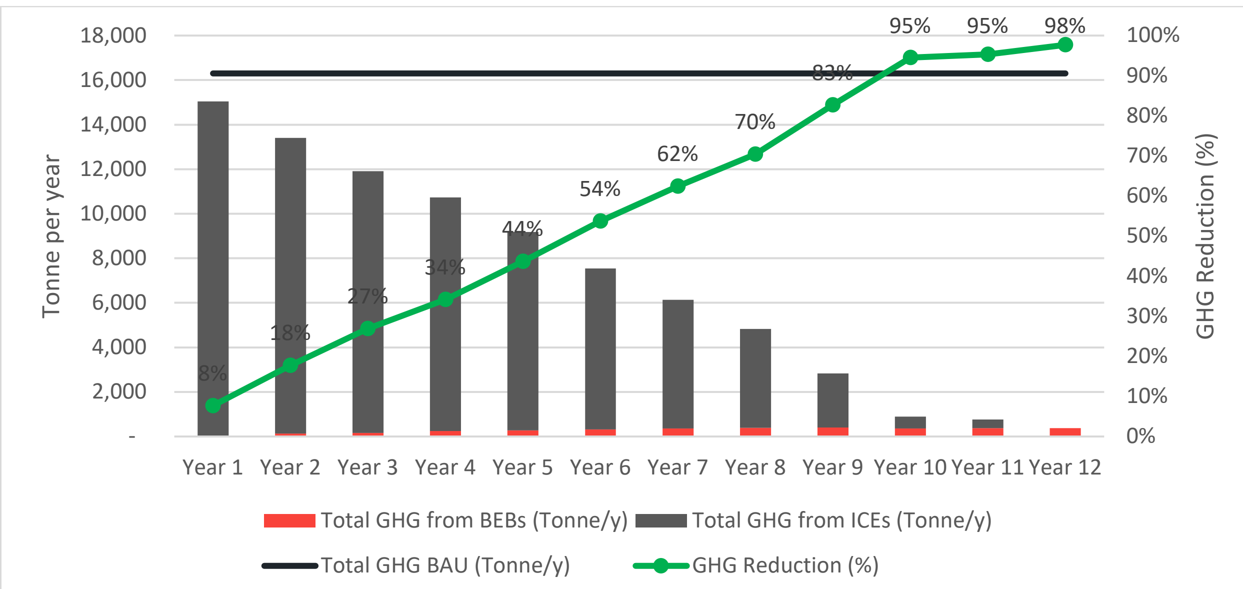

Figure 4-17. GHG Emissions Comparison for Both Depots.

4.3.2 GHG EMISSIONS FROM ST CHATHARINES FLEET

Figure 4-18 shows the lifecycle GHG emissions for the transition plan compared to the GHG emissions for the BAU at St. Catharines depot. The transition plan shows a gradual reduction in emissions by Year 7, reaching 98% when the fleet is fully electrified in Year 8. The GHG emissions stays at 98% onwards due to the GHG emissions factor of Ontario's generation portfolio.

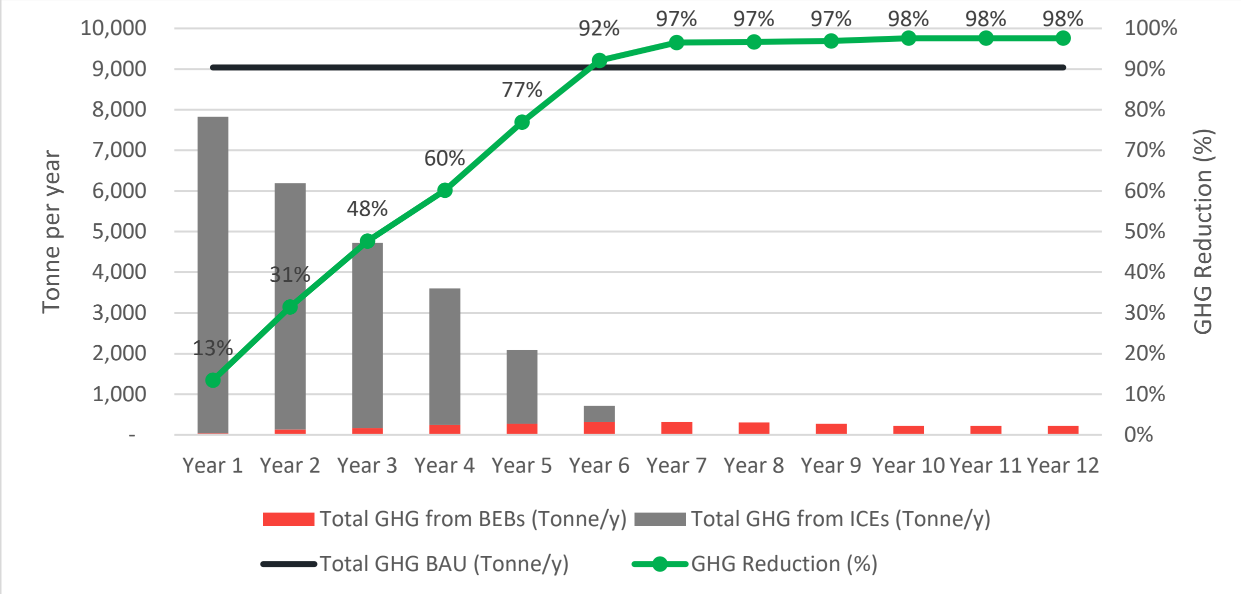

Figure 4-18: GHG Emission Comparison for St. Catharines Depot.

4.3.3 GHG EMISSIONS FROM NIAGARA FALLS FLEET

As for Niagara Falls depot, the transition plan considers the transition process at a later stage, compared to St. Catharines. Therefore, the reduction of GHG lifecycle emissions reaches the 98% plateau of 98% by Year 12, as shown in Figure 4-19.

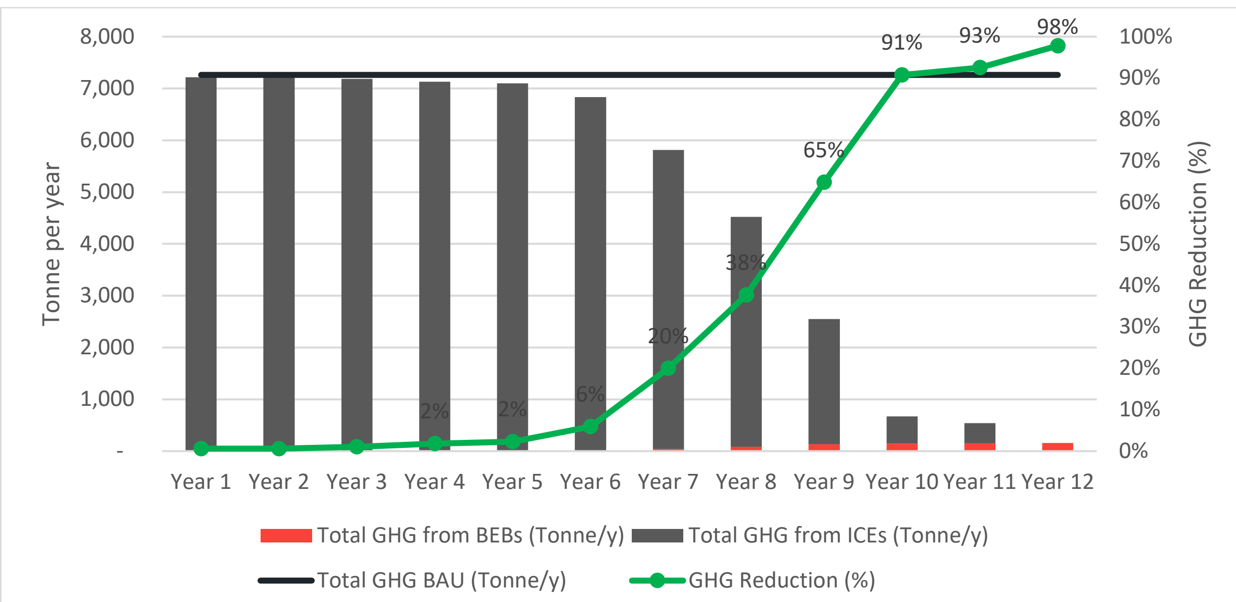

Figure 4-19. GHG Emission Comparison for Niagara Falls Depot.

5 CONCLUSION AND RECOMMENDATIONS

Niagara Region’s Climate Change Action Plan includes a commitment to reducing greenhouse gas emissions from its corporate operations and facilities in the medium term, while the Region is aiming for net-zero corporate emissions by 2050 aligning with national climate goals.

NT is conducting the *Fleet Electrification Strategy and Implementation FEED Study* to determine the requirements and costs for gradually transitioning to a zero-emissions fleet and upgrading infrastructure. The main goals are to reduce greenhouse gas emissions while maintaining transit operations and delivering value to regional taxpayers and residents.

The Study involved identifying the feasibility of electrifying regional transit operations. Both battery electric (BEB) and hydrogen fuel cell electric (FCEB) bus technologies were assessed, and battery electric bus technology was identified as the appropriate technology for NT’s initial fleet and facility deployment and has been considered for the purposes of all planning and costing in this study.

Following detailed feasibility assessments conducted in a separate task, this report defines the Fleet Transition Plan and presents an implementation roadmap with estimated costs. It outlines specific requirements for zero-emissions bus fleet procurement, details regarding transit garage retrofits, Class D cost estimates, deployment strategy development, projected emission reduction trajectories, and capital investment plans for phased deployment of battery electric buses and related infrastructure upgrades.

The following points summarize the findings of this fleet electrification study:

FACILITY MODIFICATIONS

At **St. Catharines Garage,** both indoor and outdoor spaces of the site will be used to store and charge the fleet.

Table 5-1: Proposed Fleet Makeup at St. Catharines Garage

	Core Fleet	Spares	Total
40’ BEB	67	23	90
60’ BEB	9	2	11
Paratransit Vehicles	10	2	12

The original building can accommodate forty-five 40’ BEBs, and the newer addition will store and charge 9 60’ BEBs, with roof mounted pantographs for each.

The exterior area adjacent to the southern wall of the additional garage will provide additional storage / charging for the expanded fleet of BEBs and will house outdoor gantry-mounted pantographs for twenty-four 40’ BEBs. The core paratransit vehicle fleet will be stored and charged to the southeast of the site. There will be three charging cabinets for the paratransit vehicles, each connected to four charging dispensers

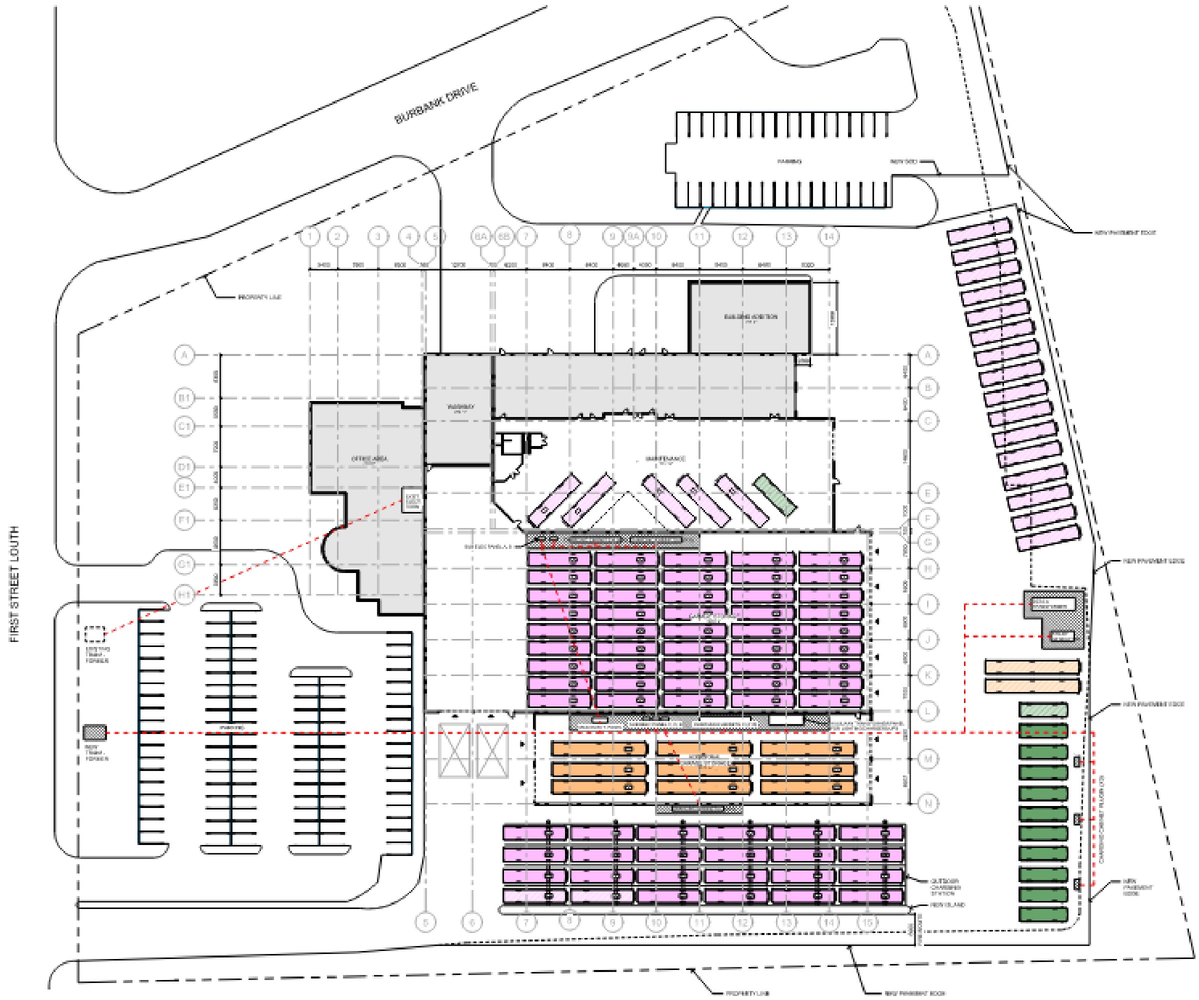

Figure 5-1: Proposed St. Catharines BEB Facility Site Plan (Conceptual Only)

The recommended construction phasing strategy aligns the delivery of the first BEBs with the completion of the initial construction phase of St. Catharines garage. The construction and installation of chargers is planned to be split into two phases. Phase 1 considers the planning, procurement and construction activities associated with the first five years of BEB deliveries. Phase 2 consists of implementation of charging equipment to cover the remainder of the BEB deliveries in years 6 though 12.

At **Niagara Falls Garage**, the preferred charging technology will also be overhead pantographs. The interior part of the garage will be used for charging 60' BEBs with roof mounted pantographs for each. An outdoor charging area is proposed comprised of exterior gantry pantograph structures for the 40' buses, and two independent gantry pantograph structures for 60' BEBs. The core paratransit vehicles will be parked in the southeast end of the site.

Table 5-2: Proposed Fleet Makeup at Niagara Falls Garage

	Core Fleet	Spares	Total
40' BEB	71	8	79
60' BEB	20	4	24
Paratransit Vehicles	11	3	14

The construction of retrofits for Niagara Falls Garage are recommended to be completed in a single construction phase - in addition to potential early works package to increase the capacity of the electrical service at the site.

Due to the heavier duty cycles and longer distance intermunicipal services operating out of Niagara Falls, five on-route chargers are proposed at Welland Bus Terminal to provide top-up charging. These are to be implemented over a timeframe of five years, which can change in case of service expansions or other changes to facilities in the future.

The leased Metrolinx GO buses lanes are excluded from the NT electrification scope and will be preserved for the use of these regional transit vehicles and related staff.

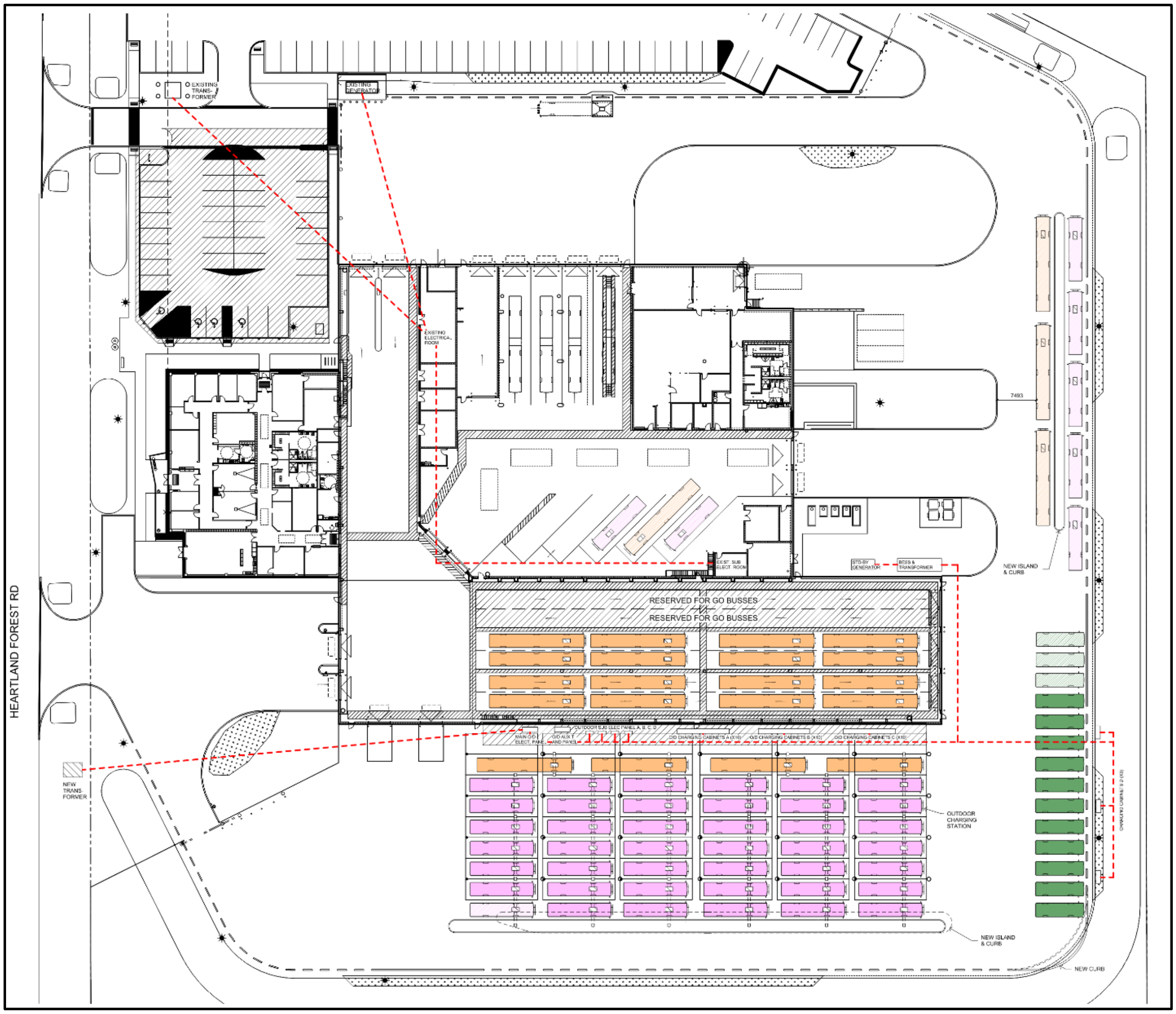

Figure 5-2: Proposed Niagara BEB Facility Site Plan.

The **proposed electrical design** at both garages enables charging of the transit fleet through a network of pantograph and plug-in chargers, backed by a utility-supplied transformer, distribution system, auxiliary services, BESS, and a standby generator for emergency scenarios. The facility will accommodate present and future charging needs with adequate spare provisions and system flexibility.

Within existing structures, **roof-mounted reinforcement supports are proposed** to accommodate the additional weight of interior pantographs.

FLEET AND FACILITIES TRANSITION ROADMAP

The fleet deployment is planned to take 12 years, corresponding the expected lifespan of 40-ft and 60-ft buses. It is recommended that two years preceding the start of BEB operations are allowed for planning / budgeting, detailed design, procurement, and facility construction. The total estimated timeline would be 14 years.

The transition NT fleet consists of a mix of diesel and gasoline-fuelled 40-ft, 60-ft, and paratransit vehicles, which can operate assigned daily transit services (blocks) without the need for midday refueling.

It is recommended that the strategy for fleet replacement is aligned with the NT's 'business as usual' Vehicle Replacement Schedule, covering the first 8 years of ZEB operations and covers both St. Catharines and Niagara Falls garages. In the final 4 years (Years 9 to 12), it is recommended that the new BEBs are deployed evenly to meet the required total number of core and spare units at each garage.

Detailed design & early enabling works for St. Catharines Phase 1 should start as a priority in Planning Year 1, anticipating the need to tender early works packages for long lead items identified above (e.g. the substation for the service capacity upgrade, associated switchgear, BESS and potentially chargers). Assume up to a 2-year lead time, then the enabling works package should be ordered in the early part of Planning Year 1.

Detailed design work will also confirm the construction schedule and cost for the St. Catharines Phase 1 Package, and potentially for Phase 2. Considering an estimated 12 to 18-month construction timeframe, and the need for the facility to be operations ready in Year 1, the award timeline for the Phase 1 construction package should be in mid Planning Year 1.

The construction packaging for the 2nd phase at St. Catharines garage will depend on the design approach, although a 1-year construction timeline and a Year 5 opening day suggests award some time in late Year 4 or early Year 5.

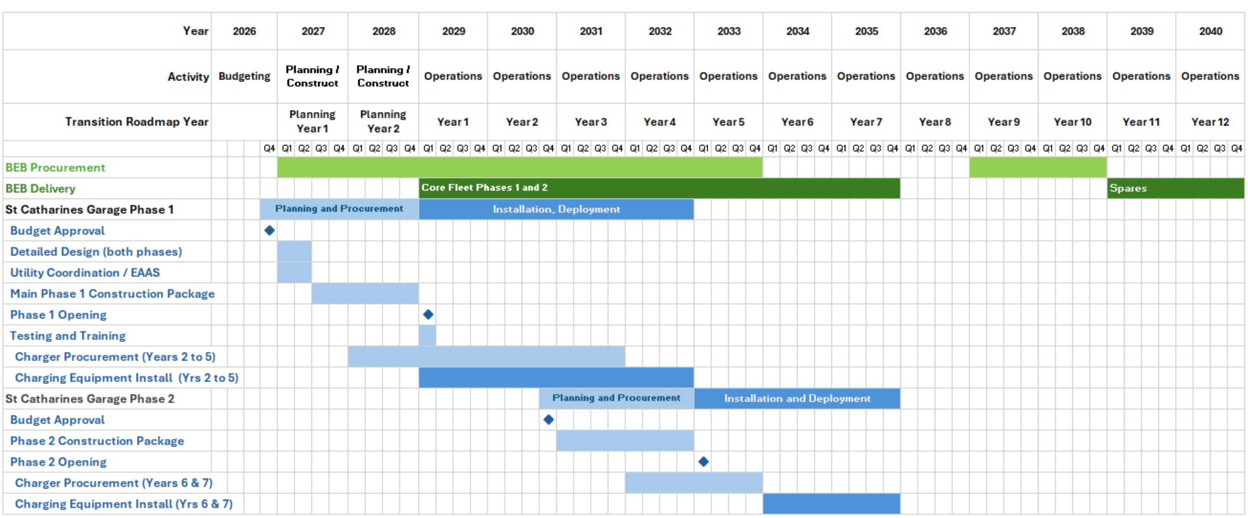

Figure 5-3. Phasing Schedule for St. Catharines Depot.

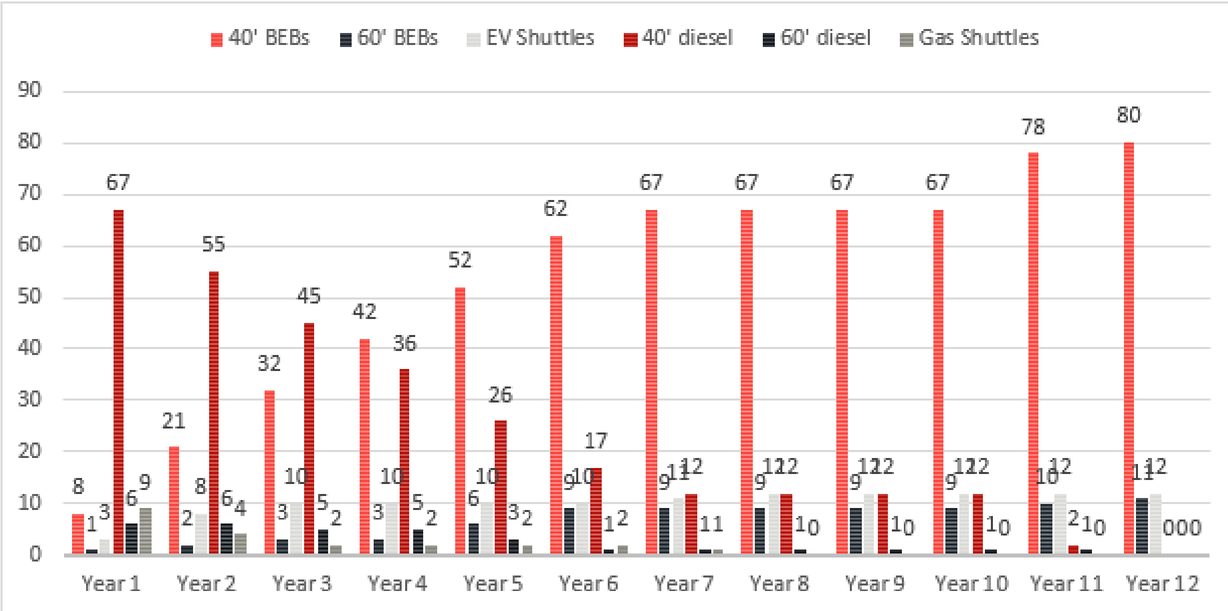

Figure 5-4. Proposed Fleet Deployment Schedule at St. Catharines Garage.

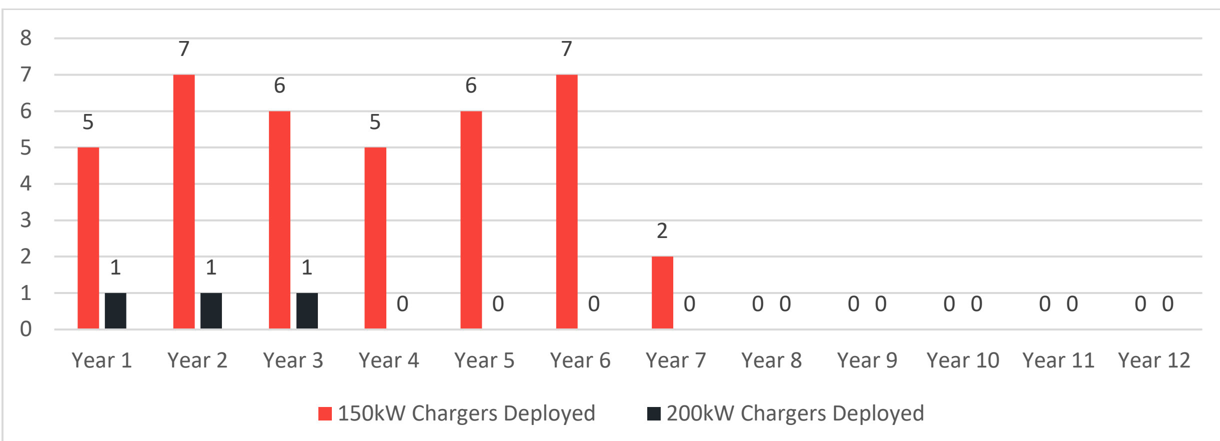

Figure 5-5. Proposed Charger Deployment Schedule at St. Catharines.

The deployment of BEBs and chargers at Niagara Falls garage is scheduled to start in Year 6, subsequent to the core fleet deployment at St. Catharines, and will coincide with St. Catharines Phase 2. Electric paratransit vehicles are set to begin their transition earlier in Year 3. The full transition of the Niagara Falls fleet is expected to be completed by Year 12, while the deployment of electric paratransit vehicles is anticipated to conclude by Year 8.

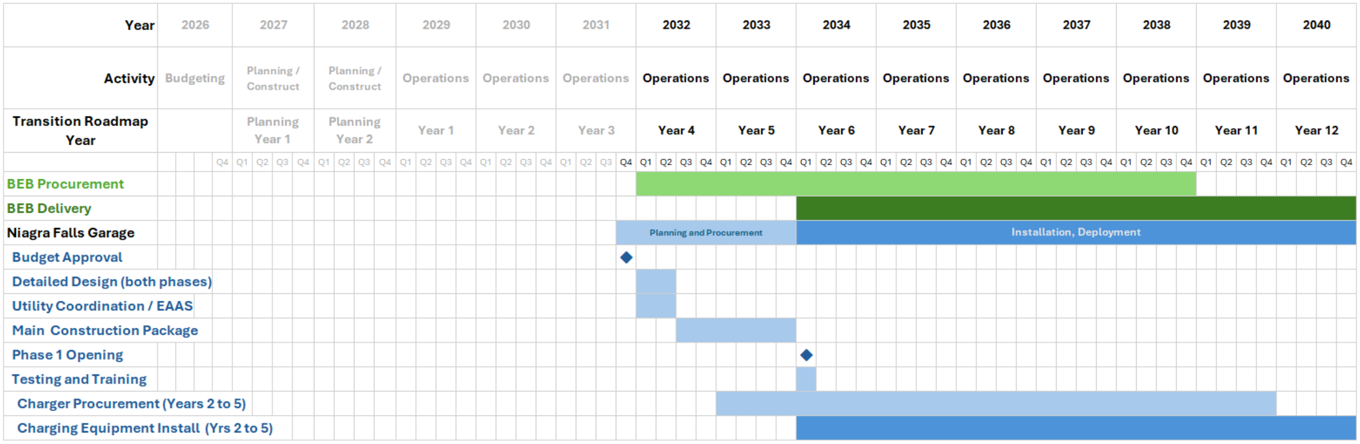

Figure 5-6: Niagara Falls Implementation Schedule.

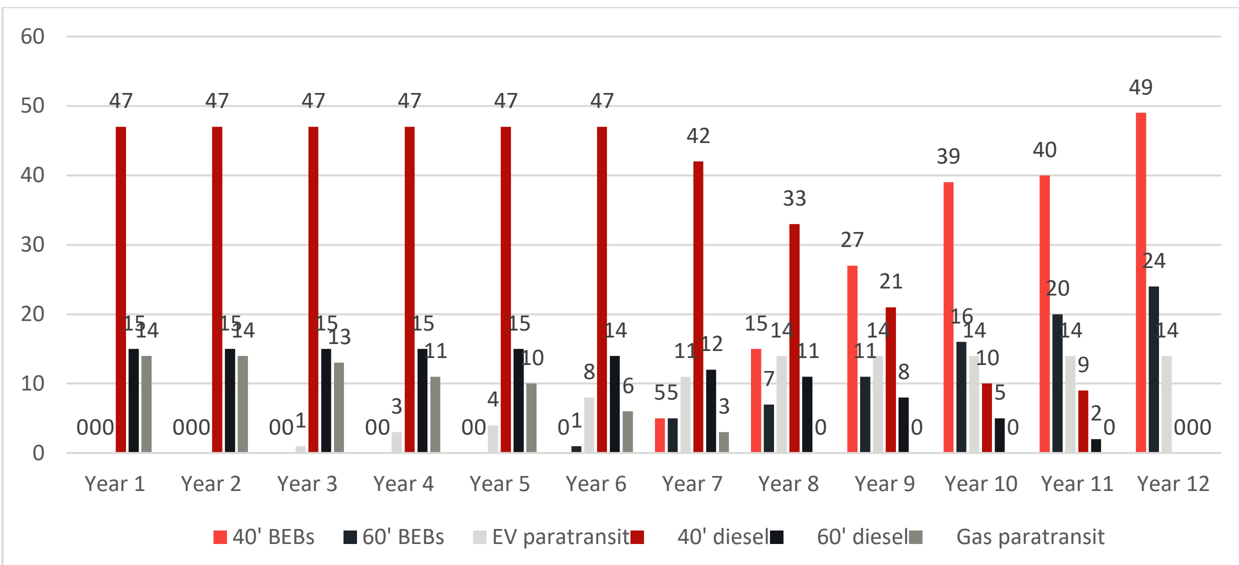

Figure 5-7: Proposed Fleet Deployment Schedule at Niagara Falls Garage.

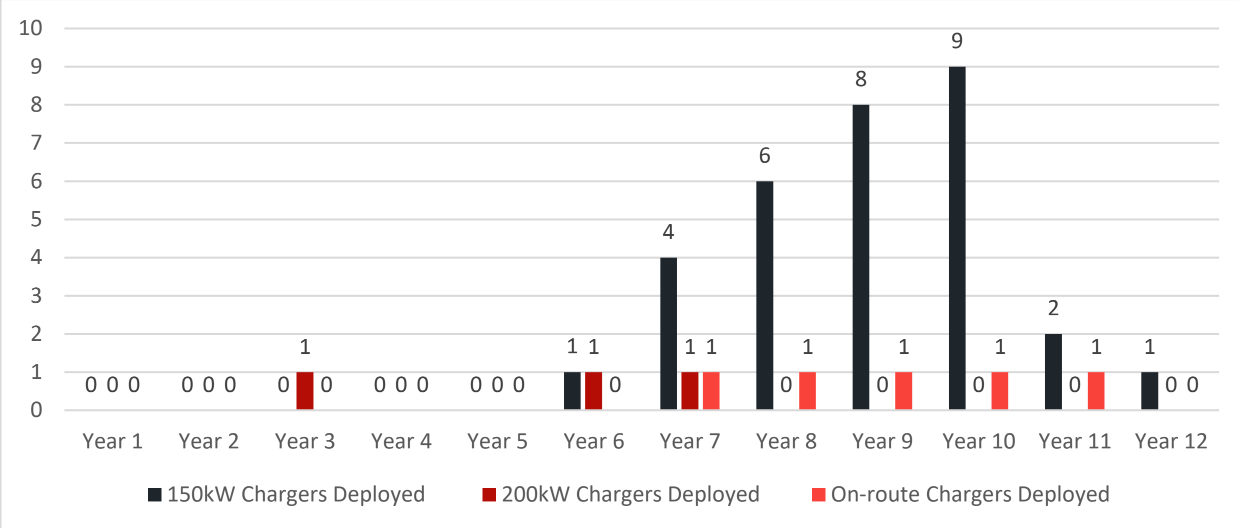

Figure 5-8: Proposed Charger Deployment Schedule at Niagara Falls Garage.

COSTS

The transition plan for the St. Catharines facility will increase the total cost by 53%, compared to the BAU. For the Niagara Falls facility, it will increase the total cost by 84%, compared to the BAU. These costs include facility and fleet capital and operational expenses. Accounting for both facilities and the overall fleet to be owned by NT, the total cost for the implementation of the transition plan will be 66% higher compared to the to the BAU. Although BEBs can generate savings in operations, these savings do not offset the extra costs associated with capital investments in BEBs, chargers, and facility modifications.

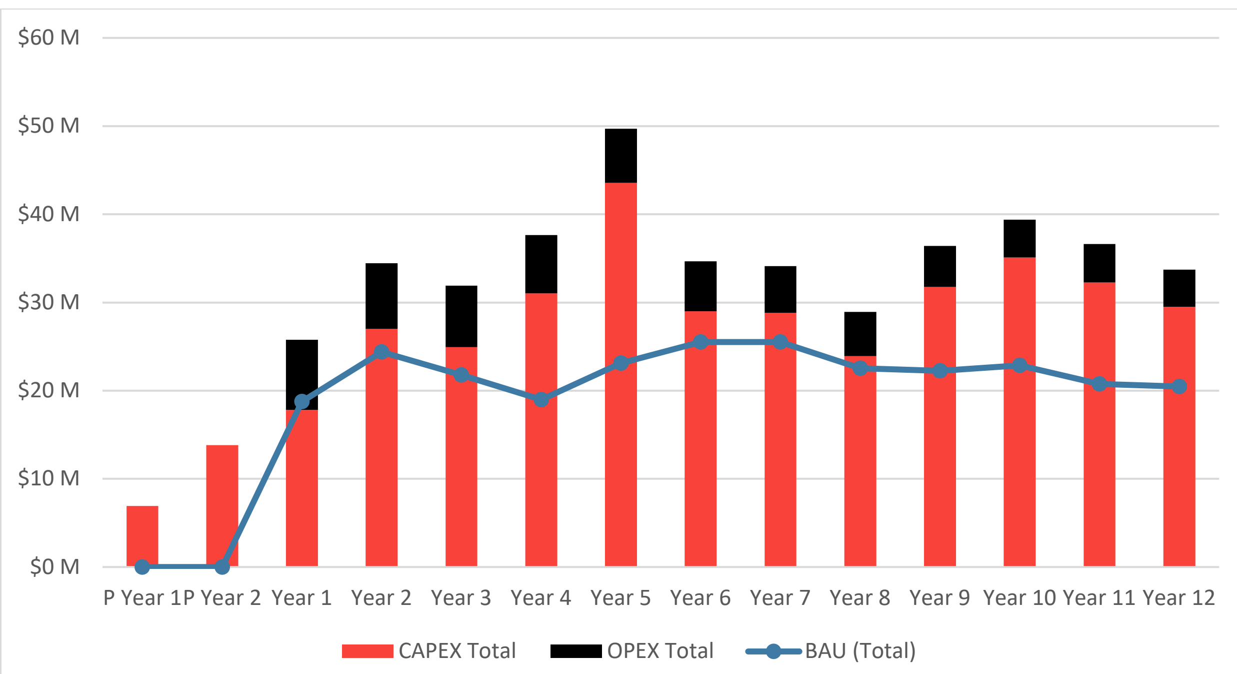

Figure 5-9: Total Cost: CAPEX & OPEX for NT Fleet and Facility Transition.

Table 5-3: Total Costs Summary: Transition vs BAU

	BAU	BAU	TRANSITION PLAN	TRANSITION PLAN
	St. Catharines	Niagara Falls	St. Catharines	Niagara Falls
CAPEX Fleet	$ 92,394,500	$ 74,566,900	$ 158,581,700	$ 137,715,100
CAPEX Construction	$ -	$ -	$ 26,252,700	$ 28,524,400
CAPEX Charging Equipment	$ -	$ -	$ 12,160,000	$ 12,260,000
OPEX Fleet - Electricity	$ -	$ -	$ 4,728,100	$ 3,040,800
OPEX Fleet - Fuel	$ 33,298,800	$ 26,679,600	$ 7,350,000	$ 17,257,800
OPEX Fleet - Maintenance ICEs	$ 25,942,800	$ 14,127,600	$ 5,579,200	$ 8,968,300
OPEX Fleet - Maintenance BEBs	$ -	$ -	$ 12,599,600	$ 3,264,300
OPEX Fleet - Maintenance Chargers	$ -	$ -	$ 4,121,900	$ 1,743,100
Totals	$151,636,100	$115,374,100	$ 231,373,200	$ 212,773,800

	BAU	TRANSITION PLAN
Totals	**$267,010,200**	**$444,147,000**

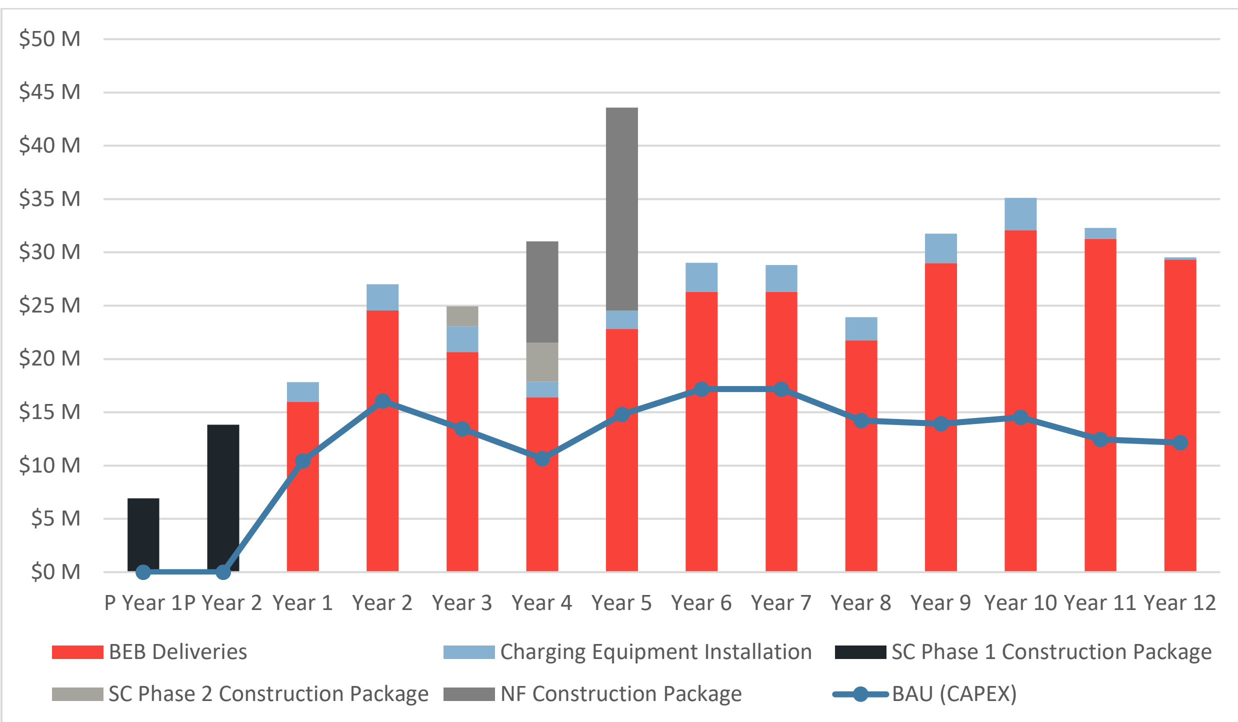

Figure 5-10: Total CAPEX (Fleet, Facility Construction, Chargers / Cabinets / Dispensers) for Both Garages.

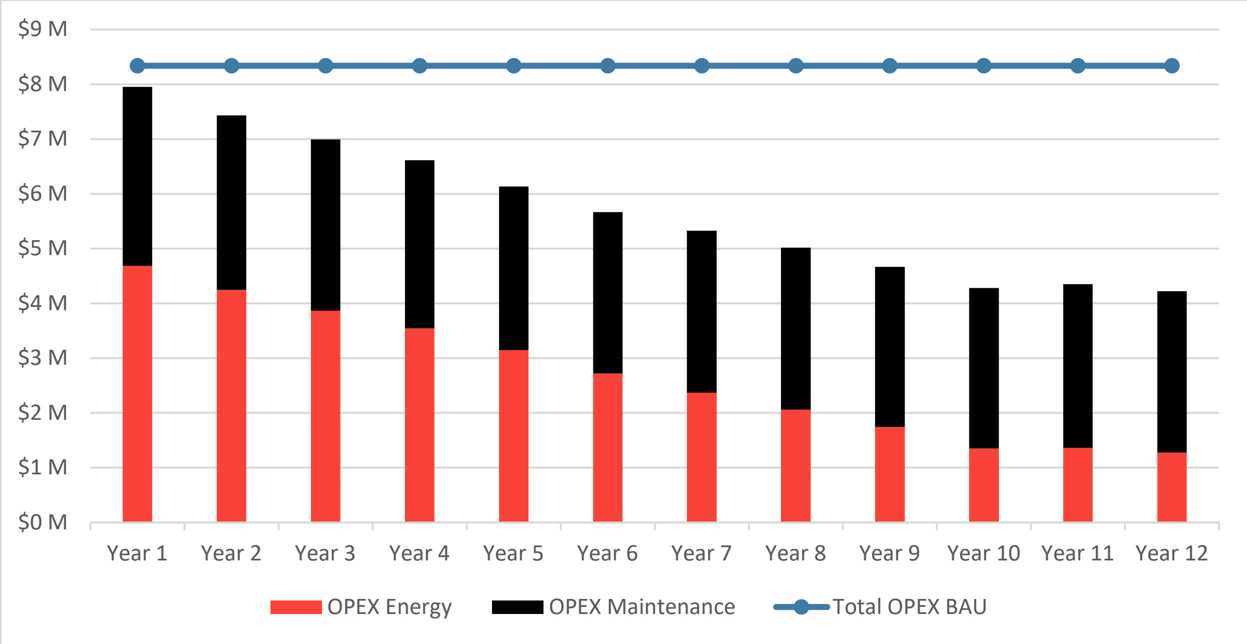

Figure 5-11: Total OPEX (Fuel, Electricity and Maintenance) for Both Depots.

GHG EMISSIONS ANALYSIS

The transition could reduce NT's transit lifecycle GHG emissions by up to 98% versus the BAU scenario, supporting decarbonisation of transport emissions in Niagara and aligning with regional goals. Additional reductions are likely as Ontario's grid becomes cleaner.

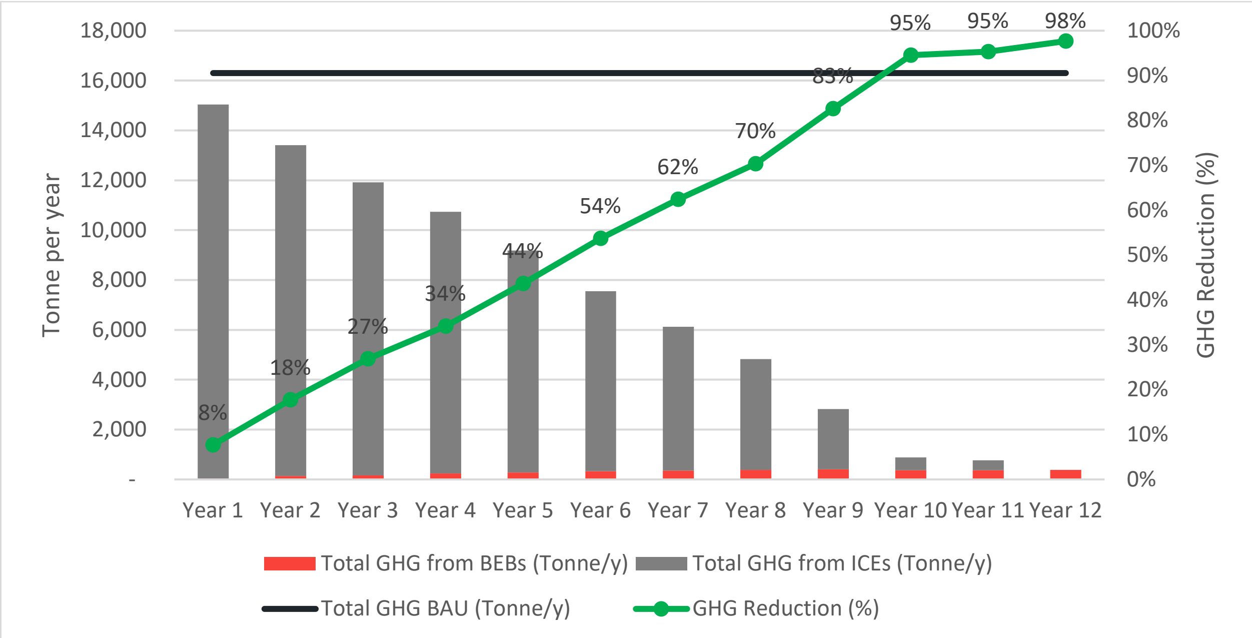

Figure 5-12: GHG Emissions for Both Depots.

APPENDIX A - DRAWINGS

Alectra's Energy-As-A-Service (EaaS) Approach

The Fleet Electrification Strategy and Implementation Roadmap Study references a procurement strategy known as Energy-as-a-Service (EaaS). Through this memo, Alectra Energy Solutions ("Alectra") is further elaborating on its EaaS solution while highlighting its capabilities as a qualified 3rd party provider of EaaS for Niagara Transit Commission's consideration.

Part of the study's findings is that the transition plan will have an overall increase in costs vs business as usual (BAU) since there is a significant capital outlay in 1) battery electric buses (BEBs), 2) facility modifications, and 3) charging infrastructure. Key benefits of the EaaS approach is that certain capex elements can be shifted to opex, while shifting material risks to a long-term partner such as Alectra.

Alectra defines Energy-as-a-Service (EaaS) as the turnkey implementation and ongoing management of 1) energy and charging infrastructure, 2) energy services, and 3) bus financing & procurement, under a long-term contract with comprehensive service and performance guarantees. As part of EaaS, Alectra (together with partners) designs, builds, finances, operates and maintains (DBFOM) the required infrastructure necessary to support NTC's Battery Electric Bus fleet. Alectra's energy services would provide NTC with optimized energy costs and reliable performance that meet operational needs. In addition, Alectra and partners can fully finance and procure BEBs on behalf of NRT.

1. Energy & Charging Infrastructure

Design

Alectra, through its design partner WSP, may design a fit for purpose and reliable electrical network for the electrification of the fleet. The design would ensure that the electrical system is robust and easily maintainable to provide maximum availability of power for charging the BEBs. The design team will work closely with the garage operations and maintenance (O&M) teams to ensure that the electrical system meets the requirements of the end user. Design may include built-in redundancies, such as redundant power supplies, charging units, and communication systems to minimize operational disruptions.

alectra
energy solutions

2. Build (Construction)

Alectra, through its construction lead, will apply for the necessary permits required during the design phase and work with NTC to ensure minimal to no disruption to operations during the construction of each electrification phase. The main construction activities (civil, structural, mechanical and electrical) that will be performed can be summarized as following:

- Coordination and management of interconnection with the utility grid, including application processes, metering, and compliance with regulatory requirements
- Electrical service upgrades and high voltage electrical work as required
- Installation of supporting electrical infrastructure for the charging equipment, such as wiring, breakers, switchgears, transformers, and distribution panels
- Site preparation, installation, comprehensive inspections and testing and commissioning of the charging equipment, back-up power systems and storage to ensure continuous operation of charging infrastructure during power outages or emergencies
- Procurement in alignment with NTC's public procurement rules and in consideration of potential long lead times
- Facility retrofits or new build, as required.

2. Finance

Alectra, through its financing partners, will arrange all financing associated with the EaaS agreement and lead the application process for any current and future federal and provincial funding programs to help optimize overall electrification transition's costs.

Alectra and partners expect to fund the project with a combination of equity and debt financing and has the necessary investment capital and access to financing to cost-effectively deliver the EaaS solution.

3. O&M

Alectra will provide an O&M plan that will maximize reliability and minimize outages. A summary of tasks include:

- Ongoing support, training and education for transit staff on the safe operation of the charging equipment
- Lifecycle management and advisory on strategies to minimize operating costs and optimize operations
- Preventative maintenance of electrical infrastructure and charging equipment

- 24/7 monitoring and emergency and repair services including both onsite and remote support
- Management of onsite spare parts inventory
- Implementation of performance monitoring systems to track key metrics like Greenhouse Gas emissions reduction.

4. Energy Services

Alectra can implement the most commercially viable strategies required to manage electricity costs and risks over the term of the EaaS contract. As an affiliate to a large, long-standing utility and as an experienced energy developer, AES has in-depth understanding of the energy and power markets in Ontario, and as owners and operators of critical energy infrastructure throughout the province, we are uniquely positioned to develop, deliver and operate a complete solution that is reliable over the term of the contract. Central to this is our combined ability to adapt to prevailing and changing market conditions, global adjustment (GA) considerations, energy storage insights, understanding of rate structures, superior asset management practices, deployment of advanced microgrids to manage peak load and costs, and our ability to facilitate utility interconnection processes.

As part of the EaaS solution, Alectra will minimize electricity costs utilizing all available market options and methods as described below, while ensuring 24/7 access to power:

- Displace grid supplied energy with on-site power generation (i.e. solar, generators)
- Load shift from on-peak periods to off-peak periods
- Levelize demand to reduce regulated distribution/transmission charges via load management using an Energy Management System
- Limit demand during top 5 system peaks via Energy Storage, reducing Peak Demand Factor (PDF) and associated GA costs
- Pursue capacity market and ancillary services revenues as a wholesale market participant
- Limit extreme electricity price volatility by actively operating natural gas generators at optimal times

5. Bus Financing & Procurement

Alectra is aware of the funding gaps and timing risks that transit agencies face as it relates to procurement and funding of BEBs. Through its partners, Alectra can reliably provide financing solutions for BEBs throughout the phases of the electrification transition.

The EaaS solution

Overall, the EaaS solution offered is a comprehensive combination of energy products and services customized to meet Niagara Transit Commission's needs. Solutions are agnostic to any particular products or technology, which allows for system flexibility and adaptability. This feature may be critical in designing a system that may be implemented in phases over several years, in parallel to the BEB fleet deployment. In this adaptive and flexible solution, we align to NTC's preferences, with the end-goal being not to sell technology but to deliver bespoke solutions that will bring the most value to the region.

As part of the EaaS offering, Alectra & partners can provide (though would not necessarily be limited to) the following energy solutions and products. All items specified below are subject to change following further consultation and review with NTC. Some of the energy products and solutions may be outsourced to third parties, as indicated below:

- Vehicles **Financing** for BEBs
- **Electric Vehicle Supply Equipment** (EVSE) to meet both depot and on-route charging needs
    - Plug-in chargers, pantograph chargers, and other evolving EV charging technologies such as wireless charging and bidirectional charging
- **Back-up generation & storage**
    - Natural gas back-up generators with emissions controls
        - Alectra understands that decarbonization requirements may be a priority for NTC and would need to find the right balance against service uptime requirements
    - Microgrids including solar panels and batter energy storage systems (BESS)
- **Transformer stations** required to step down high voltage electricity from the grid to usable levels for charging infrastructure
- **Switchgear and distribution** panels used to manage and distribute power to various charging stations and auxiliary systems
- **Onsite back-up storage** (battery energy storage systems)
- **Charge management systems** (CMS) with capabilities as follows:
    - Real-time monitoring and control
    - Smart charging, including dynamic load balancing and demand response
    - Customizable dashboards and reporting

- **Energy management systems** (EMS) to support decision making strategies that schedule and solve optimization problems for every energy resource and load asset including EV charging systems
  - EMS vendor to ensure elements such as cybersecurity, cloud connectivity, database and redundancy design are met to NTC's requirements
- **Energy services**: Alectra can actively manage energy consumed from the utility grid via demand management and provide energy cost savings, market revenues and avoided energy price risk premium for NTC using the following methods:
  - Peak notification and dispatch services (Industrial Conservation Initiative (ICI) participation)
  - Monitoring of Ontario's natural gas prices
    - Limit extreme electricity price volatility by operating the natural gas generators when the spark gap is exceeded (i.e. when natural gas fuel plus generator maintenance costs are lower than the cost of drawing energy from the utility grid at prevailing Hourly Ontario Energy Price (HOEP), Global Adjustment (GA) and Capacity charges)
    - Levelized demand to reduce regulated distribution/transmission charges via load management using Integration Software EMS
    - Register NTC entity as a wholesale market participant pursuant to Independent Energy System Operator (IESO's) market rules
    - Reduce NTC's peak demand factor to the extent feasible
    - Dispatch into IESO Capacity markets and ancillary services
    - Displace grid supply with solar photovoltaic resources, where possible
    - Load shift from on-peak periods to off-peak periods
- **Fire suppression** system to detect, control, and extinguish fires in transit facilities related to battery infrastructure
- Energy monitoring & usage **analytics tools**, including tracking of performance metrics like GHG emissions reductions
- **Secure communications network** to connect all charging infrastructure and electrical assets, including network segmentation, spectrum analysis for wi-fi interoperability
- **Telematics and fleet management solutions** for real time tracking and route optimization and predictive maintenance alerting, including Intelligent Transportation System integration
- **24/7 emergency service** (in-house, provided by Alectra's emergency restoration line of business), including onsite spare parts
- **Carbon credit** aggregation and monetization solutions
- **Structural upgrades** for depots or on-route locations, where required.

Key Benefits of Alectra's EaaS

A fundamental benefit of the EaaS model is that it manages risks to the benefit of NTC, as Alectra would take on key project elements such as financing, technology, uptime, execution, operations and so forth.

An EaaS partnership with Alectra would strongly demonstrate responsible risk sharing and mitigation by NTC in key risk categories outlined below.

Proposed Risk Mitigations

Risk	Mitigation with EaaS Partnership
EaaS Model	• While the agreement is long-term, there are strong contractual provisions to ensure supplier performance throughout the life of the contract, with appropriate offramps and early termination covenants • NTC will have one counterparty to engage with, downloading interfacing challenges between various infrastructure components, vendors, and contractual commitments to Alectra • Alectra and partners are experienced firms with advanced governance strategies for these types of complex infrastructure projects, and certain members have worked together on several successful projects
Upfront Capital Costs	• NTC can shift large, upfront capital expenditures and ongoing unpredictable
Energy Costs	• Provide physical assets on-site like batteries and solar panels, integrated with advanced energy and charge management systems to manage peak demand, optimize charging schedules based on energy costs, and participate in demand response programs (i.e. Global Adjustment mitigation) • NTC can shift the responsibility of meeting reliability standards to Alectra, reducing the risk of unexpected costs/penalties due to underperformance or equipment failures
Design Suitability	• Experienced design team will collaborate closely with the NTC's planning, operations and maintenance groups to define needs and apply lessons from

Operational	• Fleet operations & maintenance
	  ○ Minimize disruption to active Garage and Maintenance areas using compartmentalized areas
	  ○ Ensure outages and work across traffic areas occur overnight with sufficient planning and review with NTC's operations and maintenance groups
	• System Performance
	  ○ Back-to-back SLAs to support customer expectations and uptime commitments
	  ○ Ensure systems provide sufficient capacity during commissioning and support reliability through extensive planned maintenance, 24/7 monitoring, reactive maintenance and adequate critical spares on-site
	  ○ Design will include redundancy features
	• Fuel/energy availability

	○ Seek competitive contracts, secure guaranteed electrical service for critical transport service, and implement site-generated electricity and energy storage (BESS) ○ Lead early engagement and close collaboration with Alectra Utilities for any service upgrades
Safety	• Develop a phased strategy for the implementation of new technologies and include training of staff • Testing & inspections • Ensure construction lead defines time/space responsibilities and follows comprehensive safety plan during construction and follows correct protocols for maintenance activities • Implementing the latest fire safety approach to battery infrastructure
Technology Change	• Implement mature and established technologies, such as large-scale transformers, BESS, solar, and natural gas generators to support the charging infrastructure • Maximize interoperability of the various components and technologies to enhance performance, reliability and resiliency of the overall solution, as well as to facilitate the integration of future innovative solutions • With respect to charging equipment and related software, Alectra will undertake an extensive vendor analysis with key considerations
Construction Delays	• Preplanning the procurement of materials in conjunction with execution, timelines, schedules, project controls, etc. • Closely monitor construction progress with schedules and implement recovery plans, if required • Dedicated Project Management Team to ensure compliance with schedules,
Procurement Timelines & Costs	• Major equipment will be ordered after 30% design and client review are completed with defined currency and materials factors • Bulk purchase & large orders where possible to achieve discounts • Equipment deposits are incorporated into the project cashflow to lock in costs with purchase orders to suppliers
Political	• Seek to phase changes in a managed process that considers potential changes in policy and available funding programs • Electrification strategy to be reviewed regularly to avoid shock in changes in policy

The Economics: CAPEX vs OPEX

Transit agencies should be seeking long-term contracts to ensure that the overall cost of the transition is extended over the long-term for the benefit of their customers. Given the nature of these large infrastructure projects, high CAPEX spend better aligns with longer term contracts to primarily lower the ongoing cost impact on customers, as well as address investment recovery and amortization of assets. Therefore, while Alectra's base contract is for 20 years with an extension / renewal of ten additional years, there is flexibility here. The contract also includes off-ramps for both parties, providing flexibility to terminate the partnership under certain conditions if necessary.

A full comprehensive review is required to ensure all elements, SLAs, contract duration, asset lifecyle and refurbishment/replacements are factored in to provide a true CAPEX to OPEX comparison. However, as per the Study, direct avoided CAPEX for the overall transition would be around $24.4Million just on charging infrastructure for both St. Catharines and Niagara Falls, which could be used to offset other capital costs such as for BEBs or facilities. If a 15yr EaaS term is assumed for each phase (assuming each year is a phase) the OPEX would be similar to the Business as usual (BAU) OPEX cost for the first 5 yrs, and then increase as Niagara comes online. Overall the EaaS fee would be generally slightly above BAU OPEX. However, if carbon credits are factored in at present value, the EaaS Fee would be similar (slightly below) BAU OPEX.

Alectra recommends a confidential review of the EaaS cost stack, terms and scope to ensure NTC has input into the various factors that allow calibration of the EaaS fee over time and to maximize value for NTC.