ZEB Strategy and Final Report

Calaveras Transit Agency
ZEB Rollout and Implementation Plan

Final Report

April 2023

Stantec

ZEB Strategy and Final Report

ZEB Rollout Plan and Analysis Services

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Prepared for:

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Prepared by:

Stantec Consulting Services Inc.

ZEB STRATEGY AND FINAL REPORT

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EXECUTIVE SUMMARY

Calaveras Transit Agency (CTA), also known as Calaveras Connect, provides fixed-route, deviated fixed-route, and general public dial-a-ride (DAR) service to Calaveras County as well as parts of Amador and Tuolumne counties.

This document serves to guide CTA through its zero-emission bus (ZEB) transition to achieve a 100% zero-emission (ZE) fleet by 2040. It provides a detailed plan of the technology, needs, and strategies that will help CTA transition to a ZEB fleet. The previous phases of this project (summarized in this report) laid the foundation for this plan by assessing CTA's existing conditions and modeling the power and energy requirements needed to meet CTA's required service through a ZEB fleet. With this information, the initial ZEB fleet was refined through a collaborative optimization process that led to the preferred fleet composition. This involved replacing the current fleet with an equivalent number of ZEBs and increasing the fleet size by purchasing three new vehicles. Among other benefits, this strategy will help to both address range limitations and maintain existing service levels.

With the preferred fleet composition established, the next steps included determining the facility upgrades and modifications required to support ZEB operations at CTA's operations and maintenance facility. In addition, a financial model was developed to compare against a base case (business-as-usual with fossil fuel vehicles) and to assist in developing a phasing or implementation plan. Overall, implementing the ZEB fleet will cost $7 million (cumulative capital and operating costs) compared to $5.4 million for the base case within a 17-year timeframe (through 2040). Stated otherwise, the transition to ZEBs adds incremental capital and operating costs of $1.6M over the 17-year period. The infrastructure requirements are also captured in this plan to accommodate the phased acquisition of ZEBs while still operating and eventually phasing out fossil fuel vehicles.

Based on CTA's existing fleet replacement schedule, this plan recommends that the ZEB procurement begin in 2023 and continue gradually through 2040. This phased approach allows CTA to implement a small number of ZEBs and learn from the process as they slowly scale up to reach a fully ZE revenue vehicle fleet by 2040. The full phasing and implementation plan is outlined in Table 1. With a full transition to ZEBs, CTA can reduce its fleet-related greenhouse gas emissions by approximately 82% (~110 tons annually).

Taken together, this plan provides a prudent and feasible approach for CTA to implement ZEBs that meets the agency's transportation goals while providing reliable service to the community.

Table 1: ZEB implementation phasing plan, FY2023-2040

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2023		1 van	33%	Original equipment manufacturer (OEM) training	OEM training for all other staff	$378,000	$266,000	$644,000
FY2024		0	0%	Annual refreshers	Coordination with local fire and emergency response department for ZE technology for emergency responses	$196,000	$252,000	$448,000
FY2025	2 chargers with dual dispenser	0	0%	OEM training	No activity	$815,000	$236,000	$1,051,000
FY2026		1 van	50%	Annual refreshers	Local fire and emergency response department refreshers	$253,000	$222,000	$475,000
FY2027		1 cutaway	50%	OEM training	OEM training for all other staff	$265,000	$199,000	$464,000

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2028		0	No procurement	Annual refreshers	Local fire and emergency response department refreshers	$0	$189,000	$189,000
FY2029	2 chargers with dual dispenser	2 cutaways	100%	OEM training	No activity	$822,000	$158,000	$980,000
FY2030		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$157,000	$141,000	$298,000
FY2031		2 cutaways 1 van	100%	OEM training	OEM training for all other staff	$416,000	$120,000	$536,000
FY2032	1 charger with dual dispenser	2 cutaways	100%	Annual refreshers	Local fire and emergency response department refreshers	$483,000	$113,000	$596,000
FY2033		1 cutaway	100%	OEM training	No activity	$135,000	$98,000	$233,000

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2034		1 cutaway 1 van	100%	Annual refreshers	Local fire and emergency response department refreshers	$230,000	$83,000	$313,000
FY2035		1 cutaway	100%	OEM training	OEM training for all other staff	$122,000	$87,000	$209,000
FY2036		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$116,000	$88,000	$204,000
FY2037		1 cutaway	100%	OEM training	No activity	$111,000	$83,000	$194,000
FY2038		0	No procurement	Annual refreshers	Local fire and emergency response department refreshers	$0	$77,000	$77,000
FY2039		2 cutaways 1 van	100%	OEM training	OEM training for all other staff	$280,000	$74,000	$354,000

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2040		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$95,000	$69,000	$164,000

Abbreviations

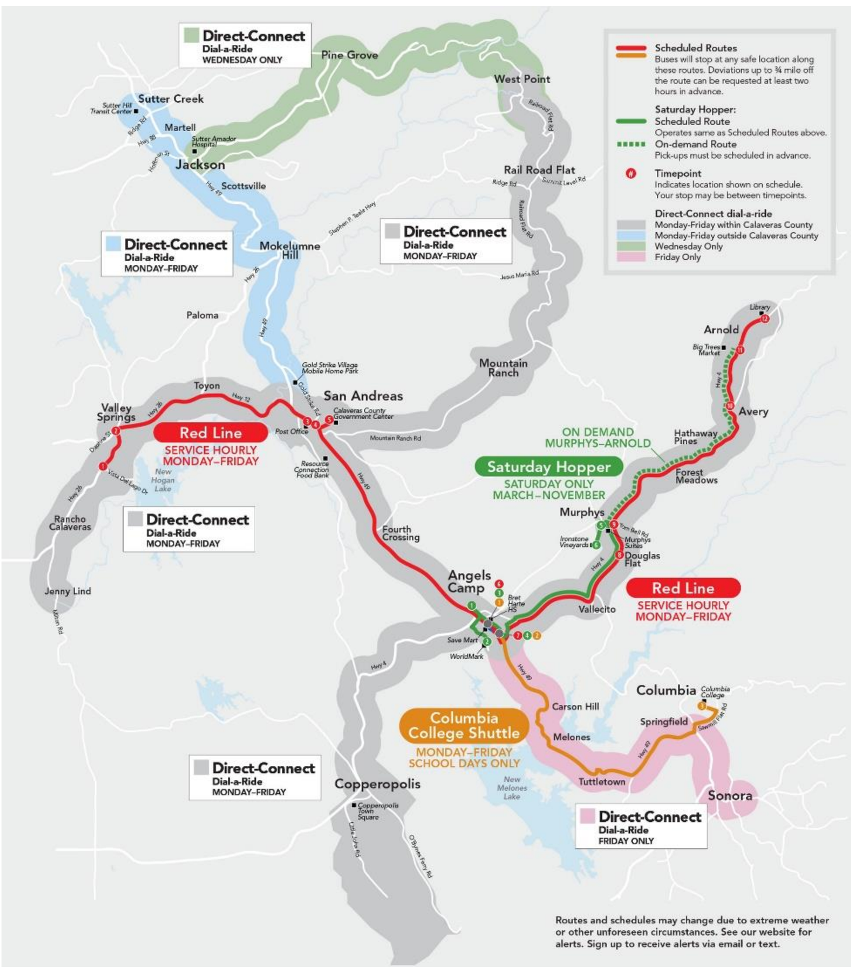
AHJ	Authorities Having Jurisdiction
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ASC	AMPLY Site Controller
BEB	Battery electric bus
BESS	Battery electric storage system
BUILD	Better Utilizing Investments to Leverage Development
CARB	California Air Resources Board
CMS	Change management systems
CNG	Compressed natural gas
CTA	Calaveras Transit Agency
DAR	Dial-A-Ride
DC	Direct current
DER	Distributed energy resource
ESS	Energy Storage System
FCEB	Hydrogen fuel cell electric bus
FTA	Federal Transit Administration
GHG	Greenhouse gas
GTFS	General Transit Feed Specification
ICT	Innovative Clean Transit
KPI	Key performance indicator

MPO	Metropolitan planning organization
NFPA	National Fire Protection Association
NREL	National Renewable Energy Laboratory
NTI	National Transit Institute
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturers
PG&E	Pacific Gas & Electric
PPE	Personal protection equipment
PV	Photovoltaic
SOC	State of charge
TAM	Transit asset management
TCTA	Tuolumne County Transit Authority
TOU	Time of use
TTC	Toronto Transit Commission
ULB	Useful life benchmark
USDOT	United States Department of Transportation
ZE	Zero emission
ZEB	Zero-emission bus

1.0 INTRODUCTION

Calaveras Transit Agency (CTA) provides fixed-route, deviated fixed-route, and general public dial-a-ride service to Calaveras County, with some services extending into Amador and Tuolumne counties through a service called Calaveras Connect. In response to pandemic-induced ridership declines, CTA transitioned Calaveras Connect to a more flexible system consisting mostly of Direct-Connect Dial-A-Ride (DAR) service open to the general public and some fixed-route service (Figure 1).

Figure 1: Current Calaveras Connect services



In 2020, CTA provided over 33,000 unlinked passenger trips with a fleet comprised predominately of gas-powered cutaways. CTA is part of the Mountain Counties Air Pollution Control District (APCD), Mountain Counties Air Basin, and Pacific Gas & Electric (PG&E) utility territory.

With a county population of 45,292[1] and fleet of 11 revenue vehicles, CTA is classified as a small transit agency under the Innovative Clean Transit (ICT) mandate and is required to submit a zero-emission (ZE) rollout plan to the California Air Resources Board (CARB) by July 1, 2023[2] for revenue service vehicles.

This document serves as the source for CTA's rollout plan submission to CARB and provides a detailed plan of the technology, needs, and strategies that will help CTA transition to a ZEB fleet. To develop this rollout plan, the following steps have been taken to determine the best ZEB strategy for CTA.

- A review of existing conditions to understand characteristics and constraints for CTA's operations and service area. This included a primer on different ZEB technologies to provide a scan of the market and technologies, including battery-electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs).
- Energy and power modeling to understand performance under different ZE technology alternatives, their viability, and suitability for CTA's needs. A quantitative and qualitative assessment of modeling results was used to determine the preferred ZE fleet composition for CTA.

This report is intended to act as a roadmap to guide CTA through the ZEB transition to 100% ZEB deployment and implementation by 2040, as well as to fulfill the CARB guidelines as outlined in the ICT mandate. As CARB has reminded transit agencies, the ICT-regulated rollout plan is intended to be a living document that can and should be regularly revisited and updated over time as ZE technologies continue to evolve.

[1] US Census Bureau 2020 Decennial Census; https://www.census.gov/search-results.html?q=calaveras+county&page=1&stateGeo=none&searchtype=web&cssp=SERP&_charset_=UTF-8

[2] CARB ICT defined large transit agencies as operating in "an urbanized area with a population of at least 200,000 as last published by the Bureau of Census before December 31, 2017 *and* has at least 100 buses in annual maximum service." Agencies that do not meet this definition are categorized as small transit agencies.

2.0 REGULATORY CONTEXT

This section provides a review of the ICT regulation to provide a basis for why the ZEB transition is taking place and to provide CTA staff and CTA Board members with information on how ICT and ZEB implementation fits within and impacts CTA operations and future plans.

2.1 INNOVATIVE CLEAN TRANSIT

CARB adopted the ICT regulation in December 2018, which requires all public bus transit agencies in the state to gradually transition to a completely ZEB fleet by 2040. This regulation is in accordance with preceding state legislation SB 375 and SB 350. SB 375, the Sustainable Communities and Climate Protection Program, creates initiatives for increased development of transit-oriented communities, better-connected transportation, and active transportation. Relatedly, SB 350 supports widespread transportation electrification through collaboration between CARB and the California Public Utilities Commission.

ICT also states that transit agencies are required to produce a ZEB rollout plan that describes how the agency is planning to achieve a full transition to a ZE fleet by 2040 as well as outlining reporting and record-keeping requirements. Specific elements required in the rollout plan include:

- A full explanation of how the agency will transition to ZEBs by 2040 without early retirement of conventional internal combustion engine buses;
- Identification of the ZEB technology the agency intends to deploy;
- How the agency will deploy ZEBs in disadvantaged communities;
- Identification of potential funding sources;
- A training plan and schedule for ZEB operators and maintenance staff;
- Schedules for bus purchase and lease options (including fuel type, number of buses, and bus type); and
- Information on the construction of associated facilities and infrastructure (including location, type of infrastructure, and timeline).

Small California transit agencies, such as CTA, are mandated to submit ZEB rollout plans to CARB by July 1, 2023. ICT also requires the ZEB purchase schedules for both large and small agencies. Beginning in 2021 and continuing annually through 2050, each transit agency is required to provide a compliance report[3]. The initial report outlines the number of and information on active buses in the agency's fleet as of December 31, 2017. Subsequent reports must include transit agency information, details on each bus purchased, owned, operated, leased, or rented (including make, model, curb weight, engine and

[3] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

propulsion system, bus purchases, and any information on converted buses), ZE mobility option information (if applicable), and information on renewable fuel usage (including date purchased, fuel contract number, and effective date, as applicable).

Table 2 below outlines the ZEB purchase schedule for small transit agencies for heavy-duty transit vehicles. Specific vehicle types, such as motor coaches, cutaways, double decker, and 60-ft. vehicles, are exempt from this purchase schedule until 2026 or later (dependent on Altoona testing being completed). Whereas large agencies are required to start purchasing ZEBs in 2023, small agencies are exempt until 2026, in that year a minimum of 25% of new bus purchases must be ZE.

Table 2: CARB Standard Bus ZEB Purchase Schedule (As a Percentage of Total New Bus Purchases for Small Transit Agencies)[4]

Year	Percentage
2023	-
2024	-
2025	-
2026	25%
2027	25%
2028	25%
2029 and after	100%

To account for circumstances beyond a transit agency's control that may impact their ability to comply with ICT regulations, the mandate laid out specific provisions for exemptions. Exemptions will be permitted for the following circumstances:

- If the required ZEB type is unavailable;
- If daily mileage needs cannot be met;
- If gradeability needs cannot be met;
- If there are delays in infrastructure construction;
- If a financial emergency is declared by the transit agency; and
- In circumstances where incremental capital or electricity costs for charging cannot be offset after applying for all available funding and incentive opportunities.

Specifically, the ZEB rollout plan required to be submitted to CARB by mid-2023 must include the following components, broken down by CARB into nine sections.

- Section A: Transit agency information

[4] In this report, standard buses refer to 35-ft. or 40-ft. unless otherwise stated

- Section B: Rollout plan general information
- Section C: Technology portfolio
- Section D: Current bus fleet composition and future bus purchases
- Section E: Facilities and infrastructure modifications
- Section F: Providing service in disadvantaged communities
- Section G: Workforce training
- Section H: Potential funding sources
- Section I: Start-up and scale-up challenges

2.2 ICT EXEMPTIONS

As discussed above, the ICT regulation has specific provisions for exemptions if at least one the following criteria are met. If the exemption is granted, transit agencies may purchase conventional ICE bus(es) instead of ZEB(s).[5]

1. Delay in bus delivery is caused by ZEB infrastructure construction setbacks beyond the transit agency's control. ZEB infrastructure includes charging stations, hydrogen stations, and maintenance facilities. The following circumstances would qualify a transit agency for exemption:

    a. Change of a general contractor
    b. Delays obtaining power from a utility
    c. Delays obtaining construction permits
    d. Discovery of archeological, historical, or tribal cultural resources
    e. Natural disaster

    A transit agency may also request an exemption if they can provide documentation that demonstrates the needed infrastructure cannot be completed within the two-year extension period or in time to operate the purchased buses after delivery, whichever is later.

2. When available ZEBs cannot meet a transit agency's daily mileage needs (due to operating conditions and the operating range of a ZEB).

3. If available ZEBs do not have adequate gradeability performance to meet the transit agency's daily needs for any bus in its fleet.

[5] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

4. When a required ZEB type for the applicable weight class based on gross vehicle weight rating (GVWR) is unavailable for purchase. A ZEB bus type is considered unavailable for purchase for any of the following reasons:
    a. The ZEB has not passed the complete Bus Testing and not obtained a Bus Testing Report
    b. The ZEB cannot be configured to meet applicable requirements of the Americans with Disabilities Act
    c. The physical characteristics of the ZEB would result in a transit agency violating any federal, state, or local laws, regulations, or ordinances

5. When a ZEB cannot be purchased by a transit agency due to financial hardship. Financial hardship would be granted for the following reasons:
    a. If a fiscal emergency is declared under a resolution by a transit agency's governing body following a public hearing
    b. A transit agency can demonstrate that it cannot offset the incremental cost of purchasing all available ZEBs compared to the cost of the same type of conventional bus
    c. A transit agency can demonstrate that it cannot offset the managed, net electricity cost for depot charging BEBs when compared to the fuel cost of the same type of conventional ICE buses

If a transit agency wishes to request an exemption, they must provide documentation demonstrating the criteria are met. Required documentation for each exemption is summarized in Table 3. In addition, a request for exemption for a particular calendar year's compliance obligation must be submitted by November 30th of that year.[6]

Table 3: Required documentation for ZEB purchase exemptions

Criteria	**Required Documentation**
1. Delay in bus delivery and infrastructure construction	• A letter from the agency's governing body • A letter from the contractor, utility, building department, or other involved organizations explaining the reasons for delay and estimating the project completion date
2. Available ZEBs cannot meet transit agency's daily mileage needs	• An explanation of why the exemption is needed • A current monthly mileage report for each bus type

[6] https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf

Criteria	Required Documentation
	• A copy of the ZEB RFP and resulting bids showing rated battery capacity • If available, measured energy use data from ZEBs operated on daily assignments in the transit agency's service
3. Available ZEBs do not have adequate gradeability performance to meet the transit agency's daily needs	• Documentation showing no other buses in the fleet can meet the gradeability requirements and the ZEBs of that bus type cannot be placed into service anywhere else in the fleet • Topography information including measurement of the grade(s) where the ZEBs would be placed in service • A description of the bus types that currently serve the route(s) • An explanation of why the gradeability of all available ZEBs are insufficient to meet the transit agency's service needs • A copy of the ZEB RFP, specifying the transit agency's required gradeability and the resulting bids • If available, empirical data including grades, passenger loading, and speed data from available ZEBs operated on the same grade
4. When a required ZEB for the applicable weight class based on GVWR is unavailable for purchase	• A summary of all bus body-types, vehicle weight classes being purchased, chassis, reasons why ZEBs are unavailable for purchase • Current fleet information showing how many ZEBs of that bus type are already in service and how many are on order • If applicable, documentation showing that ADA requirements cannot be met • If applicable, a letter from its governing body that details how the physical characteristics of the ZEB would violate federal, state, or local law

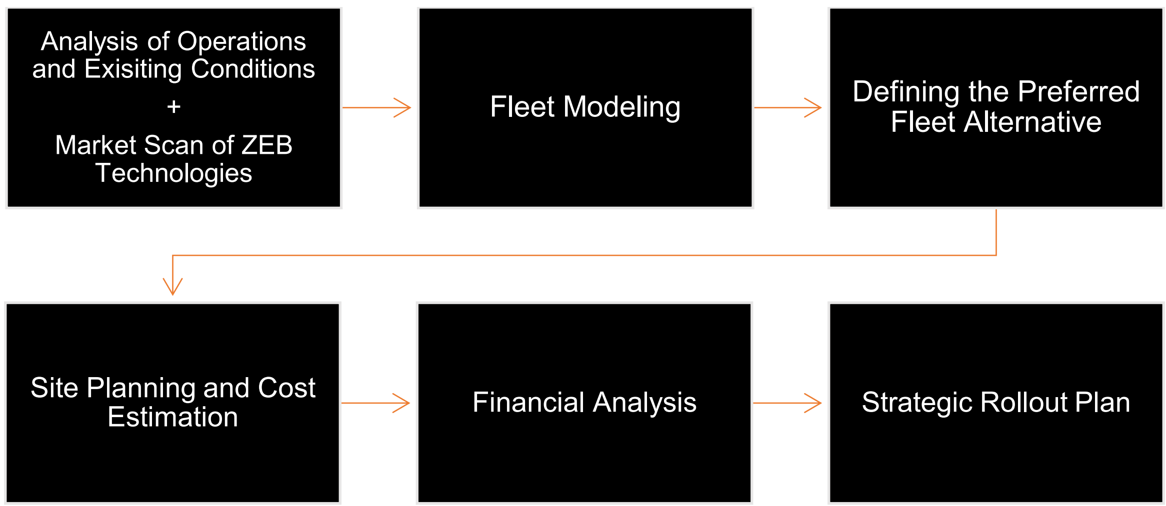
Criteria	Required Documentation
5. When a ZEB cannot be purchased by a transit agency due to financial hardship	• A resolution by the transit agency's governing body declaring a fiscal emergency • Documentation showing the transit agency cannot offset the initial capital cost of purchasing ZEBs

Taken together, CARB recognizes the challenges that transit agencies will face when adopting ZEBs and wants to avoid hardships around finances and service delivery. As such, if CTA faces certain challenges for a particular year, for example, if it does not have sufficient capital funds available to purchase a planned ZEB procurement, then CTA can apply for an exemption to CARB by documenting that CTA cannot offset the incremental cost of a ZEB compared to a conventional fossil fuel vehicle. Nonetheless, the ZEB rollout and transition plan in this document is built upon assumptions that CTA will have sufficient funding to carry out the transition. As such, the CARB ICT plan is a living document that is flexible and can be amended to account for circumstances that require exemptions or shifting of ZEB procurement or other implementation steps.

3.0 APPROACH TO ZEB PLANNING

The graphic in Figure 2 provides a high-level schematic of the major steps in this project to derive a recommended fleet concept and develop an implementation plan.

Figure 2: Schematic Representation of the Steps in the ZEB Planning Process



The first step involved a review of the existing conditions of CTA's fleet, facility, and service delivery to provide a foundation and understanding of CTA's operations and business processes that would be impacted by a transition to a ZEB fleet. An assessment of the maintenance facility provided insights into the constraints and opportunities for implementing ZEBs, as well as the condition of the facilities, buildings, and existing service cycle. CTA is a tenant at its current facility and may eventually find a new location for its operations and maintenance facility. However, without any concrete plans or locations of interest, the analysis here used the existing facility as a baseline for site planning and provides valuable information for any potential future site, such as infrastructure and space needs. A market scan was also conducted to analyze the current ZEB technologies, their limitations, as well as any in-development technologies that can help shape CTA's future ZEB fleet.

Next, we used computer modeling to simulate the performance of ZEBs on CTA's service blocks[7] and vehicle assignments. The modeling provided predicted vehicle performance, including fuel economy, operating ranges, and feasibility of the different ZEB technologies. The analysis showed that battery electric vehicles would struggle to deliver a significant amount of CTA's service and could not replace internal combustion engine (ICE) buses in a 1:1 manner. As a workaround, we worked with CTA staff to devise potential vehicle scheduling solutions that could enable CTA to operate its services with a

[7] Blocks describe a series of trips that are linked together and assigned to a single vehicle. The vehicle trips that are linked together as part of the block may cover more than one route and may also involve more than one operator during the course of the vehicle workday. The block refers to the work assignment for a single vehicle for a single service workday and includes revenue service and deadheading.

battery-electric bus (BEB) fleet by altering how it schedules vehicles and including midday charging. As battery technology improves, CTA should use an incremental approach to its deployment by operating BEBs on less strenuous and challenging services early in the deployment, and when technologies improve and the agency becomes more adept at delivering service with BEBs, CTA can electrify its most challenging routes.

Subsequently, working with CTA staff, we developed a fleet transition/implementation plan that transitions the current fleet with BEBs, along with a phasing strategy for chargers and facility modifications. Section 5.0 describes the fleet composition and recommendations and Section 6.0 describes the fleet phasing strategy. Section 7.0 describes the maintenance facility modifications required to implement and deploy the BEB fleet, while keeping in mind that CTA may eventually relocate to another bus facility.

With the identification of required facility modifications and impacts on capital and operating costs, Stantec developed a financial analysis for the ZEB rollout through 2040 (Section 8.0). Operating and planning considerations (Section 9.0, 10.0), workforce training (Section 11.0), potential funding sources (Section 12.0), service in disadvantaged communities (13.0), and greenhouse gas (GHG) impacts (14.0) are also reviewed and discussed.

4.0 SUMMARY OF KEY EXISTING CONDITIONS

The Existing Conditions Report provided a comprehensive review of CTA's existing conditions, encompassing operations, facilities, and finances to lay the groundwork for the modeling and provide an understanding of current operating conditions.

Major findings from the existing conditions report include:

- CTA serves a large, low-density service area with dispersed destinations. This presents challenges for a ZEB transition because the routes are long and midday charging or refueling is challenging as vehicles would need to travel far distances to reach the operating base.
- In 2022, CTA implemented a new service and fare structure which shifted service away from fixed route to more demand-response services.
- Calaveras Connect's revenue fleet is comprised of 11 vehicles, with two medium-duty buses, seven light-duty buses, and two vans (Table 4 and Figure 3). CTA uses mileages when assessing each vehicle's minimum useful life.

Table 4: Calaveras Connect Current Revenue Service Fleet

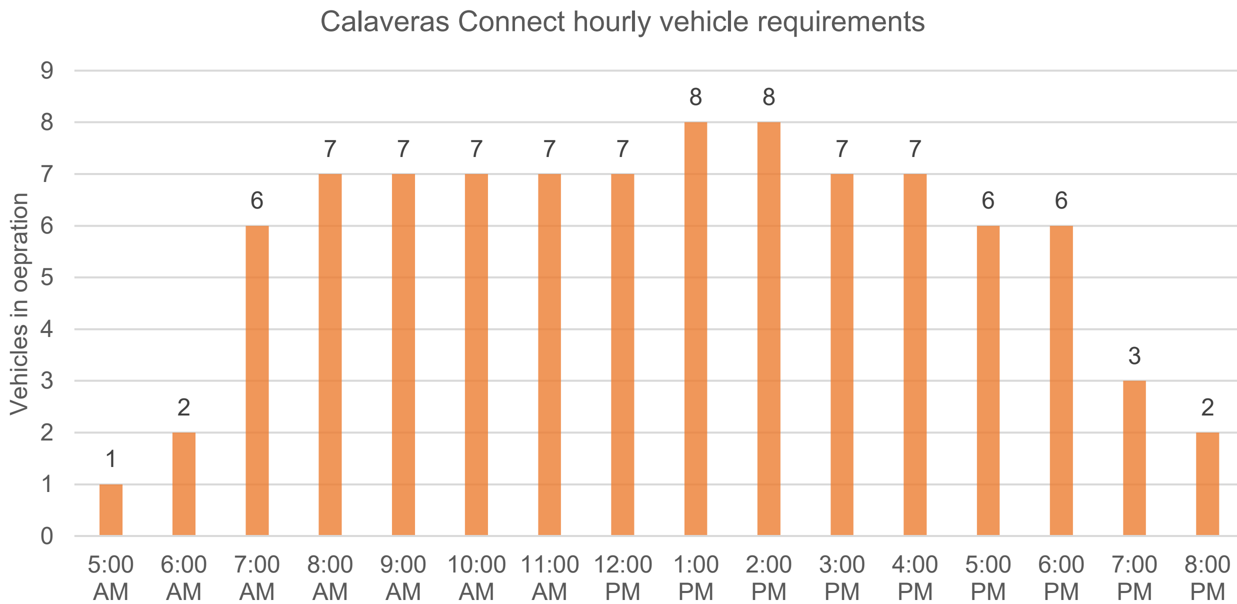
Model Year	In-Service Year	Quantity	Make	Seating capacity (amb/WC)	Fuel type	FTA minimum useful life[8]	Current age[9]	FTA minimum useful life (miles)[10]	Current mileage	Service type
2013	2014	2	Glaval	26/2	Diesel	8 years	9	200,000	• 218,399 • 222,644	Fixed route, demand response
2015	2015	2	El Dorado	21/2	Gas	6 years	7	150,000	• 225,402 • 213,110	Fixed route, demand response
2016	2016	3	El Dorado	16/2	Gas	6 years	6	150,000	• 212,909 • 210,070 • 220,197	Fixed route, demand response
2019	2019	2	Ford	17/2	Gas	6 years	3	150,000	• 53,153 • 40,568	Fixed route, demand response
2014	2015	2	Braun	6/1	Gas	6 years	8	150,000		Demand response

[8] https://www.transit.dot.gov/sites/fta.dot.gov/files/2021-11/TAM-ULB-CheatSheet.pdf
[9] Current age determined from model year, not in-service year
[10] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Useful_Life_of_Buses_Final_Report_4-26-07_rv1.pdf

Figure 3: CTA Vehicles. Cutaways (top, bottom) and Van (bottom).

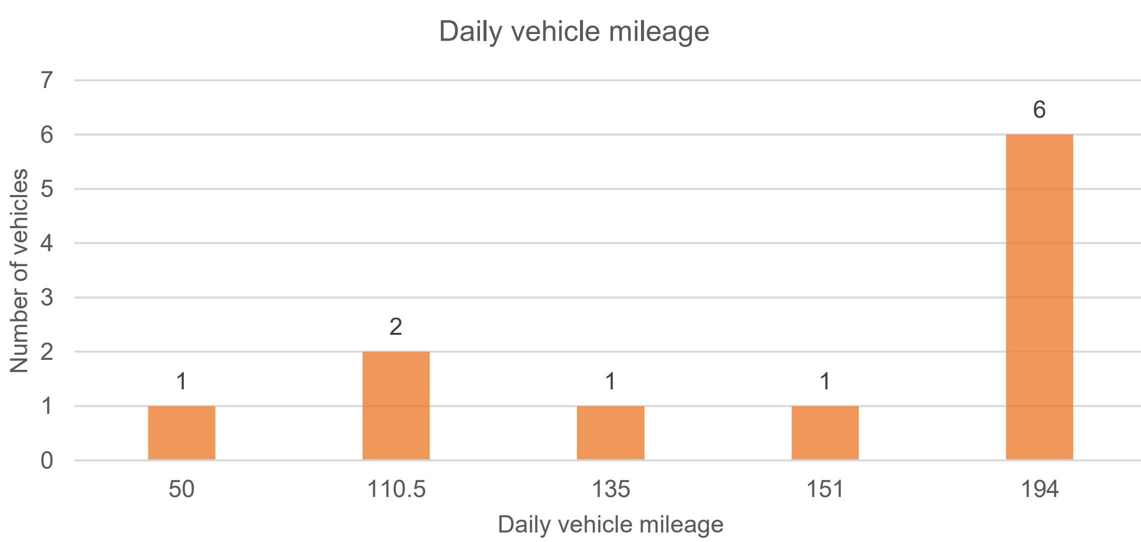
- CTA's vehicles are in operation for the majority of the service day with a peak of eight vehicles from 1:00 PM to 2:00 PM. To serve the large CTA service area, vehicles need to be in service constantly throughout the day (Figure 4).

Figure 4: Calaveras Connect Hourly Vehicle Requirements



- On average, CTA vehicles are traveling 154 miles on peak weekdays, with vehicle mileages ranging from a minimum of 50 miles to 194 miles, posing challenges for a 1:1 vehicle replacement ZEB implementation (Figure 5). For reference, the approximate range for electric cutaways is 100 miles, and 70 miles for electric vans.

Figure 5: Daily Vehicle Mileage



- Currently, CTA's largest operating expense is the operations contract, constituting between 68% and 70% of the total operating budget. Operating expenses are projected to increase by 18% between FY18/19 and FY24/25.
- CTA receives operating revenue from a variety of sources at the federal, state, and local level; CTA's largest source of operating funds come from Local Transportation Funds, FTA 5311 funds, and State Transit Assistance funds.
- ZEB adoption will increase CTA's capital expenditures due to vehicle procurement and charging equipment costs. For example, CTA purchased a battery-electric van for nearly $200,000, while a similar gasoline powered van is valued at ~$56,000. This observation demonstrates the cost premium of ZEBs over fossil fuel vehicles.

Overall, the Existing Conditions report revealed that CTA's facility, operations, and service area characteristics provide challenges for a ZEB transition. Factors like a large service area with dispersed destinations present potential challenges for range and charging needs. There are also challenges surrounding how vehicles are scheduled, with many fixed-route vehicles in operations 12+ hours a day (which could exceed range limitations of ZEBs or limit the ability for midday/opportunity charging), and a demand response fleet made up of vehicles with few ZE options that enable long daily distances. In addition, the demand response service delivery model is inherently difficult to plan for because daily service miles are dictated by demand and not adherent to a fixed schedule. While both BEBs and FCEBs were considered for CTA, as outlined under "Modeling Inputs" section, it was determined that BEBs were the preferred solution over FCEBs.

5.0 PREFERRED/RECOMMENDED FLEET COMPOSITION

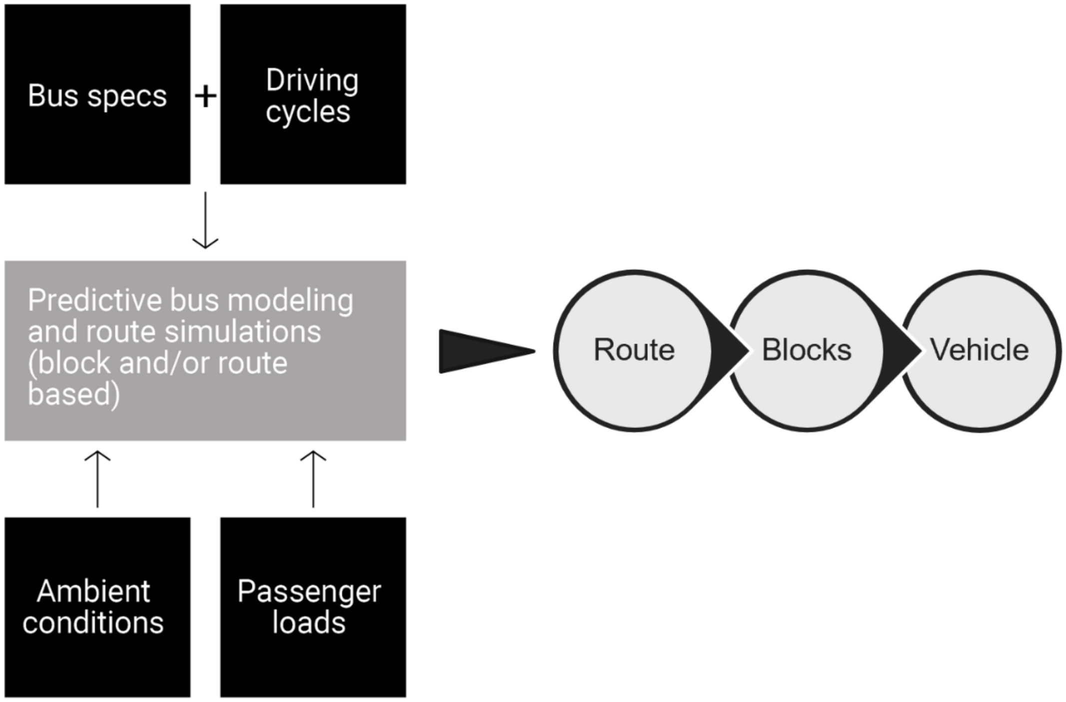
This section describes the modeling and analysis that was used to develop viable fleet concepts and specify a preferred ZEB fleet for rollout planning purposes. A fuller description of the analysis and modeling is provided in the Modeling and Fleet Concept Report that was provided to CTA as a separated deliverable during this project.

5.1 FLEET AND POWER MODELING OVERVIEW

Energy modeling uses a two-pronged approach to understanding ZEB feasibility. The two-pronged approach first examines route-level operations, and secondly, examines fuel economy by aggregating route-level outputs to provide block/vehicle level fuel/energy requirements. In this way, Stantec and CTA will understand how BEBs perform under CTA's operating conditions, providing a more realistic estimate of operating range and energy consumption, ultimately informing technology selection.

Figure 6 provides a schematic overview of the modeling process. The predictive ZEB performance modeling depends on several inputs, such as actual passenger loads, driving dynamics, topography, vehicle specifications, and ambient conditions subject to the environment in which the agency operates.

Figure 6: Modeling overview[11]



Due to CTA's recent changes to its service model that took place in 2022, in some cases, 2019 data was used to model future 2022 data when no other data was available.

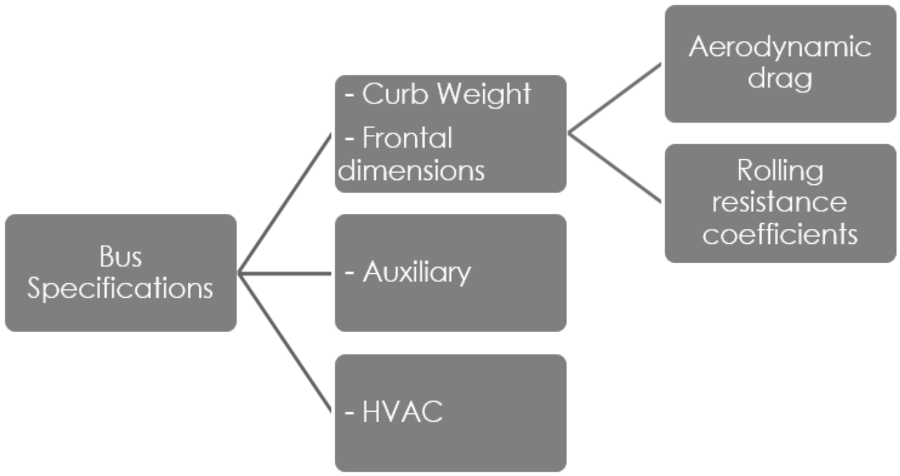
Modeling Inputs

The ZEVDecide modeling process predicts ZEB drivetrain power requirements specific to given acceleration profiles. The following inputs are included in the model to determine the feasibility of different ZEB technologies under CTA's operating conditions:

Bus/vehicle specifications: the bus specification inputs used in the modeling are shown in Figure 7. For CTA, the key BEB specifications used in the modeling process for each service type are shown in Table 5. These specifications are based on currently available models and available manufacturer information.

[11] Blocks describe a series of trips that are linked together and assigned to a single vehicle. The vehicle trips that are linked together as part of the block may cover more than one route and may also involve more than one operator during the course of the vehicle workday. The block refers to the work assignment for a single vehicle for a single service workday.

Figure 7: Schematic of the inputs for bus specifications.



As CTA operates cutaways and vans, the appropriate vehicle size was specified (for each route and block) to reflect CTA dispatching practices into the modeling. Only BEBs, and not hydrogen fuel cell electric (FCE), buses were modeled for several reasons, including:

- There are few (if any) viable and tested FCE vehicles comparable to CTA's current fleet composition.
- CTA's small fleet would translate to low hydrogen fuel demand resulting in a more expensive per-bus cost compared to BEBs, particularly if an onsite hydrogen fueling station is constructed.
- Hydrogen fueling onsite would require upgrades to the facility and construction of onsite fueling infrastructure. Offsite hydrogen fueling stations in Calaveras County are currently not available.

Table 5: BEB Specifications for Energy Modeling

BEB models	Cutaway	Van
Battery (kWh)	127	118
Curb Weight (lbs.)	14,500	14,330

BEB models	Cutaway	Van
Services modeled	Red Line Columbia College Shuttle Saturday Hopper Direct connect DAR: - Countywide - Jackson-San Andreas	Direct Connect DAR Copper/Angels to Sonora West Point-Jackson
		

Representative driving cycles: Assigning representative driving cycles, also called acceleration profiles or duty cycles, is the other major step in the energy modeling. A driving cycle is a speed versus time profile that is used to simulate the vehicle performance, and consequently, the energy use. Representative driving cycles were assigned to all routes based on CTA's operations and observed driving conditions. The driving cycles have been created from data collection of real-world operations or from chassis dynamometer tests and have been convened by the National Renewable Energy Laboratory in a drive cycle database called DriveCAT [12].

Passenger loads: As the total weight of a ZEB impacts its performance, it is important to understand and capture passenger loads in the modeling process. To examine the impacts of passenger loads and its associated weight[13], CTA provided data for each route detailing the passenger load for each route to be modeled.

Ambient temperature: The ambient temperature has a significant impact in the fuel economy of the ZEBs since it is directly related to the power output from the batteries required for the heating, ventilation, and air conditioning (HVAC) system.

Stantec developed a correlation between ambient temperature and power requirements from the HVAC system. For example, moderate daily temperatures (between 55°F and 65°F) can have a nominal power demand on the HVAC system of up to 4 kW. Colder temperatures (below 45°F) or hotter temperatures (above 70°F) can represent more strenuous loads of up to 12 kW. The power requirement for modeling purposes was set based on an annual average low temperature average of 40°F [14].

[12] NREL DriveCAT - Chassis Dynamometer Drive Cycles. (2019). National Renewable Energy Laboratory. www.nrel.gov/transportation/drive-cycle-tool

[13] Estimated average passenger weight—170 lbs.

[14] US Climate Data https://www.usclimatedata.com/climate/valley-springs/california/united-states/usca2451

Topography and elevation: CTA's service area is highly affected by elevation and topography (especially in the north and northeast). Therefore, it is important to account for the impacts of terrain and elevation on ZEB energy efficiency and performance.

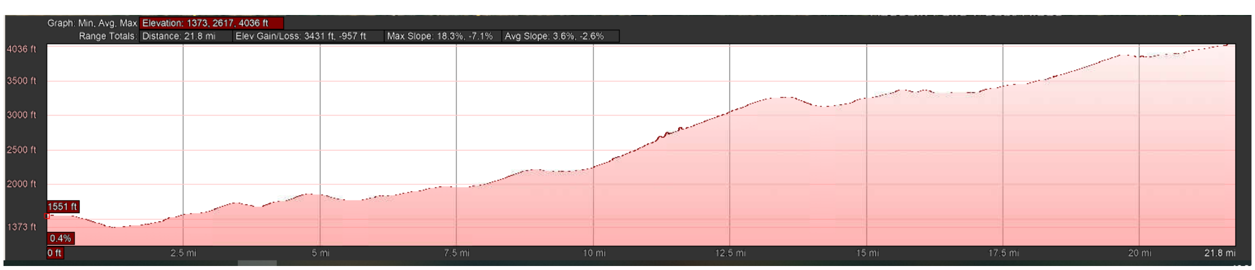
The first step in the route elevation analysis is to determine the elevation gains and losses seen across CTA's routes. Furthermore, the total elevation gains inform the maximum and average grades across each route. From there, an analysis of elevation based on route alignments was undertaken for each route (Table 6).

Table 6: Elevation Analysis

Route	Average slope	Max slope	Weighted average slope
Red Line	2.7%	10.2%	6.1%
Columbia College Shuttle	3.7%	11.3%	7.0%
Saturday Hopper	3.6%	18.3%	5.2%
Direct Connect Dial-A-Ride - Countywide	3.5%	7.1%	5.4%
Direct Connect Dial-A-Ride - Jackson	4.0%	11.2%	6.2%
Direct Connect Dial-A-Ride - West Point to Jackson	5.6%	6.6%	7.2%
Direct Connect Dial-A-Ride - Copper/Angels to Sonora	4.1%	10.8%	6.5%

Each route shapefile (derived from GTFS data) was downloaded in Google Earth to create an elevation profile and understand the total elevation gains/losses seen for each route in the system (example for Saturday Hopper in Figure 8). Additionally, the average and maximum grades for each route were similarly determined using these elevation profiles, which were used as the inputs for the topography analysis.

Figure 8: Elevation Profile Example (Saturday Hopper)

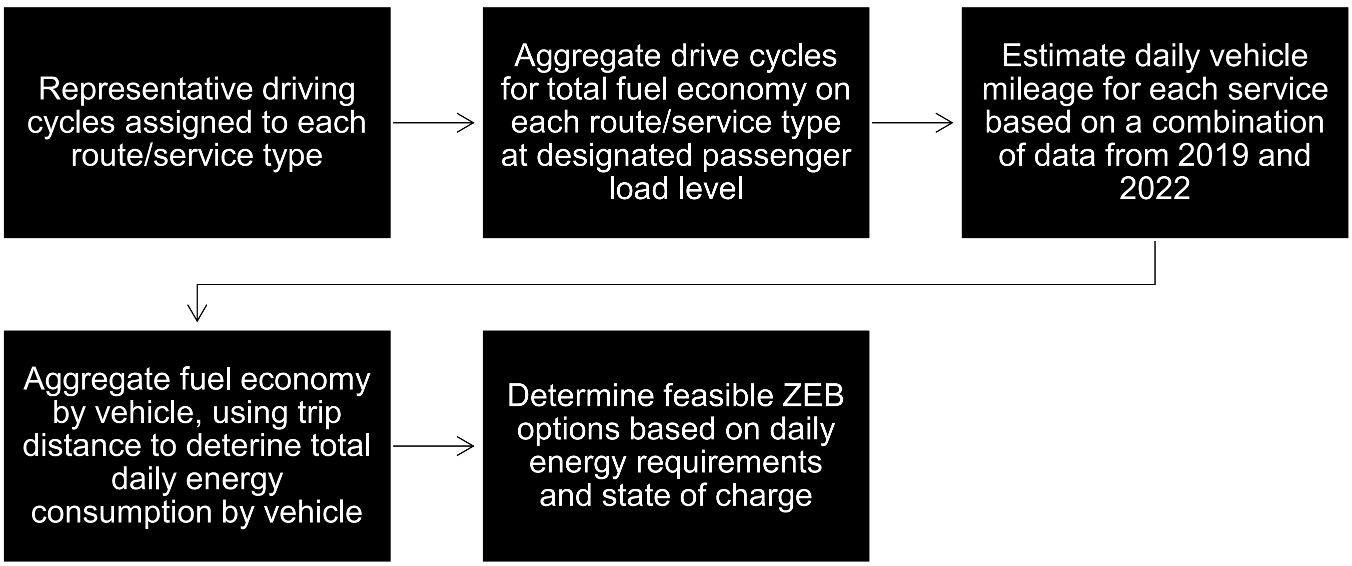


Source: Google Earth

Modeling Process

Using the inputs above, the first step in modeling is obtaining route-level fuel economy and energy use for the BEBs using the driving cycles assigned to each route/service type. Then, to account for the impacts of interlining[15], deadheading, etc., the modeling aggregates route-level results to produce a vehicle-level fuel economy and energy use metric. The process of going from route/service type to vehicle assignment is outlined in Figure 9.

Figure 9: ZEVDecide Energy Modeling Process



After the route-level modeling was completed, fuel economies were aggregated by block using a combination of 2019 and 2022 data on trip length and daily vehicle assignment mileage (using 2019 data to fill in the gaps where 2022 data was not available) to determine total energy consumption for each vehicle.

The results of the modeling provided insight into:

- Fuel economy and energy requirements
- Operating range
- BEB feasibility. This is determined through state of charge (SOC); the vehicle assignment can be successfully completed with a BEB if it can complete its scheduled service **with at least 20% battery SOC.**

[15] Interlining is a practice in the transit industry that combines two or more routes that arrive and depart from a common terminal. For example, a bus can arrive at a downtown terminal as one route and leave as a different route.

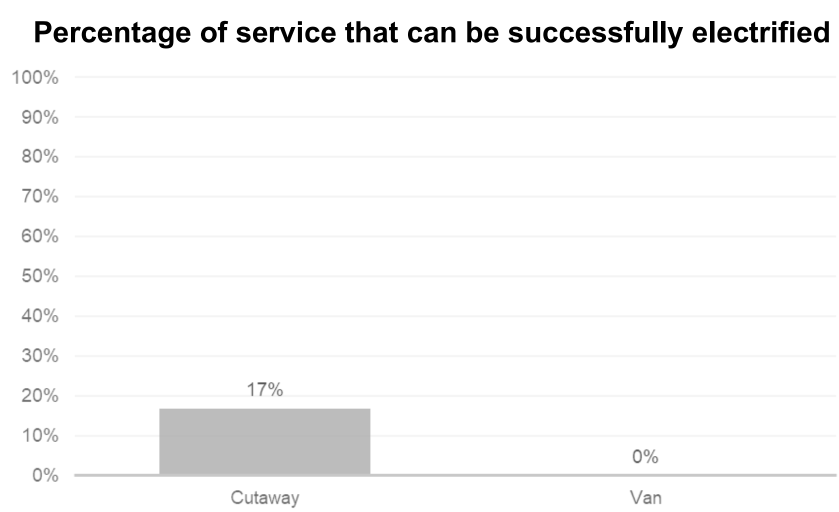
Modeling Results

The overall energy demand per block was obtained by aggregating the energy consumption from each trip according to the route-level results. As indicated above, the criteria to deem if a block can be successfully served by a BEB is if the SOC of the battery is above 20% after completing all the trips in a block[16].

The seven routes operated by CTA were modeled using BEBs. If a vehicle finishes the route with less than 20% of the battery charge remaining, then the route cannot be successfully completed using BEBs on a 1:1 replacement ratio.

The results in Figure 10 indicate that under current battery-electric (BE)-equivalents, only a small portion of vehicles (17%) can be successfully electrified. All services operated by vans were unsuccessful, and five out of six cutaways were unsuccessful. Stated differently, only one vehicle could successfully deliver its current route and service assigned if replaced with a BEB due to the extensive daily mileage.

Figure 10: Successful Services Operated by BEB Equivalents (Modeled)



Besides analyzing the overall electrification success per vehicle type, Stantec analyzed the results per service type. Figure 11 shows that electric vehicles assigned to all three fixed routes (Red Line, Columbia College Shuttle, and Saturday Hopper) would not be able to accommodate service with the currently available technology; all the vehicles fall below 20% state of charge. For example, in the case of the Saturday Hopper, a battery would need over double (250%) of current capacity to have any available power at the end of the day.

[16] OEMs recommend that a BEB charge only to 90% of its total battery capacity and not drop below 10% state of charge (SOC) to preserve battery life; dipping below 10% can void the battery's warranty.

Figure 11: Fixed-route BEB Modeling Results

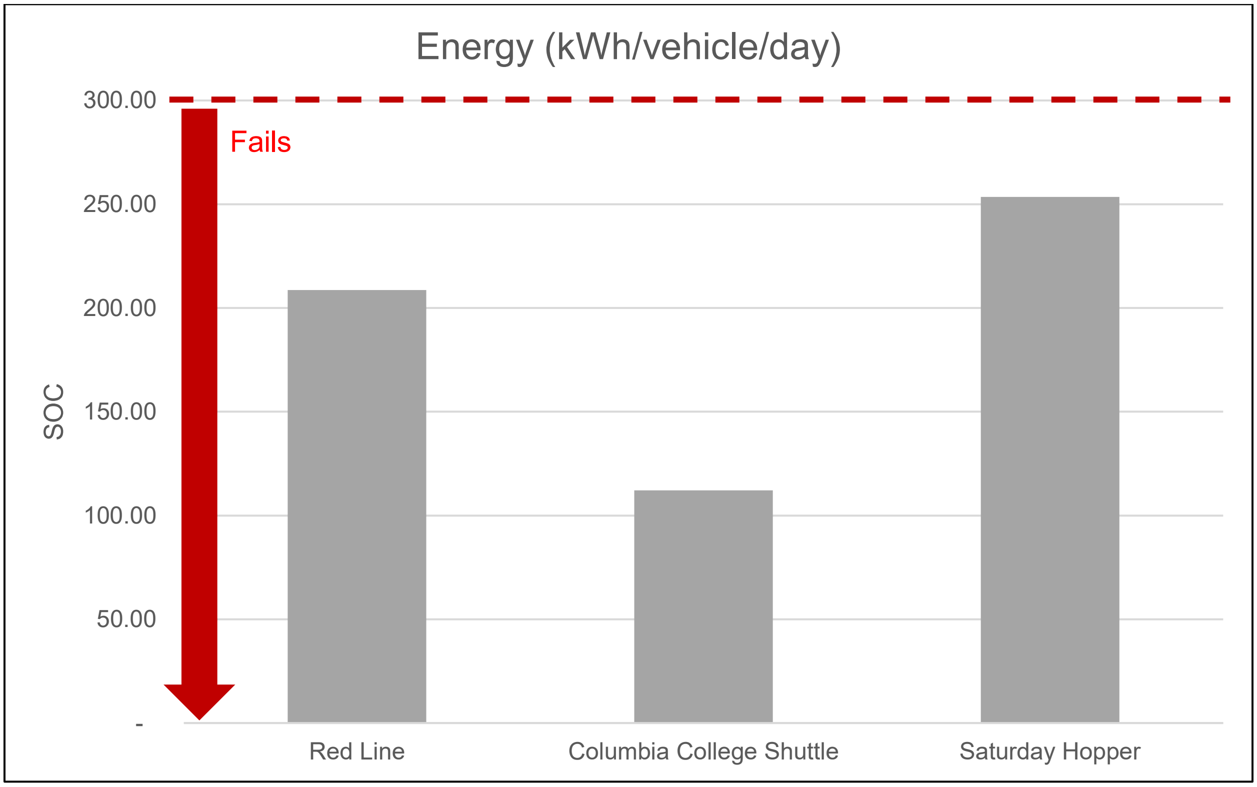


Figure 12 shows the BEB modeling results for the vehicles operating the four Direct Connect Dial-a-Ride services, including the modeling of an electric van operating the Copper/Angels to Sonora service. Three out of four services fail (i.e., fall below 20% state of charge), with only the Countywide Dial-a-Ride being successfully modeled with a BEB (returning to the station with 57% state of charge). These results indicate that operational modifications are required to accommodate using BE vehicles for the analyzed routes and services.

Figure 12: Dial-a-Ride BEB modeling results

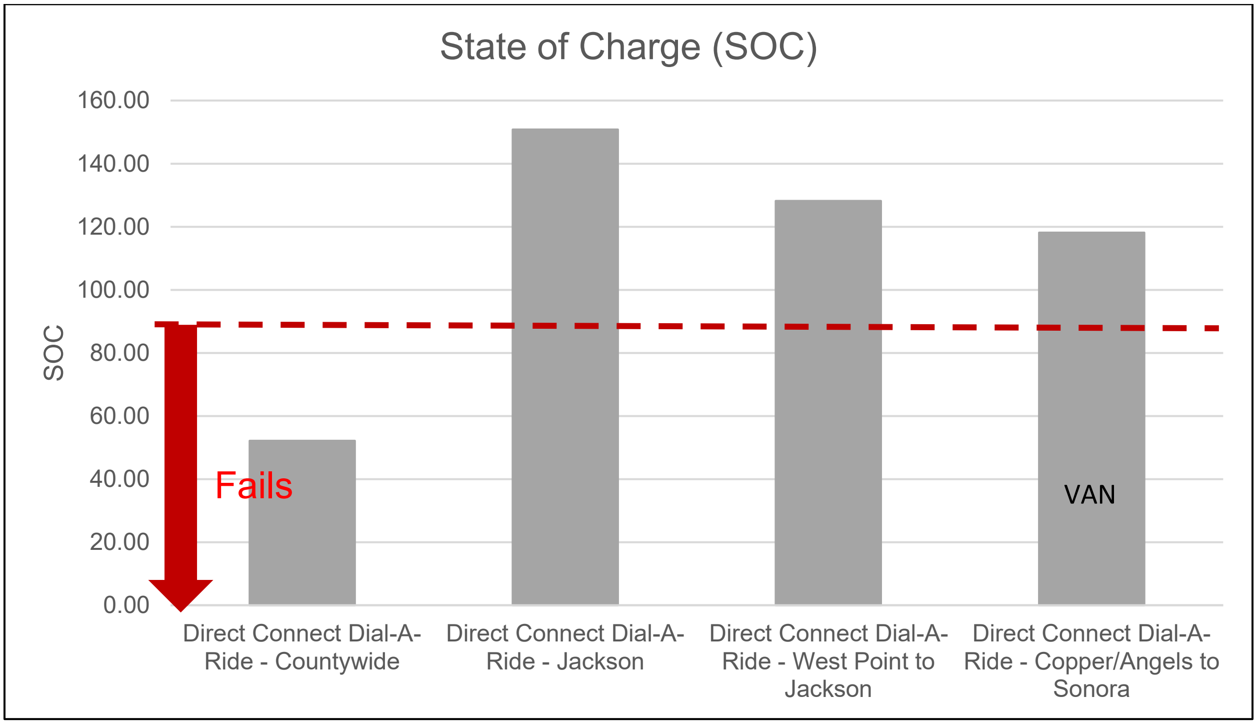


Table 7 provides a summary of fuel efficiency and maximum ranges for the modeled BEBs. The fact that electric cutaways are heavier, along with aerodynamic specifications, contributes to lower fuel efficiency compared to electric vans. However, because cutaways are equipped with larger battery packs (127 kWh) than electric vans (118 kWh), cutaways generally have a longer range than vans (101 miles vs. 71 miles).

Table 7: Average Fuel Efficiency for Fixed Route BEB Modeling Results

Vehicle type	Average fuel efficiency (kWh/mi)	Max range
Cutaway (127 kWh battery)	1.02	101.10
Van (118 kWh battery)	0.90	71.49
Overall	1.00	86.60

5.2 ZE FLEET RECOMMENDATIONS AND IMPLICATIONS

The feasibility of ZE implementation depends on many factors, including vehicle specifications, elevation, route mileage, and climate. Through modeling, we found significant challenges for electrification of CTA's services based on these factors. Therefore, the current fleet cannot be replaced with ZEVs at a 1-to-1 ratio with current technology.

This finding creates the need for a new approach to satisfy the CARB fleet transition requirement. We propose replacing the current fleet with an equivalent number of ZEVs and increasing the fleet size by purchasing three new vehicles. This strategy, coupled with operational changes, would help address range limitations and help maintain existing service levels.

As discussed above, given that hydrogen fuel cell vehicles are currently immature and not prevalent in the market, together with the lack of a viable hydrogen supply chain in Calaveras County, FCEBs were not chosen as the preferred option. Instead, the approach taken used the current vehicle dispatching schedule to determine how vehicle assignments could be split into smaller, feasible portions for BEBs. By splitting vehicle assignments into smaller ‘pieces’, we also incorporated midday vehicle recharging so that a vehicle used earlier in the day could be dispatched again later in the day. By using this strategy, the need to greatly expand the fleet was reduced (e.g., such as doubling the fleet size to provide the same level of service). An iterative process was used to determine the fewest number of ZE vehicles needed to operate CTA’s services while remaining within the 20% SOC threshold of BEBs.

Columbia College and Red Line shuttle service, as well as Direct Connect DAR service currently use or dispatch five different diesel/gas cutaways or vans on a typical day. Our proposed fleet concept would split single vehicle assignments into two, and vehicles used in the morning would be recharged in the midday and re-used in the afternoon.

For example, as shown in Table 8, DAR West Point Jackson had a single vehicle operate from 8:00 AM until 4:00 PM—this duty is too extreme for BE cutaways as modeled. The proposed concept has one passenger van (V1) operating vehicle assignment 3a from 8:00 AM until about 1:00 PM, and then returning to the yard for recharging. The rest of the DAR West Point Jackson service day, in this example, would be completed by vehicle V2 from about 1:00 PM until about 4:00 PM (vehicle assignment 3b).

The Red Line currently uses six different cutaway vehicles on a typical day. As with the approach for the DAR services, the proposed fleet concept would split single vehicle assignments on this route into two new assignments, and vehicles dispatched in the morning would be recharged in the midday and re-used in the afternoon.

For example, vehicle assignment 1 for the Red Line had a single vehicle operate from 5:40 AM until 1:48 PM—this duty is too extreme for BE cutaways as modeled. Therefore, the proposed concept has one vehicle (C1) operate vehicle assignment 1a from 5:40 AM until about 10:00 AM, return to the yard for recharging, and then C1 would be dispatched for vehicle assignment 4a later in the day, from about noon until about 5:00 PM. Vehicle assignment 1b, in this example, would be completed by vehicle C8 from 10:00 AM until about 2:00 PM, when C8 would return to the yard for recharging and then be deployed to vehicle assignment 4b from 5:00 PM until about 8:00 PM (Table 8).

It is important to note that the conceptual vehicle assignments proposed are hypothetical and conceptual in nature. These were vetted and discussed with CTA operations staff to evaluate the minimum vehicle requirements of their fleet. However, the detailed logistics for swapping and recharging vehicles throughout the day or how to schedule and assign vehicles will need further analysis and planning during implementation and testing. Other outcomes of this operating scheme will add additional deadhead mileage to the fleet as vehicles are swapped out. Furthermore, additional operators may be required to implement this scheme or at the very least, operator shifts will likely require restricting to account for vehicle exchanges. More information on these conceptual operating parameters can be found in the Energy Modeling and Preferred Fleet Concept Report (in Section 5, p. 20).

Table 8: Proposed Vehicle Assignment Examples

Service	Current Operations	Proposed Concept
DAR West Point Jackson	Single vehicle 8:00 AM – 4:00 PM	• V1 completes vehicle assignment 3a: 8:00 AM – 1:00 PM [returns to yard to recharge] • V2 completes vehicle assignment 3b: 1:00 – 4:00 PM
Red Line	Single vehicle 5:40 AM – 1:48 PM	• C1 completes vehicle assignment 1a: 5:40 – 10 AM [returns to yard to recharge] • C8 completes vehicle assignment 1b: 10:00 AM – 2:00 PM [returns to yard to recharge] • C1 completes vehicle assignment 4a: 12:00-5:00 PM • C8 completes vehicle assignment 4b: 5:00 – 8:00 PM

After careful consideration of the modeling results, operational realities, discussions with agency staff and stakeholders, and logistical considerations, Stantec developed the preferred fleet concept presented in Table 9. This fleet concept proposes replacing the current fleet with BE vehicles and only modestly expands the CTA fleet over time to account for technological limitations.

Table 9: CTA Preferred Fleet Concept

	Current Vehicles	Proposed ZE Vehicles
Total vehicles used in a day	8 cutaways 1 van	10 cutaways 2 vans

	Current Vehicles	Proposed ZE Vehicles
Vehicles at peak	7 cutaways 1 van	8 cutaways 2 vans
Spare vehicles (off-peak)	2 cutaways 1 van	3 cutaways 1 van
Total fleet size	**9 cutaways** **2 vans**	**11 cutaways** **3 vans**

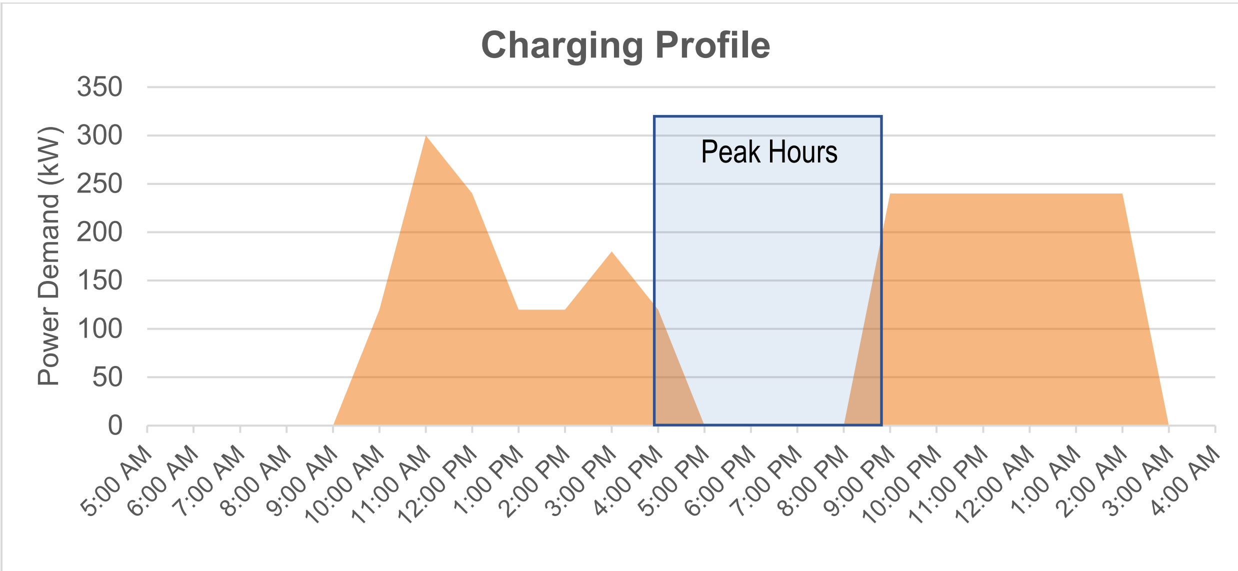
There are several implications to this fleet concept:

- Expanding the fleet compensates for the limited range of current electric cutaways (~100 mi) and vans (~70 miles) while allowing CTA to maintain the current level of service;
- The pace of fleet growth is reduced thanks to vehicles being shared among routes;
- The proposed fleet size provides flexibility for maintenance and if there are service increases; and
- The fleet and fleet composition is not ‘oversized’ for technology purposes/limitations, but rather is sized for CTA ridership demand.

This fleet concept requires investment in charging equipment to sustain the gradual transition to a 100% ZE fleet. Given the fleet operations and considering avoiding peak network times for charging, five low voltage charging stations of 60-kW each with two dispensers (for a total of ten dispensers) would be sufficient to support the fleet charging. These 60-kW chargers are more powerful than the 16.8-kW charger currently on order to support CTA’s recently procured electric Ford Transit passenger van. The reason is the need to charge quickly during the midday; a 60-kW charger could, in theory, fully charge the vehicles modeled in this study within two hours, whereas the lower power 16.8-kW charger could take up to five hours.

The proposed charging profile (Figure 13) would create a peak power demand of 300 kW, and no charging would be required between the hours of 3:00 AM and 9:00 AM. Additionally, the charging strategy minimizes charging between 4:00 PM and 8:59 PM to avoid using electricity when it is most expensive (network peak hours).

Figure 13: Facility Charging Profile



6.0 FLEET PROCUREMENT SCHEDULE

Stantec prepared a fleet phasing and purchase schedule for the proposed expanded fleet of 14 vehicles. Table 10 shows the proposed fleet purchase schedule and bus fleet summary.

Several factors were considered in the development of this replacement schedule:

- CARB has set out requirements that the transition to 100% ZE fleets be completed by 2040 and that 100% of new vehicle purchases are required to be ZE starting in 2029. The earliest procurements for a small fleet operator need to take place in 2026 with at least 50% of all purchases being ZE starting in that year.
- CTA currently operates several vehicles that are past their scheduled replacement, and under the CTA Board direction, these must be transitioned promptly to ZE technology in a fiscally responsible manner.
- Useful life benchmarks (ULB) of zero-emissions vehicles must be taken into consideration to ensure that vehicles are safe and in good repair. For this analysis, we used a ULB of eight years for diesel cutaways and six years for gas cutaways and vans; ZE ULBs were assumed to be the same as their fossil fuel counterparts.

Table 10 shows the purchase schedule of diesel/gas and ZE buses, with the timeline extending from 2022 to 2040 (the CARB-mandated final year for 100% ZE fleet transition). Table 11 details the ZEB fleet composition over time, as vehicles are purchased. Table 10 also notes bus purchases that are replacing retiring vehicles from those that are added to the fleet to support the BEB transition (due to technology limitations). CTA is not considering converting any conventional buses to zero-emission buses.

Based on the concept schedule below, the table shows that CTA will meet and exceed all the CARB-mandated deadlines for ZEB purchases and transitions.

- ZEB purchases begin in 2023, with the mandate starting in 2026.
- 100% ZE fleet replacement must be completed by 2040, and CTA could complete this requirement by 2035, based on this schedule. Actual phasing will strongly depend on the ability of CTA to procure competitive funding to finance capital requirements of the transition.
- The plan shown below is a 'living' framework in that it is intended to show an ideal procurement, but actual procurement will depend not only on financial realities, but the ability of manufacturers to build and deliver the vehicles within a reasonable amount of lead time. We note that CARB defines a purchase when a transit agency has identified, committed and encumbered funds and executes a notice to proceed to begin production of a bus, or a written purchase agreement that specifies a date to start production, or a signed lease agreement. As such, CTA can issue purchase orders and take delivery at a later date, if necessary.

Table 10: Proposed Fleet Purchase Schedule

FLEET FORECAST	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Diesel/Gas Purchases	-	2	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
ZEB purchases	-	1	-	-	1	1	-	2	1	3	1	1	2	1	1	1	-	3	1
Total ZEB in Fleet %	0%	9%	9%	9%	18%	27%	27%	45%	55%	73%	83%	92%	100%	100%	100%	100%	100%	100%	100%
ZEB purchase percentage		33%	0%	0%	50%	50%	NA	100%	100%	100%	100%	100%	100%	100%	100%	100%	NA	100%	100%
Added vehicles	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-
Total Vehicles in Fleet	10	11[17]	11	11	11	11	11	11	11	11	12	12	12	13	14	14	14	14	14

Table 11: Proposed Bus Fleet and Charger Summary

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
ZEB Cutaways	0	0	0	0	0	0	1	1	3	4	6	8	9	10	11	12	12	12	12	12
ZEB Vans	0	0	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total ZEBs	0	0	1	1	1	2	3	3	5	6	8	10	11	12	13	14	14	14	14	14
Non-ZEBs	11	10	10	10	10	9	8	8	6	5	3	2	1	0	0	0	0	0	0	0
Total Fleet	11	10	11	11	11	11	11	11	11	11	11	12	12	12	13	14	14	14	14	14

Infrastructure Phasing

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Chargers with dual dispenser					2				2			1								

[17] One vehicle will be purchased in 2023 to replace a vehicle that, due to an accident in 2022, is unusable. As such, to restore the total fleet size to 11 vehicles, CTA will need to replace this vehicle; however, this vehicle is not for expansion purposes, which is why this vehicle is not attributed in the "Added vehicles" row in Table 8.

7.0 MAINTENANCE FACILITY INFRASTRUCTURE MODIFICATIONS

This section outlines the proposed facility modifications for BEB implementation at CTA's bus operations and maintenance facility. The master plan option has been developed proposing ground-mounted dispensers. The facility has sufficient space for ground-mounted dispensers, avoiding a reduction in parking space while keeping the yard flexibility since all of the equipment can be located along the edge of the property and at the rear of the parking spaces.

Since the liquid fueling systems used by the CTA are currently offsite, there is no need to phase out and remove the fueling equipment as the fleet shifts to BEB vehicles. Phasing of the BEB charging system infrastructure installation will be relatively simple and can be carried out with minimal impacts on continued operations. As operators currently fuel the vehicles at the offsite location, work rules do not preclude operators from 'fueling' (charging) and as such, operators (or bus servicers, depending on when the bus needs to be charged) would be responsible for plugging in buses for charging each day.

We recognize that CTA's current facility is leased and not owned by the County. As such, infrastructure investments and alterations to the yard will need to be legally vetted with the landlord and the County will need to work together with the landlord and the utility, PG&E, when preparing and implementing installation of the charging equipment. Moreover, while CTA may be exploring the possibility of relocating to new site/facility, the information provided below, particularly in Section 7.1, can be used by CTA for any site; the specific locations of chargers and other infrastructure will certainly vary depending on the actual site. Detailed design will be required to ready CTA for the implementation and deployment of BEBs.

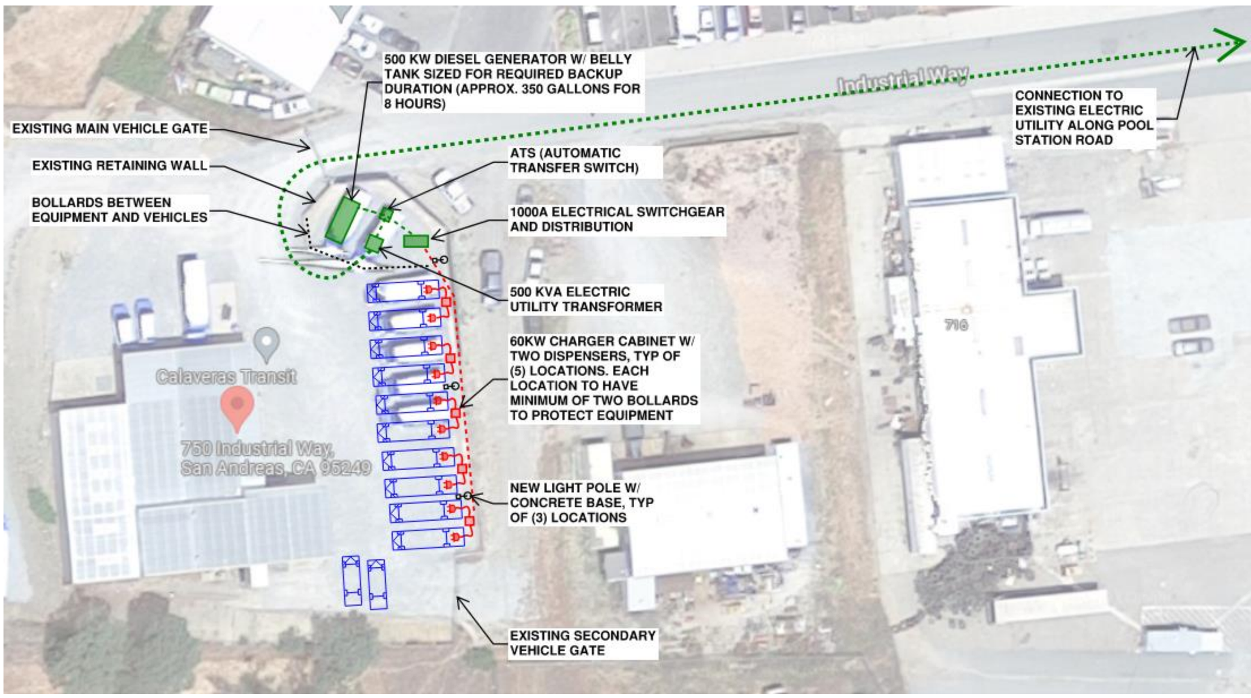
7.1 PROPOSED MAINTENANCE FACILITY MODIFICATIONS

The following summarizes the proposed improvements for the ground-mounted dispensers. While the site planning is depicted at CTA's current site (Figure 14), these proposed needed modifications can provide guidance for CTA at any potential facility:

- A new 500 kVA transformer and 1,000 A switchboard to provide adequate additional power to the facility, along with associated equipment pads and bollards;
- A new 500 kW generator with 350 gallons of onsite diesel fuel storage in order to support 100% service for one day; the current calculation assumes fuel needed for approximately one day of outage;
- New automatic transfer switch between generator and switchgear;
- A minimum of five 60-kW vehicle chargers with a 1:2 charger-to-dispenser ratio (SAE J1772-compliant) to serve a maximum of ten active (in revenue service) cutaway and passenger van vehicles;
- Equipment pads and associated bollard protection around chargers and dispensers;
- Power main feeder and sub feeders;

- Communication system panel/distribution cabinet and conduits to each charger;
- Pavement/base replacement/repair for trenching associated with electrical distribution for locations where new electrical service and switchboard will be allocated;
- New site lighting along east property line to ensure adequate lighting levels for plugging in vehicles and operation of chargers; and
- No proposed modifications to the buildings.

Figure 14: CTA ZEB Site Conceptual Master Plan



7.2 GRID CONNECTION UPGRADES

The facility will require new electrical service connections from PG&E. The utility will likely require that a service study be performed to identify any transmission or distribution system upgrades that may be needed to support the additional power demands from the bus chargers. It will be up to the utility to determine if the local power distribution system has the capacity to serve CTA's new charging loads as well as any other planned loads in the area.

The recommendations here are focused on those infrastructure upgrades that are to be located on the facility property and do not include any required utility system upgrades that the service study may identify. The extent and timing of the system upgrades will determine the net cost to the agency. Nevertheless, there is a possibility that the current transformer can support a small portion of BEB fleet without major upgrades. To evaluate this, CTA would need to coordinate with PG&E and conduct a load assessment for the current transformer to determine how many chargers can be connected as an interim step to deploy BEBs prior to completing major grid connection upgrades.

As described in Section 5.2, the proposed BEB charging system would require a new 300 kVA, 480 V, 3-phase service from PG&E to serve the entire fleet. To access this level of service, it is anticipated that a new PG&E service will be required and fed from the utility distribution lines running along Pool Station Road. The total BEB charging demand is significantly greater than the existing building electrical feeder capacity and it is typical to have a dedicated electrical feed for the charging equipment that is separate from the building feeder. This configuration simplifies operations and allows for dedicated BEB charging metering which can be necessary to take advantage of utility incentive rate structures. For example, PG&E has a dedicated time-of-use (TOU) where no demand charges are currently levied to the user and where only certain hours of the day are 'peak' hours (i.e., the most expensive time to charge vehicles), typically between 4 pm and 9 pm. Having a dedicated meter for electric vehicles charging qualifies CTA to subscribe to such TOU rate and will also allow a direct view into the total amount of power and energy that is being used to operate the vehicles.

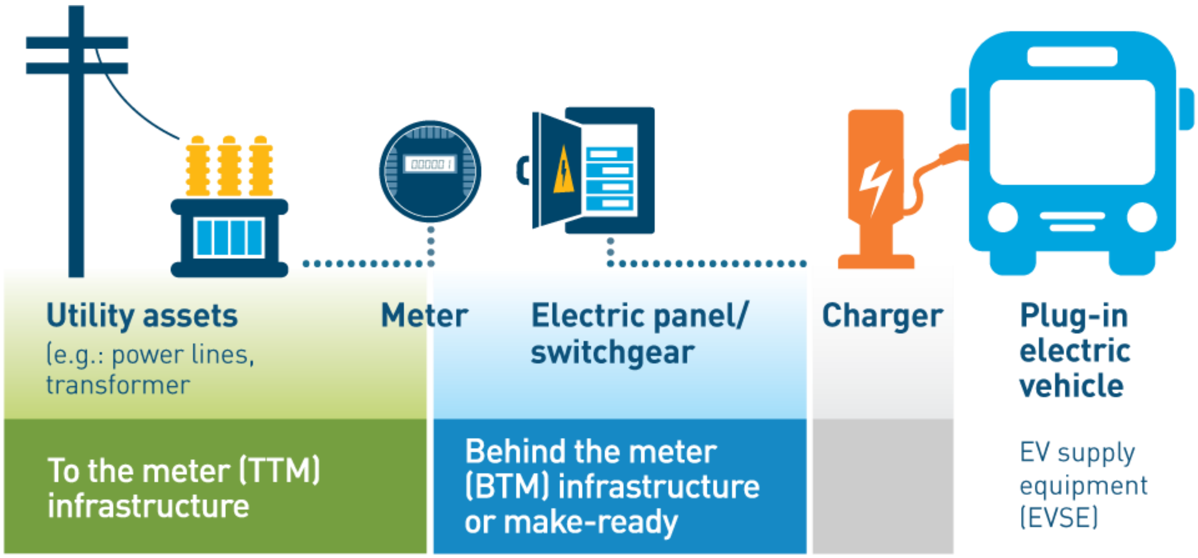
7.3 PG&E ELECTRIC VEHICLE (EV) FLEET PROGRAM

PG&E is the investor-owned electric utility in Calaveras County and throughout large swaths of California. PG&E is supporting the deployment of EV fleets for residential, commercial, and public fleets in several ways, including tariff structures providing low rates during overnight recharging, discounted grid connection upgrades, and rebates for equipment and chargers.

PG&E's EV program, called EV Fleet[18], could provide CTA with discounts on electrical upgrades if CTA's landlord signs an agreement with PG&E providing easement allowance as well as if CTA adheres to the procurement of a minimum of two EVs and chargers over a period of ten years under the behind the meter infrastructure program (Figure 15). PG&E does require vehicle purchase orders and commitments for continued ZE vehicle procurements. Additional stipulations include claw back levies if the installed infrastructure is not utilized to its capacity. Furthermore, a minimum of ten years of operation of the PG&E installed equipment is part of the agreement, which could be challenging for CTA given that its facility is leased rather than owned.

[18] https://www.pge.com/en_US/large-business/solar-and-vehicles/clean-vehicles/ev-fleet-program/ev-fleet-program.page

Figure 15: PG&E EV Fleet Program Schematic. *Source: PG&E*



The EV Fleet program also offers incentives of up to $9,000 per transit bus and Class 8 vehicle, or up to $4,000 for school buses and other vehicles to build out the necessary infrastructure to convert to an electric fleet; the maximum number of vehicles per site is 25. The program also offers charger rebates of up to 50% of the cost of the charger or a specified maximum depending on power rating. For the recommended 60-kW chargers, PG&E could cover 50% of the cost of the charger, up to a maximum of $25,000.

It is highly recommended that CTA, the facility landlord, and PG&E work together to understand the ability and implications of the EV Fleet program for CTA's transit fleet. In theory, if CTA pursues this program, the CTA could benefit from substantial cost savings around charging infrastructure and electrical upgrades.

One potential risk for CTA is waiting too long before entering the EV Fleet program, as the program's future beyond the next 5 years is unknown as the funding begins to be committed to more and more fleet conversions across the state.

The key steps involved in applying to the EV Fleet Program include:

1. Contacting the local PG&E client representative to discuss CTA's EV plans and understand grid capacity;
2. Apply through PG&E's online portal: https://energyinsight.secure.force.com/EVFleet/;
3. Complete a legal review of the terms and conditions[19] and EV Fleet Easement allowance[20]; and

[19] https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/ev-fleet-program/PGE-EV-Fleet-Program-Offer-Letter-Contract.pdf
[20] https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/program-participants/easement-template-rev3.pdf

4. Ensure the charger(s) to be purchased are on the approved charger list[21].

Once approved, PG&E will conduct a service study and begin developing a project schedule for the installation of chargers and electrical upgrades. As mentioned above, purchase orders for at least two electric vehicles and two chargers are required.

7.4 COMMUNICATION INFRASTRUCTURE

Infrastructure for data communications within the charging system will include IP Ethernet wiring between each charger and its associated dispensers, as well as between each charger and a local data switch. The actual wiring will be conventional Cat 6 Ethernet cable between devices or fiber, which would require a telecom cabinet. As the maximum length allowed for ethernet is 328 feet, the dispensers cannot be too far from their respective charger. Although longer distances are possible with fiberoptic cable, the DC power cables that need to run parallel with the ethernet cables begin to have problems with voltage drop at this distance, so 328 feet is a recommended limit.

Once the ethernet lines from each charger are routed back to the facility's data switch, the data can be contained within CTA's local network and managed directly by the agency. Alternately, the data can be routed to a cloud-based system—as needed to provide smart charging and data aggregation—that is managed by a third party and/or is provided by the charger manufacturer. However, this would likely require coordination and approval of security and access, as it would necessitate outside entities operating within CTA's local network. Additionally, it is recommended for CTA to implement a Wi-Fi network in the yard for smart charging communication to buses while any other communication upgrade is occurring or as an alternative to traditional communications systems.

7.5 FIRE PROTECTION CONSIDERATIONS

With the implementation of BEBs, fire protection and life-safety concerns can be significant. However, due to the relatively new advent of these associated technologies, building and fire protection codes have not specifically addressed most of these concerns. National Fire Protection Association (NFPA) 855 'Standard for the Installation of Stationary Energy Storage Systems' is a standard that can potentially be applied to BEB storage, but this particular standard is excessive relative to the capacity of the batteries onboard buses and considering all of CTA's buses are stored outside. The need for enhanced fire protection systems has not been determined as a baseline requirement for BEB implementation and would be left up to the discretion of the local fire marshal and the local building officials. The need for additional fire lanes or fire 'breaks' within long continuous rows of bus parking may need to be discussed with the local fire department but is unlikely considering the size of the fleet stored onsite and the relatively open nature of the site with drive aisles between all of the bus parking.

If CTA decides to install photovoltaic solar canopies above the buses parking stalls, an NFPA 13 compliant automatic sprinkler system could be required because the canopy has a 'use' underneath it as defined by the California Fire Code.

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21 https://app.powerbi.com/view?r=eyJrIjoiZWE0Mjg4MjctNjZiYi00MjhmLWFiYWEtMzBiODM2YTFhZTdlIiwidCI6IjViMmE4ZmVlLTRjOTUtNGJkYy04YWFlLTE5NmY4YWFjYjFiNiIsImMiOjZ9

Furthermore, all modifications to the facility should be reviewed with the local Authorities Having Jurisdiction (AHJs), in particular the fire marshal. Fire truck access to the site and hydrant access will need to be reviewed and approved by the pertinent AHJs prior to implementation of any additional infrastructure for charging equipment or solar canopies. However, since the site is designed for bus movements, fire truck access is relatively straightforward and should be accommodated without significant changes to the facility.

In summary, no fire protection systems are required for minimal BEB implementation but considerations for covered canopies could trigger additional fire protection system upgrades to the facilities.

7.6 FALL PROTECTION AND SAFETY INFRASTRUCTURE CONSIDERATIONS

Fall protection systems are recommended for any vehicle maintenance and inspection shop but considering that CTA only operates cutaway vehicles, it is unlikely that additional fall protection systems would be required to safely access the rooftop of buses for potential battery inspection and maintenance since it is unlikely that the batteries will be mounted on the roofs of these vehicles. If considerable rooftop access is necessary in the future, the agency should consider additional fall protection systems in the shop.

7.7 EMERGENCY BACK-UP PLANNING

Transit agencies need to consider the portion of service (and thus of their BEB fleet) that will be deployed or operated during grid-outage conditions. Calaveras County, like much of the area, is subject to emergency public safety power shutoff and ensuring that vehicles can charge during shutdowns is essential not only to maintain transit service, but enable charging for vehicles used during potential emergency evacuation situations.

Some transit agencies consider the use of a battery electric storage system (BESS) to provide temporary relief; however, these additional assets are capital intensive and require favorable energy policies to compensate such facilities for the additional services a BESS can provide.

For the purposes of the site planning and cost estimating, Stantec assumed back-up power will be provided via a diesel fired 500 kW generator with a storage capacity for 500 gallons of diesel in order to serve one revenue day at 100% service levels. CTA already has an emergency generator at its facility, but this generator can only support the operations of the facility, and does not have sufficient capacity to back-up electric vehicle chargers. See Figure 16 for example generator installation.

Figure 16: Typical Stationary Back-Up Diesel Generator with Belly Tank Fuel Storage

If CTA wishes to operate for more days during an emergency, the size of generator will stay the same, but the required quantity of fuel will scale linearly. The total amount of fuel required to be stored onsite will depend on the anticipated duration of the utility electrical outage and the amount of time required to receive a fuel delivery of diesel fuel, as well as on environmental regulations and local policies. Routine maintenance and checks will be required to ensure that the generator is in good working order and that the diesel fuel is usable.

Adequate space is available on-site for either a new permanent generator or accommodation for a mobile generator with load bank connection. The generator is placed relatively close to its respective distribution panel. The location was determined to attempt to minimize the reduction of parking and minimize disruption to the site. The proposed generator locations are indicated in Figure 14. If permanent generators are installed, bollards should be installed surrounding the entire electrical equipment yard, but if a mobile generator is chosen as the preferred method of backup power, then the protective elements should be removable or installed in a manner to allow a mobile generator to be parked near the load bank cabinet to minimize the connection cable distance.

A permanent generator on-site will require an additional permit by the Air Quality Management District (AQMD) and will have annual limitations on the durations it is allowed to run. However, a temporary mobile generator that has been certified by the CARB would not require a permit by the AQMD but will have further restrictions on when it can be used such as actual or imminent blackouts. Under any scenario, CTA should consider close coordination with both the AQMD and CARB as part of any plan to install a generator at the facility.

While diesel-fired generators will provide emergency back-up power, another potential avenue for resiliency is through renewables, such as solar energy generated through photovoltaics (PV).

Several agencies have deployed solar PV assets to generate renewable energy to power functions like administration buildings. With the adoption of a BEB fleet, additional harvesting of solar PV energy, together with storage of this energy in a BESS, can be used to charge a portion of the fleet with energy that does not come ‘from the grid’. As such, this strategy could be used to diminish some of the costs associated with charging, particularly during peak time-of-use periods.

Nevertheless, solar arrays and stationary batteries have limitations. The power generated with solar PV arrays will likely account for a small portion of the energy requirements of a BEB fleet, and in the case of stationary batteries, once they have been discharged to charge a BEB, they need to be recharged, which typically takes several hours. In the event of an emergency, relying solely on solar energy is impractical. As such, deploying complementary fossil fuel-powered generators is necessary to generate the power required to charge a BEB fleet.

In terms of an implementation strategy, the plan developed here does not include solar PV and/or stationary BESS. Additionally, PG&E’s incentive EV Fleet program prohibits additional distributed energy resource connections, such as a connection to on-site generators, solar PV, or battery (energy storage) systems to the PG&E meter and switchgear. This stipulation can significantly impact the financial feasibility of solar PV and battery storage systems. In the future as CTA deploys BEBs, CTA can re-examine the practicality and economics of a solar PV and/or stationary BESS system.

8.0 FINANCIAL EVALUATION AND IMPACTS

The financial evaluation for CTA's ZEB rollout plan consisted of the modeling of a Base Case that assumed continued use of diesel and gasoline vehicles or 'business-as-usual' and a ZEB Case that assumed a transition to 100% ZEB operations and the phasing out of diesel and gasoline vehicles, along with a comparison between the two scenarios to quantify the financial impacts of the transition and of ZEB operations. Stantec's cost estimator, Jacobus & Yuang, Inc., provided a detailed cost estimate of materials, soft costs, constructions, and other line items related to facility modifications for the ZEB case (more information is provided in Section 7.0). Please note that facility modifications do not consider the one charger CTA is currently procuring to charge the one electric van that has been ordered and slated for installation in late 2022 or early 2023.

The main assumptions for the cost modeling are:

- Financial modeling reflects real 2022 dollars (2022$);
- A 7% discount rate was applied for all calculations, as per USDOT guidance;
- The chief source of information regarding fleet planning is CTA's 2022 TAM Plan, which includes anticipated replacement years for the current fleet. Stantec worked with CTA staff to revise the phasing plan to account for long-term fleet expansion between 2022 and 2040, where the fleet will grow from ten to 14 vehicles;
- Annual average vehicle mileage is as follows for each vehicle type[22]:
    - Diesel cutaways: 38,583
    - Gasoline cutaways: 35,916
    - Gasoline vans: 18,670
    - BE cutaways: 37,249[23]
    - BE vans: 18,670;
- Average fuel economy as follows (based on CTA fuel receipts for existing fleet and Stantec modeling for the ZEBs):
    - Diesel cutaways: 9.3 miles per diesel gallon equivalent
    - Gasoline cutaways: 8.1 miles per gallon
    - Gasoline vans: 14.5 miles per gallon

[22] Based on CTA's 2022 TAM Plan.
[23] An average of the diesel and gasoline cutaway mileage was used for BE cutaways.

  - BE cutaways: 0.98 miles per kWh
  - BE vans: 1.11 miles per kWh;

- The ZEB case included the operation of diesel and gasoline vehicles (as well as BEBs) during the transition period until fossil fuel vehicles are phased out; and
- The model was completed using a consistent format for both the Base Case and the ZEB Case to facilitate clear comparisons between the two. The modeling was developed on an annual basis from 2023 to 2040.

More details about the assumptions and inputs for both the Base Case and ZEB Case can be found in Appendix A: Financial Modeling Inputs and Assumptions.

8.1 BASE CASE APPROACH

Stantec developed the forecast for the Base Case scenario, assuming that the existing diesel and gasoline fleet is maintained and renewed through 2040[24]. This model is inclusive of all scheduled fleet replacements and expansions during the 2040 project horizon. The purpose of the Base Case is for illustrative purposes to determine the comparative financial impacts of a ZEB rollout.

Capital expenses modeled consist of fleet acquisition based on CTAs 2022 TAM Plan and fleet expansion over time as discussed with CTA staff.

Vehicle maintenance costs were derived from CTA's current operations and maintenance contract with Paratransit Services, expressed as a maintenance cost per mile and projected out at the current escalation rates presented in the contract through 2040. These maintenance costs are inclusive of maintenance staff salaries, parts and supplies, oil and lubricants, tires, and other maintenance expenses. Fuel costs are based on information provided by CTA.

8.2 ZEB CASE APPROACH

The ZEB Case foresees a gradual transition to 100% BEB operations by 2040. The transition follows the fleet replacement schedule presented in Section 6.0.

The fleet phasing plan assumes that CTA will begin procuring BEBs in 2023, maintaining purchases of diesel or gasoline cutaways through 2027 to account for a gradual transition to ZE vehicles. The assumed life cycle for the ZEB is slightly longer than the current fleet's useful life[25], based on industry knowledge and FTA useful life benchmark guidelines. BE cutaways were modeled with a ten-year useful life, and BE vans with a useful life of eight years. We note that no agency has operated these types of ZEBs for a full life cycle, so actual useful life is not currently known. However, given the overlap in components, such as chassis, doors, etc. between fossil fuel vehicles and ZEBs, it is not unreasonable to assume that ZEBs can have similar useful lives. Furthermore, the reduction in moving parts of an electric motor and other propulsion-related components compared to an internal combustion engine will likely translate into fewer

[24] This scenario is illustrative; based on CARB requirements, continued operation of fossil fuel vehicles will be prohibited.
[25] Which is eight years for diesel cutaways, six years for gasoline cutaways, and six years for gasoline vans as specified by CTA.

breakdowns and thus a more reliable product. And given the assumed short vehicle life cycle, we assumed that batteries would not need replacing over the life cycle modeled here. CTA should review contract and warranty terms to understand expected battery performance and replacement conditions (see Section 9.7 for more discussion).

Capital expenses modeled consist of fleet acquisition and required facility infrastructure upgrades as outlined in Section 7.0. The facility modifications to accommodate BEBs and the related chargers will be phased in over time in accordance with the fleet phasing schedule. The ZEB case sees facility modifications required in 2025, 2029, and 2032, to ensure there are sufficient chargers to support the number of BEBs in the fleet.

Vehicle maintenance costs for BEBs were generated based on CTA's current costs and projected in the same way as the Base Case, with the line item of "oil and lubricants" removed, as ZEBs will not need oil and lubricants. The lack of data on maintenance costs, particularly for costs outside of an OEM warranty, makes maintenance costs difficult to forecast.

Electricity costs were calculated based on the expected rates from PG&E. Specifically, it's expected that CTA will be under the "electric schedule BEV" rate which eliminates demand chargers and has an attractive electricity price outside of peak hours (from 4:00 PM to 9:00 PM). Stantec utilized the Time of use (TOU) rate for the BEV-2-S option to estimate the total energy cost per day by following the charging profile (i.e., the anticipated hours that vehicles will be charging) that was developed in Section 5.2 and shown in Figure 13. The result was a projected cost of $0.1835 per kWh, which accounts for limited charging during peak hours and the subscription charges for the TOU rate.

8.3 COMPARISON AND OUTCOMES

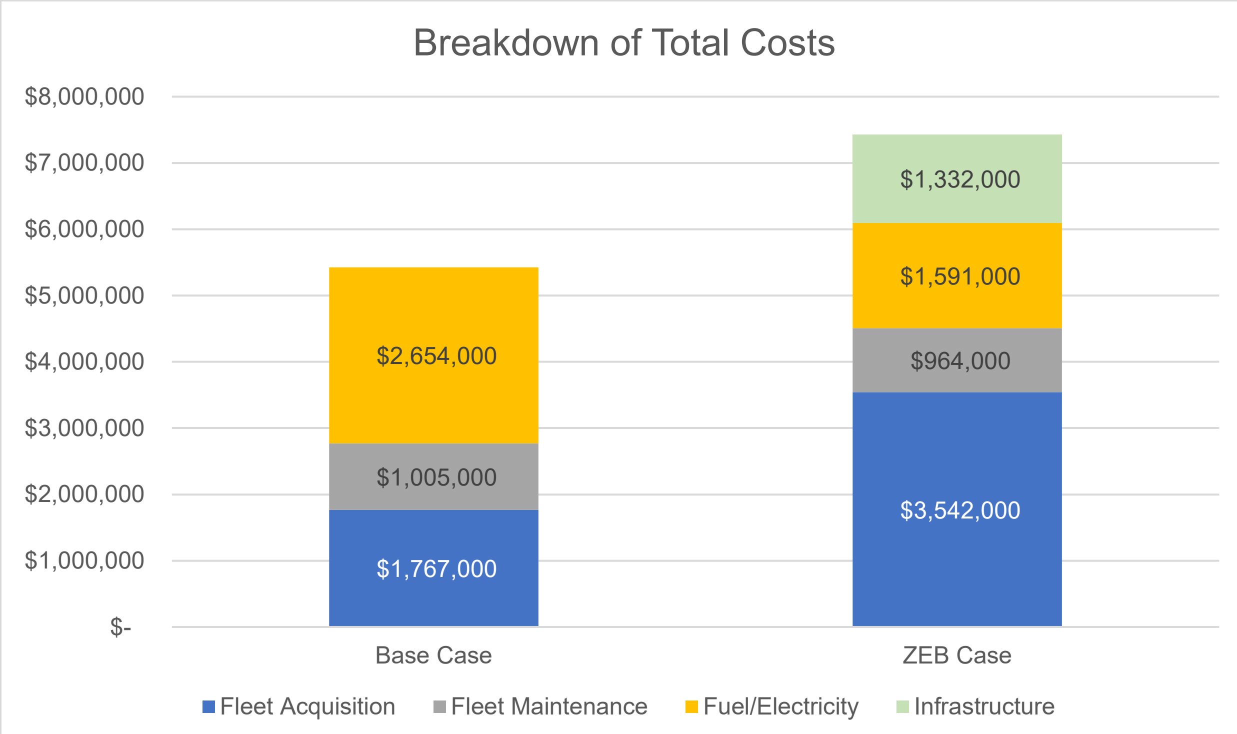
The cost comparison between the diesel Base Case and the ZEB Case transition scenario is presented in Table 12 and Figure 17, incorporating both capital (orange) and operating (blue) expenses. Over the 17-year horizon through 2040, the ZEB Case has a total cumulative cost of $7,429,000 versus $5,426,000 for the Base Case, a difference of $2,000,000 or a 37% increase[26]. The financial assessment does not consider any rebates, grants, credits, or other alternative funding mechanisms. Therefore, there may be several opportunities to offset the difference in the price between the two scenarios; the values here can be used to guide grant applications. Potential funding sources are discussed in Section 12.0.

Table 12: Total Cost Comparison 2023-2040

	Base Case	ZEB Case	Cost difference (ZEB – Base)
Fleet Acquisition	$1,767,000	$3,542,000	$1,775,000
Infrastructure	$-	$1,332,000	$1,332,000
Fleet Maintenance	$1,005,000	$964,000	$(41,000)
Fuel/Electricity	$2,654,000	$1,591,000	$(1,063,000)
Total	**$5,426,000**	**$7,429,000**	**$2,003,000**

[26] These values are in discounted dollars.

Figure 17: Breakdown of Cost Categories for Base Case and ZEB Case Scenarios



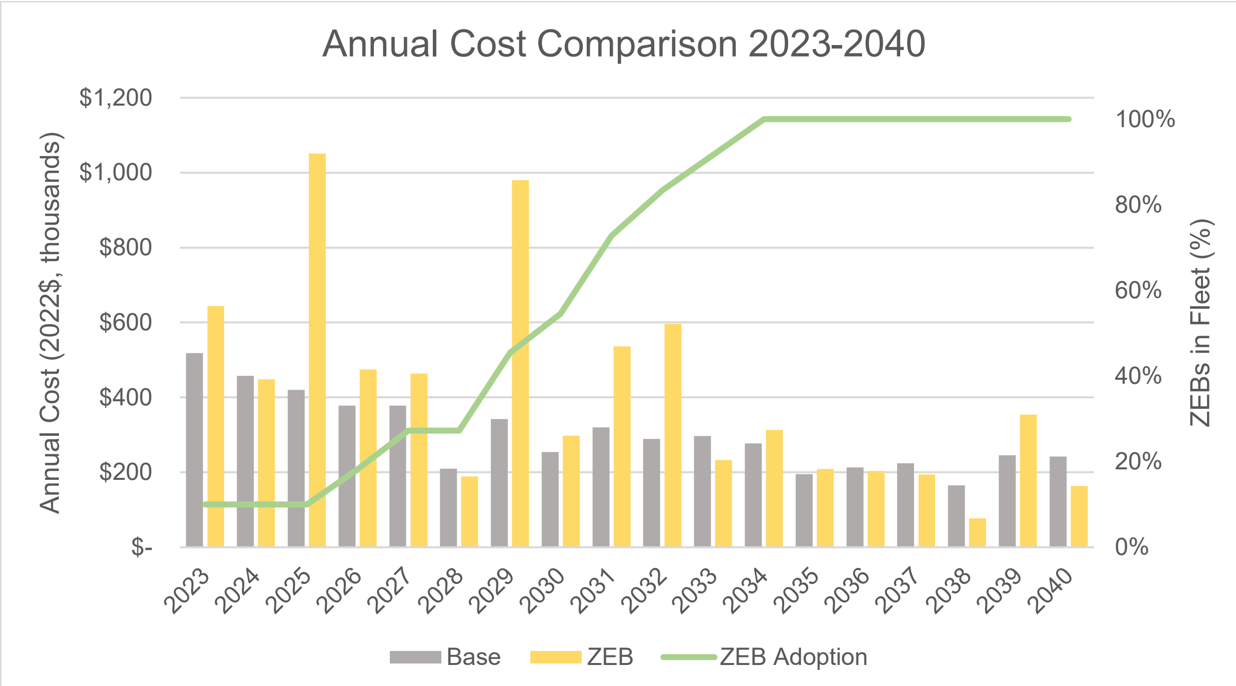
The procurement of BEBs represents $1.8 million more in expenses due to the higher purchase price of BEBs compared to fossil fuel vehicles. The conversion and upgrades to the facility to install charging infrastructure represents an additional cost of $1.3 million.

The use of electricity as a ‘fuel’ represents an economic benefit of approximately $1 million when compared to the existing diesel and gasoline refueling. These savings are a direct reflection of the improved efficiency that BEBs have with respect to legacy technologies, with the added benefit of eliminating emissions. Based on our assumptions, slightly lower overall maintenance costs are also seen with the BEB Case, representing a savings of $41,000 compared to the Base Case.[27]

Figure 18 shows the year-to-year comparison between the Base Case and the ZEB Case. The higher costs for the BEB scenario occur during the years that new modifications are conducted at the yard and when vehicle purchases are made (2025, 2029, 2031, and 2032).

[27] It is important to note that potential savings would be seen in a phased capacity.

Figure 18: Annual Total Cost Comparison



9.0 OPERATIONAL AND PLANNING CONSIDERATIONS

This section provides guidance and strategies for various operational and planning requirements when implementing BEBs.

9.1 PLANNING, SCHEDULING, AND RUNCUTTING

According to the phasing schedule, the first ZEBs will be introduced in 2023, but construction and deployment of chargers will need to be occur prior to that, preferably at least 6 months ahead of the acquisition.

Key considerations for BEB planning and scheduling include the fact that the useable energy of the battery is 80% of the nameplate capacity. In other words, while CTA may purchase buses that have a 120-kWh battery, for instance, it should plan for 80% of that capacity or ~96 kWh. Together with the modeling conducted by the Stantec team in this study, this will help guide the deployment and charging parameters for BEBs in CTA's operations scheduling.

Developing a guide like the depot planning tool from Siemens below (Figure 19) that tracks the requirements for SOC, energy (kWh), estimated and planned mileages, and fuel economy (kWh per mile) will be important for planning and dispatching.

Figure 19: Depot Planning Tool to Understand Scheduling and Operations of BEBs *(next page; Source: Siemens)*

Example – 4 buses and 2 chargers c/w 2 dispensers each

Parameter	Value	Notes
	filter data...	
Scheduled buses	4 / 4	
Used chargers	2 / 2	
Total energy required, KWh	969.2544	
Total energy delivered, KWh	1091.76	
Maximum power, KW	105.11	

BusID	Capacity, KWh	EleCon, KWh/km	Planned distance, km	Max distance, km	SoC start, %	SoC end planned, %	SoC end expected, %
filter data..							
191	349	1.29	195.79	243.48837209302326	17	90	90
192	349	1.29	179.89	243.48837209302326	23	90	90
193	349	1.29	179.89	243.48837209302326	23	90	90
194	349	1.29	195.79	243.48837209302326	17	90	90

Non-revenue tests during vehicle commissioning should be conducted in different parts of CTA's service area to establish actual range and fuel economy on longer routes, routes with topography variations, and with simulated passenger loads and HVAC testing. Regarding HVAC testing, it is important to keep in mind that energy consumption varies with seasonality.

Training for the scheduling and planning team will be needed to understand the importance of scheduling BEBs to the correct blocks. Training will also likely be needed in collaboration with CTA's scheduling software provider to account for hybrid deployments of BEB and fossil fuel buses, and finally an entirely-BEB operation.

In the long term, it is also important to consider battery capacity degradation; most BEB battery warranties specify that expected end of life capacity is 70% to 80% of the original capacity over six to twelve years[28]. With an estimated 2% battery degradation per year, CTA will also need to rotate buses so that older buses are assigned shorter blocks, while newer BEBs are assigned the longest blocks. Transit agencies can improve battery outcomes through efforts like avoiding full charging and discharging events, avoiding extreme temperature exposure, and performing regular maintenance on auxiliary systems that consume energy.

Developing specific performance measures, goals, and objectives for BEB deployment can also help to track BEB progress and understand if adjustments to the BEB deployment strategy will be required.

9.2 OPERATOR NEEDS

As BEBs have different components and controls than conventional buses, BEB bus performance also differs. Operators should understand how to maximize BEB efficiency—such as mastering regenerative braking and handling during slick conditions—and have hands-on experience prior to ZEB deployment for revenue service. Operations staff should also be briefed on expected range and limitations of BEBs (such as variability in energy consumption from HVAC under different weather conditions) as well as expected recharging times and procedures.

BEB operators should be able to understand battery SOC, remaining operating time, estimated range, and other system notifications as well as become familiar with the dashboard controls and warning signals. In addition, operators should be familiar with the correct procedures when a warning signal appears.

It is well known that driving habits have a significant effect on BEB energy consumption and overall performance and range (i.e., fuel economy can vary significant between operators). Training is required to assure that operators are knowledgeable on the principles of regenerative braking, mechanical braking, hill holding, and roll back. Operators should also be trained on optimal driving habits including recommended levels of acceleration and deceleration that will maximize fuel efficiency. Another option is to implement a positive incentive program that encourages operators to practice optimal driving habits for BEBs; this can be accomplished through rewards like priority parking in the employee lot, certificates, or other incentives. The Antelope Valley Transit Authority in Lancaster, California, an early adopter of

[28] National Academies of Sciences, Engineering, and Medicine 2020. Guidebook for Deploying Zero-Emission Transit Buses. Washington, DC: The National Academies Press. https://doi.org/10.17226/25842.

BEBs, has a program of friendly competition between operators, where, for instance, an operator with the best average monthly fuel economy (the lowest kWh per mile) receives one month of a preferred parking spot in the employee lot.

Finally, BEBs are much quieter than conventional fuel buses. Operators need to be aware of this and that pedestrians or people around the bus may not be aware of its presence. Agencies have also stated that due to the vehicle's lack of noise, some operators forget to turn off the bus after parking so operator training needs to address this as well.

9.3 MAINTENANCE NEEDS

Early data suggests that ZEBs may require less preventative maintenance than their counterparts with combustion engines since they have fewer moving parts; however, not enough data currently exists to provide detailed insights into long-term maintenance practices for large-scale ZEB deployment in North America, particularly for cutaways and vans. One early finding is that spare parts may not be readily available, so one maintenance consideration is to coordinate with OEMs and component manufacturers to develop spare parts inventories and understand lead times for spare parts. It will also be important for CTA to coordinate spare parts procurement needed for ongoing BEB maintenance sooner rather than later so maintenance can be completed without interruption.

In terms of preventative maintenance, BEB propulsion systems are more efficient than internal combustion engines and thus can result in less wear and tear. Without the diesel engine and exhaust, there are 30% fewer mechanical parts on a BEB. BEBs also do not require oil changes and the use of regenerative braking can help to extend the useful life of brake pads. Early studies from King County Metro show that the highest percentage of maintenance costs for BEBs came from the cab, body, and accessories system. It is recommended that CTA require OEMs to provide a list of activities, preventative maintenance time intervals, skills needed, and required parts needed to complete each preventative maintenance task for BEBs.

Many current BEBs also contain on-board communication systems, which are helpful in providing detailed bus performance data and report error messages, which can assist maintenance personnel in quickly identifying and diagnosing maintenance issues.

9.4 VEHICLE PROCUREMENT GUIDANCE

Currently, CTA operates a fleet of cutaways and smaller vans, and this same fleet composition will be carried over through the ZEB transition. Current BEB options for these vehicle types are limited, and by extension, procurement options are more limited as well.

There is a clear and growing need for more ZE cutaway alternatives with larger batteries and longer ranges from agencies that operate in rural settings and demand-response services, like CTA. Currently, two BE cutaways are on the market but neither have been Altoona-tested. Our modeling assumed that Altoona testing will be completed prior to any CTA procurements. A key assumption is that battery capacity will improve enough to meet the needs of CTA's service. This assumption is based on the growing number of ZE cutaways on the market in the past few years, improved efficiencies in batteries and fuel efficiency, and market response to a growing demand for cutaways with larger batteries and longer ranges. To provide CTA with guidance when the time comes to procure the first BE cutaway, this section discusses currently available options that come the closest to this goal

The Lightning Systems E450 Shuttle Bus has a 129-kWh battery with a range of up to 120 miles. The vehicle is eligible for a $60,000 incentive per vehicle under the Truck and Bus Voucher Incentive Program (HVIP) [29]. Another cutaway available for a $60,000 HVIP voucher is the GreenPower EV Star+ with a battery size of 118 kWh and stated range of up to 150 miles[30]. Finally, the Optimal-EV S1LF is a low-floor cutaway with a 113-kWh battery and 125-mile range. The vehicle utilizes Proterra's battery management system. Currently, only the GreenPower EV Star+ is listed in the CalACT/MBTA Purchasing Cooperative, but as more agencies begin to purchase BEBs, it is expected that more vehicles will be added. CTA should specify two rear-mounted charging ports accepting a minimum charging rate of 60 kW (200 ADC) at 480 VDC or greater via SAE J1772 to maximize flexibility when parking and charging the vehicles.

In addition to cutaways, CTA may wish to explore passenger vans, such as the Ford eTransit van, which is not a cutaway, but can be outfitted to accommodate six ambulatory passengers with one wheelchair position, four ambulatory passengers with two wheelchair positions, or three ambulatory passengers with three wheelchair positions. Indeed, CTA is in the process of procuring an electric Ford Transit 350 van (with Lightening Systems engine and 80 kWh Proterra battery from AZ Bus Sales, total quote of ~$208,000 including taxes and accessories), to put into service as a first step into the ZEB space. Finally, to enhance the accessibility of CTA's vehicles, it is recommended that CTA purchase BE vehicles that are low floor.

Some example vehicles are summarized Table 13, and these are only illustrative examples. CTA should develop a competitive tendering process for its fleet procurement and use programs like the CalACT/MBTA Purchasing Cooperative to streamline procurement. CTA should also leverage APTA's Standard Bus Procurement Request for Proposal which contains language about charger specifications, data logging and telematics, and other information that would be useful to include for vehicle and charger procurements[31].

Table 13: Summary of Vehicle Options

Vehicle type	ZEB type	Make and model	Battery size (kWh)	Range (miles)	Notes	Example Vehicle Photos
Cutaway	BE	Lightning Systems E450 Shuttle Bus	129	120	Eligible for $60,000 HVIP voucher. Supports both Level 2 and DC fast chargers.	

[29] https://californiahvip.org/vehicles/lightning-systems-lev110e-bus-ford-e-450-with-lightning-powertrain/
[30] https://californiahvip.org/vehicles/greenpower-ev-star-plus/
[31] https://www.apta.com/research-technical-resources/standards/procurement/apta-bts-bpg-gl-001-13/

Vehicle type	ZEB type	Make and model	Battery size (kWh)	Range (miles)	Notes	Example Vehicle Photos
	BE	GreenPower EV Star+	118	150	Eligible for $60,000 HVIP voucher. Supports both Level 2 and DC fast chargers.	
	BE	Optimal-EV S1LF	113	125	Low-floor vehicle with ADA-compliant entry ramp. Uses Proterra battery management systems. Supports both Level 2 and DC fast chargers.	
Passenger Van	BE	Lightning Systems Electric Zero Emission Transit Passenger Van	80-120	140-170	Eligible for $45,000 HVIP voucher. Low-floor vehicle and CARB certified Uses Proterra battery management systems. Supports both Level 2 and DC fast chargers.	

9.5 O&M CONTRACTOR PROCUREMENT GUIDANCE

Like many smaller transit agencies throughout the country, CTA's bus operations and vehicle maintenance are handled by a third-party contractor, currently Paratransit Services. The operations and maintenance (O&M) contractor provides an all-inclusive billing rate for operations based on scheduled vehicle hours, an all-inclusive rate for maintenance based on scheduled vehicle miles, with a fixed monthly fee for a set contract term, with option rates for additional terms.

Based on this service delivery model, one of the chief factors that could result in cost savings from a ZEB transition is maintenance and the savings would in theory flow to the O&M contractor. As a small agency, CTA's O&M contractor provides a lean staff, so savings originating from maintenance is likely to be negligible. Nonetheless, Stantec recommends that in future procurement documents, CTA stipulates language for conditions to revisit the contracted rate once a certain portion of the fleet is transitioned to ZEBs to ensure than any cost savings realized by the O&M contractor is passed on to CTA. Example language from a recent procurement document drafted by Stantec is shown below:

> *The Contractor acknowledges that, as of the Commencement Date, the County's fleet comprises the Buses listed in Appendix E to the SOP and includes* ***[XX] Electric Buses****. The Contractor further acknowledges that the County intends to increase the number of Electric Buses available for Service and the Contractor shall cooperate fully with the County in the transition from diesel to Electric Buses, in accordance with the terms of this Contract and the SOP.*
>
> *…*
>
> *The Contractor shall support the County during the transition from a fossil fuel fleet to a zero-emission fleet. If the County transitions greater than* ***35 percent (35%)*** *of the fleet to zero-emission buses, the* ***County may request the Contractor to review the Hourly (or per Mile) Rate to identify reductions associated with zero-emission bus maintenance programs and requirements****. Within thirty (30) days of receipt of the request from the County, the Contractor shall submit a proposal setting out the proposed new Hourly (or per Mile) Rate.*

Stantec highly encourages CTA to ensure that as it goes out to procurement when the current contract ends, that protections are built in such that any cost benefits the O&M contractor accrues due to ZEB operations is passed along to the County.

9.6 CHARGING NEEDS

BEB recharging is substantially different than fueling a fossil fuel bus. As part of the recommendations, plug-in chargers (60 kW) are proposed for BEB charging at the main operations and maintenance facility. Once BEBs return to the yard and are parked, a service line technician or operator would plug in the dispenser to recharge the bus. Smart charging software described in Section 10.0 (below) would monitor and control overall charging levels to balance energy needs with overall power demand, in essence helping ensure that BEBs are charged but that this charging is spread out to avoid large surges in power demand.

Figure 20: A BEB Passenger Van Plugged into a Charger.

9.7 BATTERY DEGRADATION

Battery degradation is unavoidable due to battery use and charging/recharging cycles. The magnitude and rate of degradation can be controlled by the user to some extent.

Following the recommendations of the manufacturer becomes especially important to preserve the battery life. This includes charging the battery to a maximum of 90% SOC and not allowing the battery to dip below 10% SOC. Furthermore, avoiding fast charging (below 300 kW) can help extend the lifespan of the batteries. The charging equipment recommendations detailed in Section 7.1 will provide that benefit for CTA.

Nevertheless, natural battery degradation will always occur, and vehicle manufacturers are offering extended warranties in their purchase agreements to account for battery degradation of 20% of its nameplate capacity. Battery replacements for cutaways are also assumed to be available but might not be necessary to go beyond the warranty given the short utilization cycle that cutaways will have at CTA (7 years). Actual experience may differ, and CTA will need to work with its vendors to understand warranty terms.

10.0 TECHNOLOGY

Technology for ZEBs will help CTA manage the fleet and its investment into zero-emission propulsion. First, for BEBs, charge management or smart charging technology is imperative to manage electrical demand and to curb potentially costly demand charges and to mitigate maximum power requirements of bus charging. Second, fleet tracking software, also known as telematics, typically provided by an OEM will help track useful analytics related to the fleet and operations to help CTA make informed decisions.

10.1 SMART CHARGING

To optimize BEB charging by minimizing charging during peak times of the day and to restrain the total power demand required for a BEB fleet, transit agencies deploy **smart charging**. Smart charging refers to software, artificial intelligence, and switching processes that control when and how much charging occurs, based on factors such as time of day, number of connected BEBs, and SOC of each BEB. This requires chargers that are capable of being controlled as well as a software platform that can effectively aggregate and manage these chargers. A best practice is to select chargers where the manufacturers are participants in the Open Charge Point Protocol (OCPP), a consortium of over 50 members focused on bringing standardization to the communications of chargers with their network platform.

A simple example of smart charging is if buses A, B and C return to the bus yard and all have an SOC of about 25%, all have 440 kWh battery packs, and all are plugged in in the order they arrived (A, B, C, though within a few minutes of each other). Without smart charging, they would typically get charged sequentially based on arrival time or based on SOC, with A getting charged first in about 2.2 hours, then B would be charged after 4.4 hours, and C about 6.6 hours. But if bus C is scheduled for dispatch after three hours, it would not be adequately charged. Furthermore, while vehicles can potentially charge all at once, such strategy is not recommended since once PG&E starts charging for power demand utilization, a high price tag can be passed to CTA. For example, the current peak at the facility is anticipated to be 300 kW and if all chargers are active simultaneously that peak can go up to 720 kW and that would be an immediate 58% increase on the electrical bill.

But by implementing smart charging, the system would ‘know’ that bus C is to be dispatched first and therefore would get the priority, charging first in 2.2 hours so it is ready in time for its ‘hour three’ rollout.

Another implementation is to mitigate energy demand when possible. For example, if two buses are each connected to their own 150 kW charger and they both need 300 kWh of energy and if the buses do not need to be dispatched for five hours, the system will only charge one bus at a time, thus generating a demand of only 150 kW, while still fully charging both buses in four hours. However, if both buses need to be deployed in two hours, the system will charge both simultaneously as needed to make rollout. A smart charging system would help optimize costs by also avoiding or minimizing charging during the most expensive times of day and help curb potential demand charges.

Well-planned and coordinated smart charging can significantly reduce the electric utility demand by timing when and how much charging each bus receives. Estimations on the ideal number of chargers is critical to the successful implementation of smart charging strategies.

There are several offerings in the industry for smart charging, charger management, and fleet management from companies such as ViriCiti, I/O Systems, AMPLY Power, Better Fleet (previously Evenergi), and Siemens. Additionally, the charger manufacturers all have their own native charge management software and platforms. These platforms have management functionality and integration that often exceeds the abilities of the other platforms and provide data and functionality similar to that of the third-party systems, particularly in the yard when BEBs are connected to the chargers. However, the third-party platforms provide more robust data streams while the BEBs are on route, including real-time information on SOC and usage rates. These platforms can cost well over $1,000 per bus per month, depending on the number of buses, and type of package procured, in addition to set up costs. BetterFleet's cost is approximately $15,000 for initial set-up and systems integration, while ongoing operating costs can be approximately $20,000 per year.

Three leading charge management system (CMS) providers have been evaluated as shown in Table 14. Information within this table was provided by the providers. This table indicates this point in time—at the time of procurement the features and criteria should be verified with the provider. Note that Viriciti was purchased by ChargePoint in 2021, the intent is to operate Viriciti separately from ChargePoint. A Buy America evaluation will be required for these providers.

Table 14: Charge Management System Vendor Comparison (based on manufacturer's information)

Item No.	Criteria Description	Amply Power - OMEGA	Viriciti - Agnostic Management Platform	ChargePoint - CMS
1	Number of installations (facilities) with multiple high voltage direct current chargers utilizing the software	14	More than 300	300+
2	Quantify uptime % of cloud base service	99.99%	99.99%	99.99%
3	What networking protocols or modes are supported, i.e., wired Ethernet, cellular, other	Hardwired ethernet is recommended, cellular and facility WIFI are supported	Cellular is recommended, wired Ethernet, and WIFI are supported	Cellular
4	OCPP 1.6 compatibility	Yes	Yes	Yes
5	OCPP 2.0 compatibility	Yes	Yes	Yes
6	List available data fields that can be reported (such as starting and ending SoC, bus ID, charging power, …)	SOC: start and end of charging session, SOC all the time whether bus in plugged in, parked or in the field. Rate of charge (kW) of each charger port. Bus ID all the time whether bus is plugged in or not. Location of bus (in-depot, in field, etc.) Charging session: Energy dispensed Duration of charging, Power and energy consumed at electrical meter and dispensed at each charger port. Charger health: Available Faulted Maintenance needed, etc.	Reports: Uptime, Downtime, and Offline chargers (in hours, percentage, and total for a group) Energy Reports (in kWh and hours of duration) Transactions: Charger OEM, Charger Name, Connector type, Connector/port number (1 or 2) Vehicle Name/Number Start Time and End Time Start SOC and End SOC Power Reason for ending charge session Duration of Charging session kWh Charged Range at start of transaction Range at the end of the transaction A visual graph representation of Power, SOC, and Energy throughout each transaction A complete list of charging transactions (equipped with the data previously stated) A complete list of user logs and documentation of user interactions.	
7	OpenADR2.0b or better common signals	Yes. In addition to OpenADR, also support custom DR integrations including CPower and Leap Energy.		Yes

Item No.	Criteria Description	Amply Power - OMEGA	Viriciti - Agnostic Management Platform	ChargePoint - CMS
8	Support Network Time Protocol (NTP/UTC) time synchronization	Yes	Yes	Yes
9	Describe software security features for system integrity and reliability	AMPLY has implemented security procedures at multiple levels for protecting customer information: • AMPLY databases are encrypted using industry standard AES-256 encryption • Both the database and application are running inside a VPC which has tightly managed access using IAM • The database is accessible only to the application nodes • No passwords are stored in the database and authentication is done using AWS Cognito • Authorization is tightly managed as part of the lower layers of the Amply software framework • Credentials are not stored in the database or code and are managed via the AWS systems manager • Software packages and dependencies are regularly reviewed for security vulnerabilities • Cloud infrastructure, roles & security groups are regularly reviewed for ensuring security		ISO 27000:2015
10	Capable of remote software upgrades	Yes – automatic, over the air updates	Yes – Updates happen though the Cloud	Yes
11	Is user interface web based or is any local app or software required	Web based UI accessible from any web enabled device	The system operates through a cloud-based platform which can be accessed through any web browser on a computer or mobile device. Web base only.	Web based
12	Ability to set charge-power limit to reduce energy charges while also maximizing bus availability	Yes. Pause or curtail charging session during peak energy costs. Optimized charging during off-peak or vehicle dwell times to achieve target SOC by defined roll-out times.	Yes, this is a customizable application which allows the user to create and manipulate charging parameters as needs or schedules change.	Yes
13	Ability to set charging to minimize demand charges while also maximizing bus availability	Demand (kW) management and reduction to achieve roll-out but will spread out charging. Sequential, dynamics and parallel charging capable (limitations are determined by EVSE not AMPLY system).	Yes, this is a customizable application which allows the user to create and manipulate charging parameters as needs or schedules change.	Yes
14	Ability to recognize bus stall and bus number and evaluate charge needs by block and state of charge (i.e., park management)	Yes	Yes	Yes

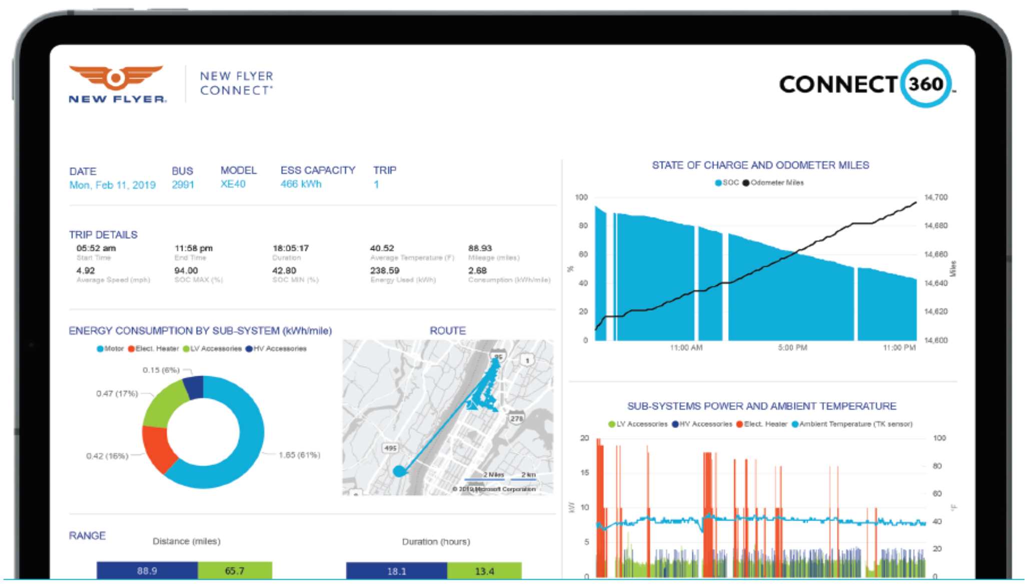
Item No.	Criteria Description	Amply Power - OMEGA	Viriciti - Agnostic Management Platform	ChargePoint - CMS
15	Manual override (computer/HMI input) for selection of (bus) charging sequence	Yes. Manual override button located within UI accessible by a specific user creditable. Override can also be performed by email, phone call or ticket request.	Yes, users can manually prioritize groups of chargers or single chargers in order to meet the demand as needed.	Yes
16	Describe desktop output/reports for charge telematics	• Energy Report - net (panel) load, modelled load (assuming no CMS), aggregate and individual charger load • Charge Detail Records - plug-in and session start & stop times, session duration, session energy, vehicle start & end soc, vehicle ID • Health Records - % normal, faulted, offline and uptime for EVSEs, controllers, system & software components • Vehicle Logs - Geo location and SOC information • Charge Ready Transport - CRT formatted report for PG&E, SCE and other Utilities Fleet Ready Programs	• Uptime, Downtime, and Offline chargers (in hours, percentage, and total for a group) • Energy Reports (in kWh and hours of duration) • A complete list of charging transactions (equipped with the data previously stated) • A complete list of user logs and documentation of user interactions.	No response
17	Is there a local controller to preserve the same control functionality in case cloud connectivity fails (e.g., WIFI outage)?	Yes, AMPLY Site Controller (ASC) installed at electrical main and is connected to breaker. CT's will meter 3- phases of power for real- time demand management. ASC can be hardwired to each EVSE via CAT6 to send OCPP directly to charger. If CMS cellular connection temporarily down, ASC has programmed commands to continue charging until cellular connection is restored.	With all communications we send to the charger, there are two signals that are sent: The set parameter and a failsafe value. If connection is disrupted for any reason or duration of time, the charger will revert to the failsafe value until connectivity is reestablished.	Yes
18	Other features criteria, or comments	OMEGA supports algorithmic optimization across a wide set of use cases in addition to TOU energy management including load management, tariff-based optimization across usage, demand and subscription charges, factoring in unmanaged loads, demand response signals from OpenADR and other providers. It also offers flexible alerting and notifications for EVSE faults and other conditions.	• Provided system is built to scale. If charging needs change or if a new OEM is desired, the system is able to monitor any charging infrastructure (assuming that charger OEM is OCPP compliant) and easily exchange chargers in the system. • Through an API, there is the ability to integrate with other planning or ITCMS platforms to optimize planning. • Other features may include our agnostic telematics system, which is capable of monitoring any vehicle OEM and operates off the same platform as the charger monitoring infrastructure - decreasing operational complexity by reducing software applications and increasing visibility into energy usage/expenditure.	No response

10.2 FLEET TRACKING SOFTWARE AND TELEMATICS

Software like Fleetwatch provide agencies with the ability to track vehicle mileage, work orders, fleet maintenance, consumables, and other items. However, with more complex technologies like ZEBs, it becomes crucial to monitor the status of batteries, fuel consumption, and so on of a bus in order to track its performance and understand how to improve fuel efficiency. Many OEMs offer fleet tracking software. Tracking fuel consumption and fuel economy will start to form important key performance metrics for fleet management as well as help inform operations planning (by informing operating ranges, among other elements).

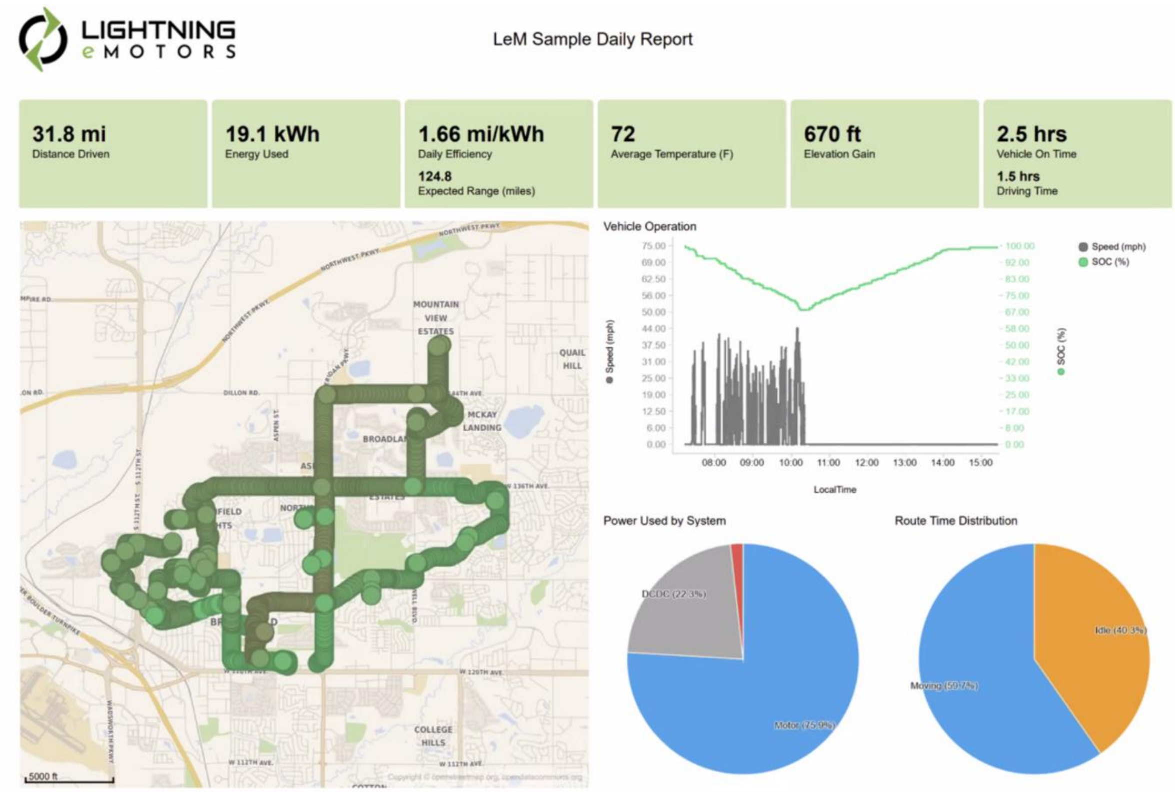
The screenshot below is an example of New Flyer's tool (New Flyer Connect 360; Figure 21), Lightning's dashboard (Figure 22), while other OEMs also offer similar tools (like ViriCiti) all depending on an agency's preference.

Figure 21: Example of New Flyer Connect 360.[32]



32 https://www.newflyer.com/tools/new-flyer-connect/

Figure 22: Example of Lighting eMotors daily report summary.



At a minimum, the fleet tracking software should track a vehicle's SOC, energy consumption, distance traveled, hours online, etc. Tracking these key performance indicators (KPIs) can help compare a vehicle's performance on different routes, under different ambient conditions, and even by different operators.

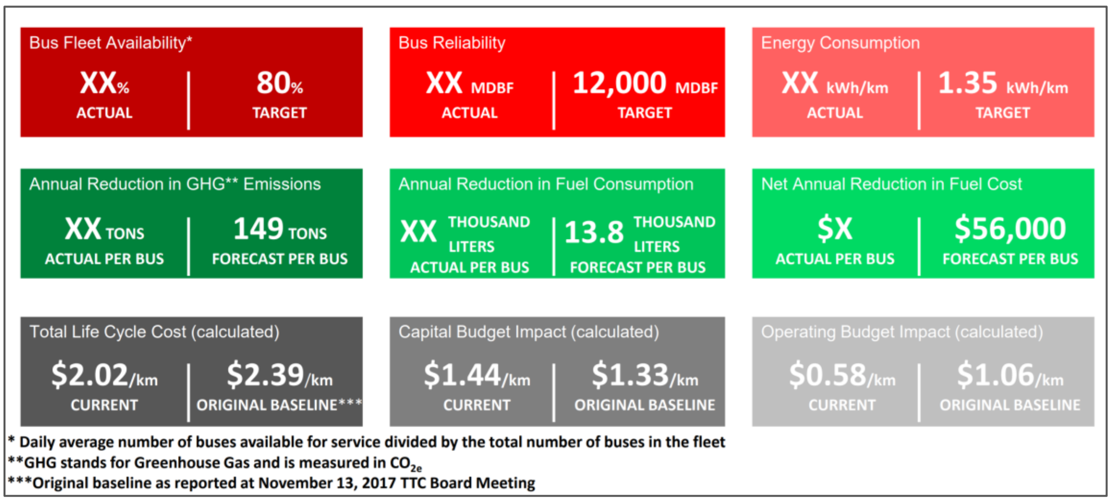
As CTA transitions from a fossil fuel fleet to ZEB fleet, it will be important to collect and compare data between the fleet types to understand the benefits (and costs) of the transition. Some example KPIs can include:

- ZEB vs. non-ZEB miles traveled,
- ZEB vs. non-ZEB maintenance cost per mile,
- ZEB vs. non-ZEB fuel/energy costs by month ($ per kWh vs. $ per gallon),
- ZEB vs. non-ZEB fuel/energy cost per mile,
- Average fuel consumption/fuel economy per month,
- Total ZEB vs. non-ZEB fuel and maintenance costs per month,

- Mean distance between failures, and/or
- ZEB vs. non-ZEB fleet availability.

The Toronto Transit Commission is currently testing BEBs from three different OEMs and is tracking the following KPIs for its BEBs to compare with its fossil fuel buses (Figure 23). This example is to provide some insights into what CTA could be tracking as comparable KPIs between fossil fuel vehicles and ZE vehicles.

Figure 23: Example of TTC eBus KPIs.[33]



All BEB equipment should be connected to CTA's current data collection software, networks, and integrated with any existing data collection architecture. All data should be transmitted across secure VPN technology and encrypted.

Beyond the BEB itself, charger data should be collected as well, such as the percentage of battery charge status and kWh rate of charge. Furthermore, it will be important for CTA to track utility usage data from PG&E to understand energy and power demand and costs.

33 https://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2018/June_12/Reports/27_Green_Bus_Technology_Plan_Update.pdf

11.0 WORKFORCE CONSIDERATIONS

The deployment of a new propulsion technology will require new training regimes for operators and maintenance staff. This section describes some key training considerations as well as the implications of the adoption of BEBs.

11.1 IMPLICATIONS OF BEBS ON WORKFORCE

Early data suggest that BEBs may require less preventative maintenance than their diesel or gasoline counterparts since they have fewer moving parts. However, BEBs are so new that there is not enough data to provide detailed insights into long-term maintenance practices for large-scale BEB deployments in North America.

Since BEBs have fewer moving components that can malfunction and require replacement, repair, and general maintenance, transit agencies could theoretically save on maintenance costs because: 1) fewer parts could break and need replacement (capital) and 2) less labor is needed to work on the vehicles (operating). The broader concern throughout the industry is related to a possible reduction in the number of maintenance staff required for a BEB fleet vs. a traditional diesel fleet. However, because CTA has one maintenance staff member, a reduction of staff is infeasible and should not be a concern for the agency; marginal cost savings are possible, but would need to be passed along from the O&M contractor to CTA. Generally, while fewer maintenance practices may be needed, such as oil and lube changes, new ones may emerge, such as checking cabling and other electric motor components. As technology continues to mature and become more sophisticated, technicians will need to be trained not only on machinery and high-voltage safety, but also on components that require computer and diagnostic skills.

11.2 TRAINING

BEB manufacturers include basic training modules for bus operators and maintenance technicians that are typically included in the purchase price of the vehicle, with additional training modules and programs also available for purchase. It will be important for CTA leadership to work with its O&M operator and staff to understand how best to approach training for BEBs, and whether in addition to basic training from OEMs, further training is needed.

The minimum required training recommendations are as follows for operators and maintenance technicians:

- BEB Operator training (total 56 hours)
    - Operator drive training (four sessions, four hours each)
    - Operator vehicle/system orientation (20 sessions, two hours each)

- BEB Maintenance technician training (total 304 hours)
    - Preventative maintenance training (four sessions, eight hours each)
    - Electrical/electronic training (six sessions, eight hours each)
    - Multiplex training (four sessions, each session consisting of three eight-hour days)
    - HVAC training (four sessions, four hours each)
    - Brake training (four sessions, four hours each)
    - Energy Storage System (ESS), lithium-ion battery and energy management hardware and software training (six sessions, eight hours each)
    - Electric drive/transmission training (six sessions, eight hours each)

Acquiring the following tools and safety materials should be a top priority to ensure successful in-house ZEB maintenance and management.

- Operational training module
- High voltage interface box
- Virtual training module
- High voltage insulated tools
- Insulated PPE
- Electrical safety hooks
- Arc flash clothing

Table 15 below provides a framework of potential training methods and strategies to bolster CTA's workforce development and successfully transition to a 100% ZEB fleet.

Table 15: Potential Training Methods

Plan	Description
Train-the-trainer	Small numbers of staff are trained, and subsequently train colleagues. This maintains institutional knowledge while reducing the need for external training.

Plan	Description
Bus vendor training and fueling vendor	OEM training provides critical, equipment-specific operations and maintenance information. Prior to implementing ZEB technology, CTA staff will work with the OEMs to ensure all employees complete necessary training.
Retraining & refresher training	Entry level, intermediate, and advanced continuous learning opportunities will be offered to all CTA staff.
ZEB training from other transit agencies	CTA should leverage the experience of agencies who were early ZEB adopters, such as the ZEB University program offered by AC Transit.
National Transit Institute (NTI) training	NTI offers zero-emissions courses such as ZEB management and benchmarking and performance.
Local partnerships and collaborations	CTA could work with local schools to showcase potential careers in bus and facilities management to students.
Professional associations	Associations such as the Zero Emission Bus Resource Alliance offer opportunities for sharing and lessons learned across transit agencies.

The priority in maintenance needs will be the issue of safety in dealing with high-voltage systems. All maintenance personnel in the garage, whether doing servicing, inspection, or repairs and those in other routines (e.g., plugging and unplugging BEBs) must be educated on the characteristics of this technology. One essential component is the provision and mandate of additional Personal Protective Equipment (PPE) beyond that which is required by automotive garage workplace legislated standards or CTA's policies. Examples of such apparel include high voltage insulated work gloves, flame retardant clothing, insulated safety footwear, face shields, special insulated hand tools, and grounding of apparatus that staff may be using. Also, procedures in dealing with accidents and injuries must be established with instructions and warning signs posted.

Current BEBs also contain on-board communication systems, which are helpful in providing detailed bus performance data and report error messages, which can assist maintenance personnel in quickly identifying and diagnosing maintenance issues.

In addition, agencywide orientation to familiarize the agency with the new technology should also be conducted prior to the first BEBs deployment.

Coordination with Emergency Responders

Finally, it is highly recommended that CTA coordinate with all local fire and emergency response departments. This can include reaching out to the fire marshal and other AHJs to inform these agencies about the storage, layout, componentry, safety devices, and other features of BEBs. This should reoccur every few years, but the specific frequency can be dependent on agency discretion. Important safety precautions and warnings should be installed in the appropriate locations in the facility and more information can be found on NFPA's website for emergency response guides for different OEMs[34].

[34] https://www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides

12.0 POTENTIAL FUNDING SOURCES

As a clear cost driver for transit agencies, funding the ZE transition will require external financial aid. Due to the long timeframe over which buses will be procured and infrastructure will be constructed, it is imperative that CTA constantly monitors existing funding and financing opportunities and is aware of when new sources are created. Additionally, as more transit agencies in the state and country consider ZEB transitions, new funding opportunities may occur. Below are major current programs available for ZEB transition in Table 16.

Table 16: Grants and Potential Funding Options for ZEB Transition

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
Federal	Federal Transportation Administration (FTA)	Low or No Emission Program (Low-No Program) (5339(c))	Low-No provides competitive funding for the procurement of low or no emission vehicles, including the leasing or purchasing of vehicles and related supporting infrastructure. This has been an annual program under the FAST Act since FY2016 and is a subprogram of the Section 5339 Grants for Bus and Bus Facilities. There is a stipulation for a 20% local match.	In FY2021 the FTA awarded $180 million to 49 projects for the Low-No program.[35] In FY2021, Golden Empire Transit District received $3 million to construct a permanent hydrogen fueling station to support its electric bus operations.[36] $1.1 billion has been announced for FY2022 projects.[37].
		Buses and Bus Facilities Program (5339(a) formula, 5339(b) competitive)	Grants applicable to rehab buses, purchase new buses, and invest and renovate related equipment and facilities for low or no emission vehicles or facilities. A 20% local match is required.	FY2021 5339 funding totaled $409 million in grants to 70 projects in 39 states. $372 million has been announced for FY2022 grants. [38]
		Urbanized Area Formula Grants (5307)	5307 grant funding makes federal resources available to urbanized areas for transit capital and operating assistance. Eligible activities include capital investments in bus and bus-related activities such as replacement, overhaul and rebuilding of buses. The federal share is not to exceed 80% of the net project cost for capital expenditures. The federal share may be 90% of the cost of vehicle-related equipment attributable to compliance with the Clean Air Act.	Typically, the MPO or another lead public agency is the direct recipient of these funds and distributes these to local transit agencies based on TIP allocation. Agencies can allocate these funds for the purchase of ZEBs.

[35] https://www.transit.dot.gov/funding/grants/fiscal-year-2021-low-or-no-emission-low-no-bus-program-projects
[36] https://www.transit.dot.gov/funding/grants/fiscal-year-2021-low-or-no-emission-low-no-bus-program-projects
[37] https://www.transit.dot.gov/lowno#:~:text=On%20March%207%2C%202022%2C%20FTA,improve%20air%20quality%20and%20combat
[38] https://www.transit.dot.gov/bus-program

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program (CMAQ)	The Congestion Mitigation and Air Quality Improvement (CMAQ) Program provides funds to states for transportation projects designed to reduce traffic congestion and improve air quality, particularly in areas of the country that do not attain national air quality standards.	Projects that reduce criteria air pollutants regulated from transportation-related sources, including ZEBs.
	United States Department of Transportation (USDOT)	Local and Regional Project Assistance Program (RAISE)	Previously known as BUILD and TIGER, RAISE is a discretionary grant program aimed to support investment in infrastructure. RAISE funding supports planning and capital investments in roads, bridges, transit, rail, ports, and intermodal transportation. A local match is required.[39]	FY2020 provided $1 billion in BUILD grants to 70 projects with a stipulation requiring 50% of funding for projects in rural areas. In FY2022, $2.28 billion in funding was announced for the RAISE Grant Program. [40]
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP)	Voucher program created in 2009 aimed at reducing the purchase cost of zero-emission vehicles. A transit agency would decide on a vehicle, contact the vendor directly, and then the vendor would apply for the voucher.	$430 million in funding for the FY21-22 year was announced in March 2022.[41] Hydrogen fuel cell vehicles are eligible for HVIP but must not have plug-in capacity.[42]
		Carl Moyer Memorial Air Quality Standards Attainment Program	The Carl Moyer Program provides funding to help procure low-emission vehicles and equipment. It is implemented as a partnership between CARB and local air districts.	Transit buses are eligible for up to $80,000 funding.

39 https://www.transportation.gov/RAISEgrants/about
40 https://www.transportation.gov/sites/dot.gov/files/2022-04/RAISE_2022_NOFO_AMENDMENT_1.pdf
41 https://californiahvip.org/funding/
42 https://californiahvip.org/wp-content/uploads/2022/03/HVIP-FY21-22-Implementation-Manual-03.15.22.pdf

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
		Volkswagen Environmental Mitigation Trust Funding	VW's settlement provides nearly $130 million for zero-emission transit, school, and shuttle bus replacements.	Transit may be eligible for up to $65 million. Applications are open for transit agencies and are processed on a first come, first serve basis. Maximum: $400,000 per FCEB and maximum of $3,250,000 total funding per agency.[43]
		Sustainable Transportation Equity Project (STEP)	STEP was a pilot that took a community-based approach to overcoming barriers to clean transportation. The future of STEP is currently being determined by CARB and stakeholder groups through the FY22-23 Funding Plan and Three-Year Plan for Clean Transportation Incentives.[44]	There are two different grant types: Planning and Capacity Building Grants (up to $1.75 million for multiple grantees) and Implementation Grants (up to $17.75 million for between one and three grantees). Lead applicants must be a CBO, federally-recognized tribe, or local government representing a public transit agency. Award amounts ranged from $184,000 to a maximum of over $7 million.[45]
	California Transportation Commission (CTC)	SB1 Local Partnership Program (LPP)	The Local Partnership Program provides funding to counties, cities, districts and regional transportation agencies to improve aging infrastructure, road conditions, active transportation, transit and rail, and health and safety benefits. Funds are distributed through competitive and formulaic components.[46]	To be eligible, counties, cities, districts, and regional transportation agencies must have approved fees or taxes dedicated solely to transportation improvements. $200 million is available annually. In Ventura County, a transportation sales tax measure may be placed on voter ballots for the November 2022 election. If passed, the LPP will be a potential future funding option.[47]
		Solutions for Congested Corridors Program (SCCP)	The SCCP includes programs with both formula and competitive funds. Funding is available to projects that make specific performance improvements and are a part of a multimodal comprehensive corridor plan designed to reduce congestion in highly traveled corridors by providing more transportation choices for residents, commuters, and visitors.	Improvements to transit facilities are eligible projects. Cycle 2 funding of $500 million covers two years (FY2022 and FY2023). To submit a SCCP application, the applicant needs to know exactly what sources will be funding the project and when the funds will be used, as well as which project phase they will be used for. Total estimated funding: $500,000,000 for FY22-23[48]

43 http://vwbusmoney.valleyair.org/documents/FAQ.pdf
44 https://ww2.arb.ca.gov/lcti-step
45 https://ww2.arb.ca.gov/news/grant-awards-announced-new-195-million-pilot-funding-equitable-clean-transportation-options
46 https://catc.ca.gov/programs/sb1/local-partnership-program
47 https://www.vcstar.com/story/news/local/2021/10/22/group-proposing-transit-sales-tax-measure-countys-2022-ballot/5988391001/
48 https://www.grants.ca.gov/grants/solutions-for-congested-corridors-program/

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	California Department of Transportation (Caltrans)	SB1 State of Good Repair	SGR funds are formula funds eligible for transit maintenance, rehabs, and capital programs. Agencies receive yearly SB1 SGR funding through their MPO, based on population and farebox revenues.	Agencies can decide to devote its portion of SB 1 funds to ZEB transition.
		Low Carbon Transit Operations Program (LCTOP)	The LCTOP provides capital assistance to transit agencies in order to reduce greenhouse gas emissions and improve mobility. 5% and 10% of the annual Cap and Trade auction proceeds fund this program.	Many agencies are already recipients of these funds and can use these funds to purchase ZEBs and related equipment.
		Transit and Intercity Rail Capital Program (TIRCP)	The TIRCP was created to fund capital improvements that reduce emissions of greenhouse gases, vehicle miles traveled, and congestion through modernization of California's intercity, commuter, and rail, bus, and ferry transit systems.[49]	The five cycles of TIRCP funding have awarded $6.6 billion in funding to nearly 100 projects throughout California. In 2022, the Humboldt Transit Authority (HTA) received $38,743,000 to procure 11 hydrogen fuel cell buses, design a hydrogen fueling station, and design and construct an intermodal transit and housing center.[50]
		State Transportation Improvement Program (STIP)	The STIP is a five-year plan for future allocations of certain state transportation funds including state highway, active transportation, intercity rail, and transit improvements. The STIP is updated biennially in even-numbered years. [51]	ZEB procurement could compete for STIP funding. The 2022 STIP was adopted in March 2022 and included $796 million in available funding. [52] Funding is distributed via a formula for a variety of projects.

[49] https://calsta.ca.gov/subject-areas/transit-intercity-rail-capital-prog
[50] https://calsta.ca.gov/-/media/calsta-media/documents/tircp---program-of-projects-as-of-july-2022---cycle-5-only-a11y.pdf
[51] https://catc.ca.gov/programs/state-transportation-improvement-program
[52] https://catc.ca.gov/-/media/ctc-media/documents/programs/stip/2022-stip/2022-adopted-stip-32522.pdf

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
		Transportation Development Act (Mills-Alquist-Deddeh Act (SB 325))	The TDA law provides funding to improve existing public transportation services and encourage regional transportation coordination. There are two funding sources: the Local Transportation Fund and the State Transit Assistance) fund.[53]	Funding opportunities include transportation program activities, pedestrian and bike facilities, community transit services, public transportation, and bus and rail projects.
	California Energy Commission	Clean Transportation Program (Alternative and Renewable Fuel and Vehicle Technology Program)	The California Energy Commission's Clean Transportation Program provides funding to support innovation and acceleration of development and deployment of zero-emission fuel technologies. A local match is often required.	The Clean Transportation Program provides up to $100 million annually for a variety of renewable and alternative fuel transportation projects throughout the state, including specific projects for heavy-duty public transit buses. In 2021, between $4 million and $6 million were awarded to the following transit agencies to assist with zero-emission transit fleet infrastructure deployment: Anaheim Transportation Network ($5 million), LADOT ($6 million), Sunline Transit ($5 million), and North County Transit District ($4 million)
	Department of Housing and Community Development	Affordable Housing and Sustainable Communities Program	The AHSC Program funds land use, housing, and transportation projects to support development that reduces GHG emissions. The program provides both grants and loans that reduce GHG emissions and benefit disadvantaged communities through increasing accessibility via low-carbon transportation. $405 million in available funds was announced in 2021.[54] The maximum award amount is not to exceed $30 million per project, with a minimum award of at least $1 million.[55]	Sustainable transportation infrastructure projects, transportation-related amenities, and program costs (including transit ridership) are eligible activities. Agencies can use program funds for assistance in construction or modification of infrastructure for ZEB conversion as well as new vehicle purchases.
	California Climate Investments	Clean Mobility Options (CMO) Voucher Pilot Program	CMO awards up to $1 million vouchers to develop and launch zero-emission mobility projects including the purchase of zero-emission vehicles, infrastructure, planning, outreach, and operations projects in low-income and disadvantaged communities.[56] Funding is limited.	In 2020, the CMO Voucher Pilot Program awarded $20 million worth of mobility project vouchers, with $18 million going to eligible under-resourced communities. For example, the City of Chula Vista received funding to launch an on-demand community shuttle service in northwest Chula Vista using four electric vehicles. Also, Fresno County Rural Transit Agency is on a wait list to potentially receive $36,885 in funding.

[53] https://dot.ca.gov/programs/rail-and-mass-transportation/transportation-development-act
[54] https://www.hcd.ca.gov/grants-funding/active-funding/ahsc/docs/final_ahsc_nofa_round_6.pdf
[55] https://www.hcd.ca.gov/affordable-housing-and-sustainable-communities#:~:text=Communities%20Program%20(AHSC)-,Affordable%20Housing%20and%20Sustainable%20Communities%20Program%20(AHSC),(%22GHG%22)%20emissions.
[56] https://cleanmobilityoptions.org/about/#

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	California Pollution Control Financing Authority (CPCFA)	Medium-Heavy-Duty (MHD) Zero Emission Vehicle Financing Program	The CPCFA is developing a purchasing assistance program for MHD ZEV fleets. This will provide financial support and technical assistance to fleet managers deploying ZEV fleets. The program will be established by January 1, 2023.[57]	CPCFA will designate high priority fleets based on implications for climate change, pollution, environmental justice, and post-COVID economic recovery. A minimum of 75% of financing must be directed towards fleets that directly impact or operate in underserved communities.
Other		Low Carbon Fuel Standard (LCFS credits)	LCFS credits are not necessary funding to be applied for; rather, they are offset credits that are traded (through a broker) to reduce operating costs.	Once ZEBs are acquired and operating, agencies can collect LCFS and 'sell' them to reduce operating costs of ZEBs. Both hydrogen and electricity used as fuels are eligible for LCFS credits. Credit prices range, but average credit price between 2016 and 2019 was between $65 and $200 per credit, with an average of $10,000 per vehicle.
		Transportation Development Credits	Although they are not funds for projects, Transportation Development Credits, also called "Toll Credits", satisfy the federal government requirement to match federal funds.[58]	Toll credits provide a credit toward a project's local share for certain expenditures with toll revenues. FHWA oversees the toll credits within each state.[59]
	Pacific Gas & Electric	EV Charging Station Incentives for Medium-Heavy-Duty Fleets	PG&E's EV Fleet Program offers incentives to facilitate the installation of EV charging stations for medium and heavy-duty fleets. EV charging stations with an output of 50.1-149.9 kW can receive up to $25,000 in rebates.[60]	Entities eligible to receive rebates for the purchase and installation of new charging stations include schools, transit agencies, and disadvantaged communities.

57 https://afdc.energy.gov/laws/12858
58 https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0010121-toll-credit-fact-sheet.pdf
59 https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0009899-2-toll-credits-fact-sheet-a11y.pdf
60 https://www.pge.com/en_US/large-business/solar-and-vehicles/clean-vehicles/ev-fleet-program/ev-fleet-program.page?WT.mc_id=Vanity_evfleet

An important source of potential funding is the FTA's Low-No funding opportunity. In December 2021, the FTA released a Dear Colleague letter outlining new requirements for Low-No and Bus and Bus Facility Grant Applications. The letter details the requirement for a Zero-Emission Fleet Transition plan in response to amendments in the statutory provisions for these programs as part of the Bipartisan Infrastructure Law. The FTA Zero-Emission Fleet Transition plan includes six major elements, presented in Table 17. Moving forward, to qualify for these funding opportunities, a transit agency must include a transition plan with these elements. CTA can use much of the material in the ZEB Rollout Plan document to develop a ZE Fleet Transition Plan to comply with the FTA's requirements[61].

Table 17: FTA Zero-Emission Fleet Transition Plan Requirements

Element	Description
1: Long-Term Fleet Plan and Application Request	Demonstrate a long-term fleet management plan with a strategy for how the applicant intends to use the current application and future acquisitions.
2: Current and Future Resources to Meet Transition	Address the availability of current and future resources to meet costs for the transition and implementation
3: Policy and Legislative Impacts	Consider policy and legislation impacting relevant technologies.
4: Facility Evaluation and Needs for Technology Transition	Include an evaluation of existing and future facilities and their relationship to the technology transition.
5: Utility Partnership	Describe the partnership of the applicant with the utility or alternative fuel provider.
6: Workforce Training and Transition	Examine the impact of the transition on the applicant's current workforce by identifying skill gaps, training needs, and retraining needs of the exiting workers of the applicant to operate and maintain ZEVs and related infrastructure and avoid displacement of the existing workforce.

[61] To view a list of winners and projects, please see https://www.transit.dot.gov/funding/grants/fy22-fta-bus-and-low-and-no-emission-grant-awards

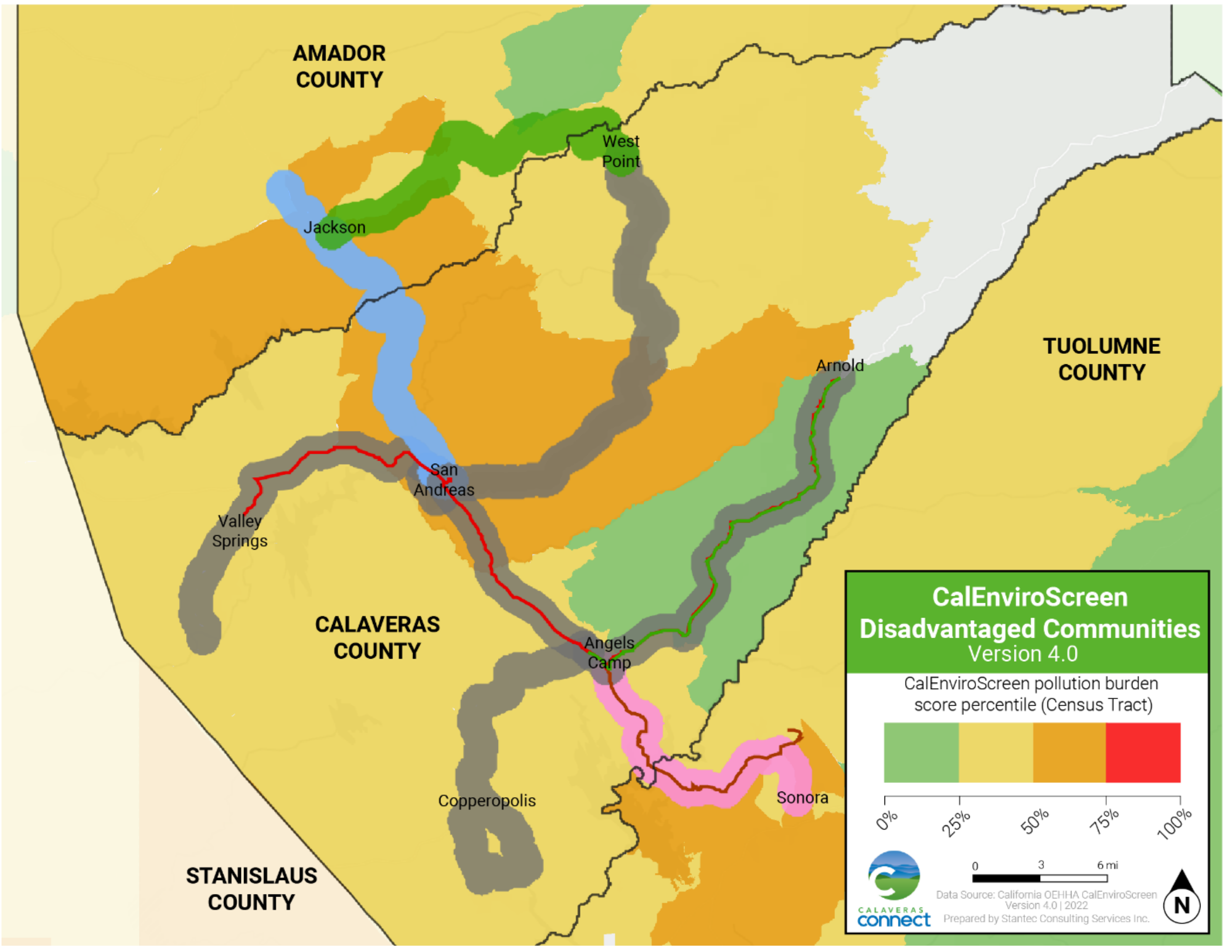
13.0 SERVICE AND ZEB DEPLOYMENT IN DISADVANTAGED COMMUNITIES

CARB defines Section F of the rollout plan as “Providing Service in Disadvantaged Communities” based on disadvantaged communities as identified by CalEnviroScreen, an online mapping tool developed by the Office of Environmental Health Hazard Assessment. The tool identifies (at the census tract level) the state’s most pollution-burdened and vulnerable communities based on geographic, socioeconomic, public health, and environmental hazard criteria.

ICT provisions require that transit agencies describe how they are planning to deploy ZEBs in disadvantaged communities by outlining the location of the disadvantaged community (census tract) where the ZEB will be deployed, how many ZEBs, and in what year the ZEBs will be deployed.

Figure 24 shows that there are no census tracts that are classified as ‘disadvantaged communities’ according to CalEnviroScreen 4.0 in CTA’s service area.

Figure 24: CalEnviroScreen disadvantaged communities in the CTA service area



While none of the census tracts in CTA's service area are classified as disadvantaged communities (in the top 25th percentile), CTA can make the largest impact by prioritizing ZEB deployment on Direct Connect services that go through the areas that are the most disadvantaged; in this case, the tracts that are in the top 50th percentile, or the orange-colored census tracts in Figure 24.

14.0 GHG IMPACTS

Based on the ZEVDecide modeling of greenhouse gas emissions (GHG), CTA's diesel/gasoline fleet is estimated to emit 134 tons of GHGs in a year, inclusive of upstream emissions[62] related to the fossil fuel supply chain.[63] In contrast, the future BEB fleet will only emit close to 24 tons annually; while tailpipe emissions of BEBs are nil, residual GHGs results from the carbon-intensity of the electric grid. As modeled, a completely BEB fleet can reduce CTA's GHG footprint by ~110 tons annually (an 82% reduction). Table 18 shows the annual emissions of the fleet by service type, and Table 19 presents a summary and the average emissions per vehicle.

Table 18: Annual Emission in Tons of CO_2 per year for CTA's fleet by service type

	Zero Emissions		Diesel/Gasoline		
	BEB cutaways	BEB vans	Diesel cutaways	Gasoline vans	Gasoline Cutaway
Upstream (ton CO_2/year)	20	4	17	3	11
Tailpipe Emissions (ton CO_2/year)	-	-	47	13	44
Total (Ton CO_2/year)	**20**	**4**	**64**	**16**	**55**

Table 19: Summary of Annual Emissions for CTA's fleet

	Fleet Emissions (Ton CO_2/year)	Emissions per Vehicle (Ton CO_2/vehicle/year)
BEB fleet	24	4
Diesel/Gasoline Fleet	134	31
Difference	**110**	**27**
	82%	**87%**

On average, implementing BEBs reduces the annual emissions by 82% when compared to the conventional diesel/gasoline fleet.

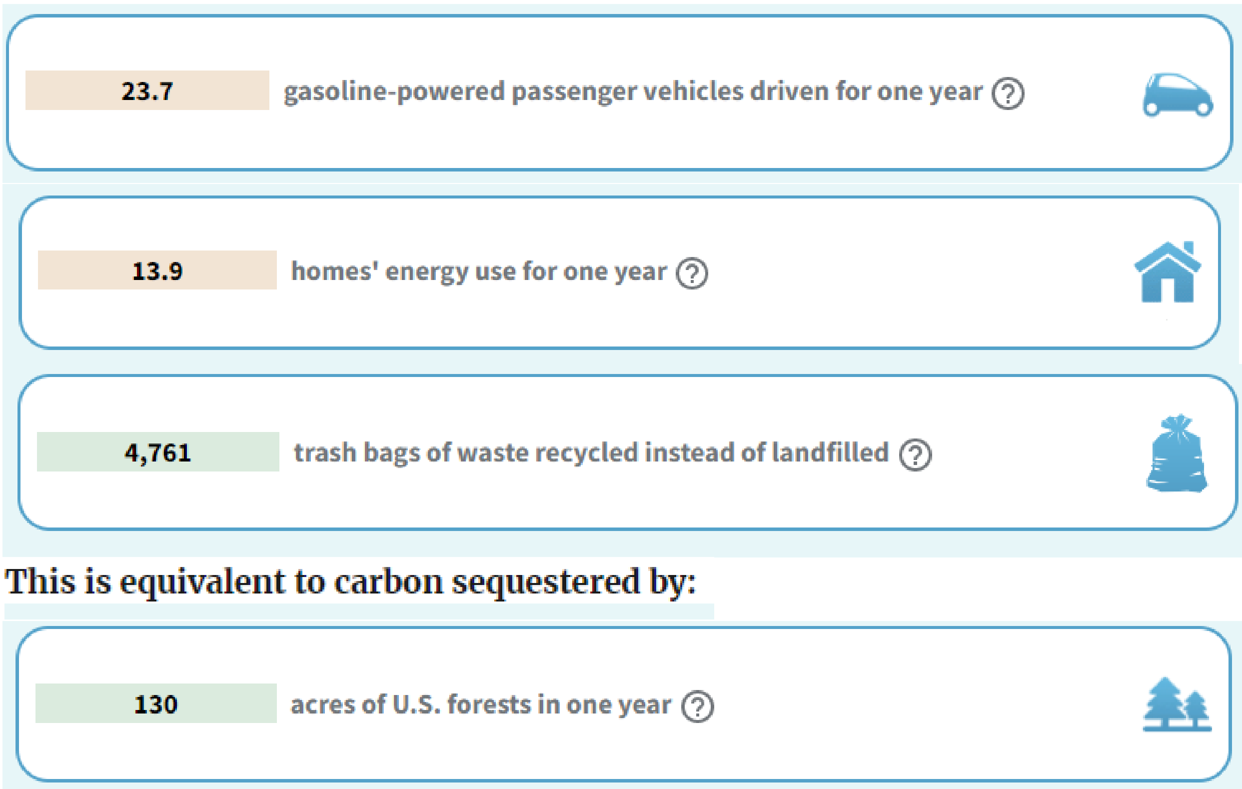
Using the EPA GHG equivalent calculator[64], we used the annual emissions that will be displaced by the BEB fleet to create relative comparisons to the benefits. As presented in Figure 25, implementing a ZEB

[62] Upstream emissions are GHG emissions related to the production of the fuel used to power vehicles, such as emissions from the production of electricity used to power vehicles (https://www.epa.gov/greenvehicles/light-duty-vehicle-emissions)
[63] All GHG calculations are presented in tons (not metric tons) of CO_2 equivalent, which is calculated using the short-term 20-year global warming potential of CO_2, methane, black carbon, and particulate matter.

[64] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

fleet will eliminate emissions equivalent to removing 24 passenger vehicles per year or reducing emissions of 14 households in a year.

Figure 25: Equivalent GHG benefits of implementing a BEB fleet at CTA[65].



[65] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

15.0 OTHER TRANSITION ITEMS

15.1 JOINT ZEB GROUP AND ASSESSMENT OF MULTI-OPERATOR VEHICLE PROCUREMENT

According to the CARB ICT regulation, transit agencies can pool resources when acquiring ZEB infrastructure if they:

- Share infrastructure
- Share the same MPO, transportation planning agency, or Air District
- Are located within the same Air Basin

The Calaveras Council of Governments is the Regional Transportation Planning Agency for the County of Calaveras and the City of Angels, and it is the designated planning and administrative agency for transportation projects and programs in the county. CTA's service area is located within the Calaveras County APCD and the Mountain Counties Air Basin. Table 20 lists the agencies that operate transit services within the same air basin. While CTA could theoretically partner with any transit agency in the region, the geographic proximity of service areas might negatively impact the feasibility of creating effective joint groups.

Table 20: Other bus transit agencies in Mountain Counties Air Basin

County	Agency	Total revenue vehicles[66]	ZEB Choice	Notes
Calaveras	***Calaveras Transit Agency***	***11***	***BEB***	
Plumas	Plumas County Transportation Commission	9	TBD	
Sierra	Sierra County Transportation Commission	4	TBD	Sierra County contracts with two non-profits to offer demand response and scheduled transit service to older adults and persons with disabilities, while also providing service to the general public if space is available. These two organizations are

[66] Based on NTD 2020 data.

County	Agency	Total revenue vehicles[66]	ZEB Choice	Notes
				Incorporated Seniors Citizens of Sierra County, offering service in Eastern Sierra County; and Golden Rays Seniors Citizens, offering service in Western Sierra County.
Nevada	Nevada County Transit Services	25	TBD	
Placer	Placer County Transit	56	TBD	No ZEB plan yet, but SCAG's 2021 FTIP noted the purchase of electric vehicles by Thousand Oaks transit to replace existing buses.
El Dorado	El Dorado Transit	51	BEB	
Amador	Amador Transit	20	TBD	ZEB plan currently underway.
Tuolumne	Tuolumne County Transit	20	BEB, hydrogen	
Mariposa	Mariposa County Transit	8	TBD	Mariposa County Transit is administered by the Mariposa Health and Human Services Agency

While CTA could potentially partner with any of these transit agencies to form a joint ZEB group, the most likely candidates for partnering are agencies moving forward with battery electric as their ZEB technology choice; this could potentially enable sharing the costs associated with charging infrastructure.

Regardless of whether a decision is made to explore formation of a formal joint ZEB group, CTA should remain in communication with other transit agencies in the region to understand how the agencies can work together to leverage resources and coordinate efforts on a regional level.

Another recommended strategy is developing a multi-operator vehicle procurement group. That is, CTA could join with any of the agencies outlined above to produce common specifications for ZEBs, thus potentially driving down the purchase costs of ZEBs by increasing the quantity of vehicles purchased. Leveraging joint procurement through the CalACT/MBTA purchasing cooperative (Cooperative) is a prudent approach, as the Cooperative offers a variety of ADA compliant vehicles like vans and cutaways. Currently, ZE options are limited. CTA and other operators may wish to encourage OEMs to develop vehicles with longer ranges and more hydrogen options, especially vehicle types like cutaways and vans.

15.2 CONSIDERATIONS FOR PARTNERSHIPS AND ALTERNATIVE FUELS

Based on our analysis of current service and operations, route modeling and bus simulations, market considerations, site audits, and meetings with stakeholders, Stantec's recommendation is for CTA to deploy an expanded fleet of BEBs (see Section 5.0 for further discussion for why FCEBs were not recommended at this time). Nonetheless, as a rapidly evolving field, technology maturation and changes in the local market for hydrogen may make fuel cell vehicles a potential alternative for CTA. Below we describe some considerations for hydrogen fuel cell technology for CTA's fleet.

The CARB ICT regulation regarding the rollout planning notes that these rollout plans are flexible, accounting for rapidly evolving technology and the challenge that transit operators face when implementing a new technology. So, while the recommendation of BEBs for CTA's fleet is the one presented on this report, fleet advancements could make a hydrogen vehicle an attractive option for CTA. However, in addition to the vehicle, reliable and readily access hydrogen fuel is an absolute requirement for the viability of hydrogen vehicles.

At the time of this writing, Ideanomics together with US Hybrid is producing a hydrogen-powered passenger van with a stated range of up to 250 miles.[67] Currently, no transit agencies are operating FCE cutaways, but new offerings are positive developments showing the interest in new technology for different vehicle styles along with the rapid evolution of the ZE field.

One of the major obstacles to deploying FCEBs over BEBs is that they are, depending on configurations, 15-20% more expensive than a BEB[68]. This price premium results from a combination of the fuel cell stack and related technology, leading to an increase in the number of specialized parts on a FCEB compared to BEBs. This has also resulted in costlier maintenance in pilots to date. As an example, a FCE passenger van from Ideanomics is quoted at $220,000, while the BE passenger van that CTA is purchasing is quoted at ~$200,000 with base options; a fossil fuel-powered equivalents can be below $100,000.

Nonetheless, the major advantage of a FCEB is its operating range of ~300 miles, approaching the operating ranges of diesel buses. This means that FCEBs are more likely than BEBs to support a one-to-one replacement scheme with traditional fossil fuel-powered vehicles. Indeed, Stantec modeling for a nearby transit agency in Tuolumne County with similar operating profiles and challenges demonstrated a nearly 100% success rate for hydrogen-powered vehicles.

Fueling is always a primary concern when considering FCEB implementation, as nearby access to a reliable source of hydrogen is required to support the fleet. The potential cost of arranging hydrogen fueling for a fuel-cell CTA fleet will likely be prohibitive for several years. Two options for hydrogen fueling include on-site fueling and offsite fueling.

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[67] https://www.ushybrid.com/wp-content/uploads/2022/05/USH_CaseStudies_SARTAVan_2022_DIGITAL.pdf
[68] However, if more BEBs are required to maintain service compared to the diesel/gasoline fleet size, the capital vehicle cost of a BEB fleet could approach the capital vehicle cost of a FCEB fleet.

- One route would be to build a hydrogen fueling facility onsite. Fueling is comparable to a CNG or diesel bus, and takes, on average, 8-12 minutes per bus. The refueling facility would have to store hydrogen as a liquid since gaseous hydrogen stations are only used for a max of 180 kg/day and the anticipated hydrogen demand for CTA would likely be higher. Detailed calculations regarding the amount of FCEBs that could be served by an on-site station would need to be performed. Costs would also be determined; however, estimates for this fleet size usually land at around $2 million. Therefore, the approximate cost of a liquid hydrogen station for CTA would be close to $4 million and would require one pump and one hydrogen dispenser with an average flow rate of 4 kg/minute.
- Offsite fueling opportunities in Calaveras County are currently insufficient, as the closest bus fueling stations to the County are in the Oakland area, over a hundred miles away. Building offsite fueling facilities would require more investment than on-site fueling and would need the involvement of more regional stakeholders (including utilities).

If fueling infrastructure was implemented on-site, then significant upgrades and equipment would be required at a sizable cost in addition to items like installing hydrogen gas detection systems. If fueling occurred offsite, then CTA would only need to install hydrogen gas leak detection systems, along with other safety precautions, but little else of the facilities would need alteration. In both scenarios, the maintenance facilities would require additional tools and equipment specifically for repairs and upkeep of hydrogen fuel cell specific items. Spare bus parts would need to be acquired as well.

As the demand for hydrogen grows, it is possible that hydrogen fueling stations become more prevalent and closer to CTA's facility. Indeed, Stantec is working with the Tuolumne County Transit Authority (TCTA) to develop their ZEB rollout plan and the tentative approach for TCTA is a mixed fleet of BE and FCE vehicles due to an interesting opportunity developing in Tuolumne County. Yosemite Clean Energy, a private energy firm, is developing plans to open a hydrogen producing plant in Tuolumne County. This plant is designed to use forest waste as a biomass method of producing hydrogen. TCTA is planning on using offsite fueling at a proposed retail hydrogen fuel station. In this way, TCTA can offload the investment in a costly on-site fueling yard by fueling at a retail station. While this potential option in Tuolumne County is nearly an hour away from CTA's bus yard, Yosemite Clean Energy could in the future look at expanding into Calaveras County. If hydrogen becomes more readily available nearby CTA's facilities and if the pricing is reasonable, CTA should explore offsite fueling opportunities.

15.3 CHANGE MANAGEMENT

Finally, because a ZEB transition and implementation is an agencywide endeavor that also includes the need to actively consider utilities as a stakeholder and partner, an agencywide approach is required. Communication will be critical during the transition to ensure customers are made aware of potential disruptions and changes to bus operations. ZEB conversion also offers an excellent marketing opportunity for CTA to promote its climate commitments.

16.0 PHASING AND IMPLEMENTATION

Table 21 provides an overview of the phasing plan for CTA's ZEB rollout strategy. Note that expenses are in the year of cost incurred, while the fleet quantity columns show when vehicles are delivered, which is offset from the purchase year.

Table 21: ZEB Implementation Phasing Plan, FY2023-2040

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2023		1 van	33%	Original equipment manufacturer (OEM) training	OEM training for all other staff	$378,000	$266,000	$644,000
FY2024		0	0%	Annual refreshers	Coordination with local fire and emergency response department for ZE technology for emergency responses	$196,000	$252,000	$448,000
FY2025	2 chargers with dual dispenser	0	0%	OEM training	No activity	$815,000	$236,000	$1,051,000
FY2026		1 van	50%	Annual refreshers	Local fire and emergency response department refreshers	$253,000	$222,000	$475,000
FY2027		1 cutaway	50%	OEM training	OEM training for all other staff	$265,000	$199,000	$464,000
FY2028		0	No procurement	Annual refreshers	Local fire and emergency response department refreshers	$0	$189,000	$189,000
FY2029	2 chargers with dual dispenser	2 cutaways	100%	OEM training	No activity	$822,000	$158,000	$980,000
FY2030		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$157,000	$141,000	$298,000

Year	Charging Equipment Installation	ZEB Fleet Procurements	ZEB Fleet Adoption as Percentage of Procurement	Training: Operators, Maintenance staff, Technicians	Training - Other	Capital Expenses (2022$)	Operating Expenses (2022$)	Total Expenses (2022$)
FY2031		2 cutaways 1 van	100%	OEM training	OEM training for all other staff	$416,000	$120,000	$536,000
FY2032	1 charger with dual dispenser	2 cutaways	100%	Annual refreshers	Local fire and emergency response department refreshers	$483,000	$113,000	$596,000
FY2033		1 cutaway	100%	OEM training	No activity	$135,000	$98,000	$233,000
FY2034		1 cutaway 1 van	100%	Annual refreshers	Local fire and emergency response department refreshers	$230,000	$83,000	$313,000
FY2035		1 cutaway	100%	OEM training	OEM training for all other staff	$122,000	$87,000	$209,000
FY2036		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$116,000	$88,000	$204,000
FY2037		1 cutaway	100%	OEM training	No activity	$111,000	$83,000	$194,000
FY2038		0	No procurement	Annual refreshers	Local fire and emergency response department refreshers	$0	$77,000	$77,000
FY2039		2 cutaways 1 van	100%	OEM training	OEM training for all other staff	$280,000	$74,000	$354,000
FY2040		1 cutaway	100%	Annual refreshers	Local fire and emergency response department refreshers	$95,000	$69,000	$164,000

APPENDICES

APPENDIX A: FINANCIAL MODELING INPUTS AND ASSUMPTIONS

Table 22 presents a description as well as the sources for the cost inputs (in 2022$) of the Base Case and the ZEB Case.

Table 22: Summary of cost inputs

Main Category	Item	Description	Inputs for Base Case	Inputs for ZEB Case	Sources and comments
Fleet Acquisition	Bus purchase price	Purchase price of a bus/vehicle inclusive of options and taxes and standard warranty.	Diesel cutaway: $115,080 Gasoline cutaway: $98,601 Gasoline vans: $58,973	BE cutaway: $255,574 BE van: $202,644	Base Case: based on recent vehicle quotes and most recent purchase prices from 2018 TAM Plan adjusted for inflation to 2022$. ZEB Case: based on vehicle quotes. Values are in 2022$ and adjusted over time based on price trendlines from the California Air Resource Board.
Infrastructure and Facility Modifications	Infrastructure Modification Costs	Includes equipment, installation, testing, civil and electrical work, as well as contractor's fees and escalation factors.	N/A	Main facility: $1,965,674	Engineer's cost estimate.
Operating	Vehicle fuel	Cost of fuel commodity for revenue vehicles.	Diesel: $5.13 per gallon Gasoline: $5.24 per gallon	Electricity: $0.184 per kWh	Base Case: CTA ZEB Case: the average price for electricity in $/kWh was calculated based on the current rates for PG&E.

Main Category	Item	Description	Inputs for Base Case	Inputs for ZEB Case	Sources and comments
Maintenance	Vehicle maintenance costs	Maintenance costs (per mile) inclusive of labor and parts for scheduled and unscheduled maintenance. Listed in 2022$ and projected out through 2040.	2022: $0.21 per mile	2022: $0.20 per mile	Base Case: CTA's OM contract with Paratransit Services, adjusted to 2022$, and projected through 2040. ZEB Case: based on the Base Case but adjusted to assume no fluids (oil and lubricants).

APPENDIX B: PDF OF SITE PLANS

GENERAL NOTES:

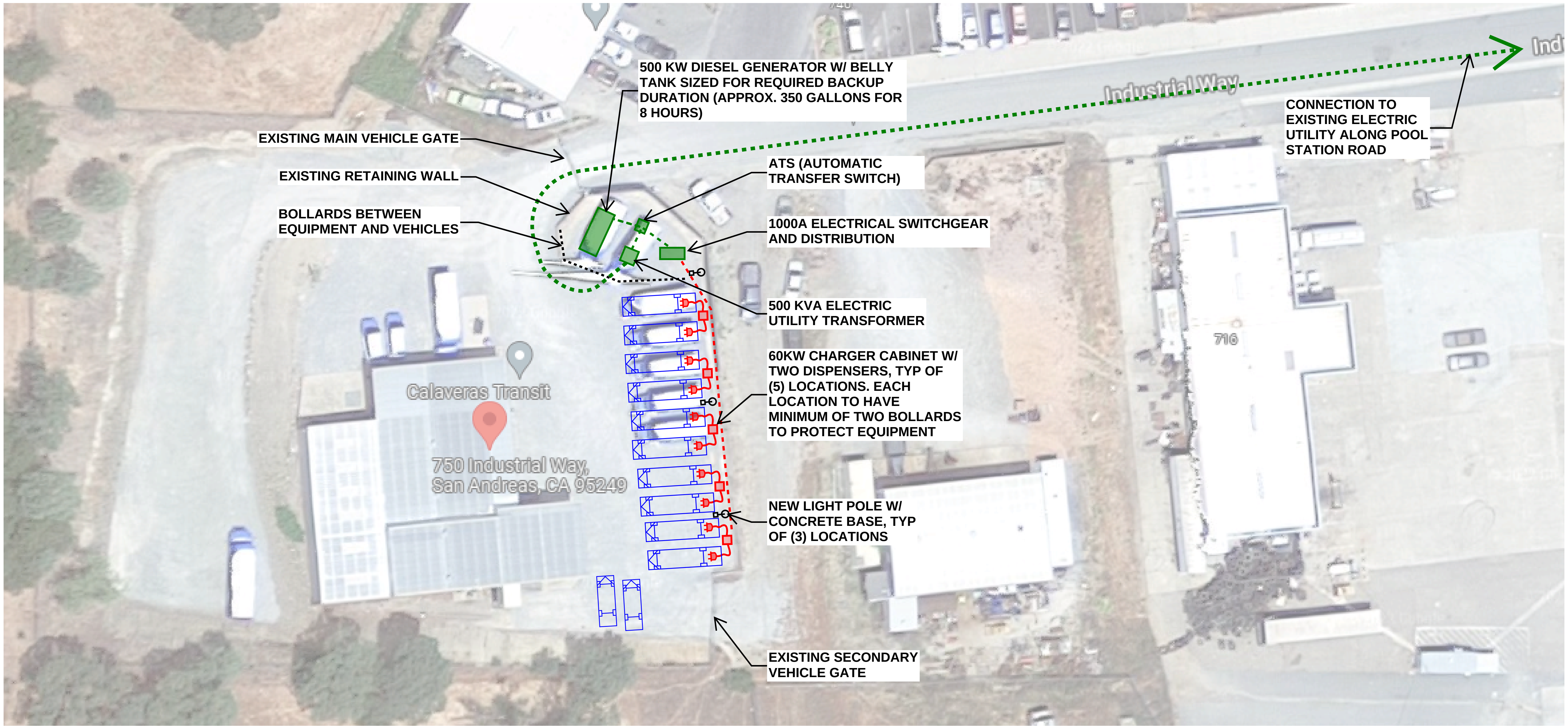
1. DIMENSIONS SHOWN ARE APPROXIMATE AND FOR SPACE PLANNING PURPOSES ONLY.
2. PROPOSED LAYOUT UTILIZES 1:2 RATIO OF CHARGING CABINETS TO DISPENSERS. DISPENSER LOCATIONS ARE BASED ON CHARGING PORTS ON BUSES BEING LOCATED ON BOTH SIDES OF THE REAR OF THE BUSES. LAYOUT SHOWN IS CONCEPTUAL AND FOR PLANNING PURPOSES ONLY.
3. PROPOSED LAYOUT MAINTAINS EXISTING PARKING CONFIGURATIONS AT THE FACILITY AND ASSUMES THAT BUSES WILL CONTINUE TO BE BACKED INTO PARKING STALLS.
4. DISPENSERS SHOULD NOT EXCEED ~330' OF CABLE DISTANCE FROM CHARGER CABINET TO STAY WITHIN STANDARD COMMUNICATION CABLING LIMITATIONS.
5. NEW BOLLARDS TO BE INSTALLED AROUND ALL NEW ELECTRICAL EQUIPMENT.
6. CHARGING EQUIPMENT NOT SHOWN TO SCALE.

LEGEND

- NEW UNDERGROUND CONDUIT
- NEW UNDERGROUND SERVICE CONDUIT
- NEW ELECTRICAL SERVICE EQUIPMENT
- CHARGING CABINET / EQUIPMENT W/ QUANTITY OF DISPENSERS SHOWN

Stantec

Stantec Proj No.
2073016240



CALAVERAS TRANSIT AGENCY
750 INDUSTRIAL WAY, SAN ANDREAS, CA 95249

ZEB ROLLOUT & IMPLEMENTATION PLAN
CONCEPTUAL SITE PLAN

DATE:
10/18/22

DWG:
1.0

SCALE: 1" = 40'
IF PRINTED ON 11x17

N

APPENDIX C: COST ESTIMATES

JACOBUS & YUANG, INC.

CALAVERAS TRANSIT AGENCY

ZEB ROLLOUT & IMPLEMENTATION PLAN
SAN ANDREAS, CA 95249

CONCEPTUAL DESIGN
OPINION OF PROBABLE COST

JYI #: C2633A-R1

October 12, 2022
REVISED October 14, 2022

PREPARED FOR:

STANTEC

BY:

JACOBUS & YUANG, INC.
355 North Lantana Street, #220
Camarillo, CA 93010
Tel (213) 688-1341 or (805) 339-9434

PROJECT: CALAVERAS TRANSIT AGENCY	**JYI #: C2633A-R1**
LOCATION: SAN ANDREAS, CA 95249	**DATE: 12-Oct-22**
CLIENT: STANTEC	**REVISED: 14-Oct-22**
DESCRIPTION: R.O.M. OPINION OF PROBABLE COST - SUMMARY	

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
	COST SUMMARY				
	TRANSIT CENTERS				**$**
	CALAVERAS TRANSIT	10	EA	$ 196,567.35	1,965,674
	R.O.M. TOTAL OF OPINION OF PROBABLE CONSTRUCTION COST W/ PRORATES + ESCALATION	**10**	**EA**	**$196,567**	**1,965,674**

BASE WORK SCOPE ESCALATION CALCULATION PARAMETERS

BASE MONTH	Oct-22
CONSTRUCTION START MONTH	**Jul-25**
CONSTRUCTION DURATION (MONTHS)	4
MID POINT OF CONSTRUCTION	Sep-25
% ANNUAL ESCALATION	7.50%
ALLOWANCE FOR ESCALATION (TO MIDPOINT OF CONSTRUCTION)	23.55%

NOTES:

SPECIFIC INCLUSIONS

1 PREVAILING WAGE RATES IN THE AREA OF THE PROJECT
2 (5) DUAL CABLE BEB CHARGING DISPENSERS WITH POWER CONNECTIONS
3 ALLOWANCE FOR COMMUNICATIONS RELATED TO BEB SYSTEM
4 INCOMING PRIMARY SERVICE CONDUIT IN DUCTBANK

SPECIFIC EXCLUSIONS

1 ASBESTOS OR HAZARDOUS MATERIAL ABATEMENT
2 PROJECT SOFT COSTS & CONSTRUCTION CONTINGENCY
3 PUD TRANSFORMER

GENERAL NOTES

1 ESTIMATE ASSUMES THAT ALL COMPONENTS WILL BE BID AS A SINGLE BID PACKAGE
2 ESTIMATE ASSUMES WORK TO BE DURING NORMAL WORKING HOURS
3 ESTIMATE ASSUMES BID COVERAGE FROM AT LEAST 4-5 RESPONSIVE BIDDERS
4 ESTIMATE IS BASED ON CONCEPTUAL SITE PLAN DRAWINGS PREPARED BY STANTEC DATED 10/04/2022 & RECEIVED THE SAME DAY.

PROJECT: CALAVERAS TRANSIT AGENCY		**JYI #:**	**C2633A-R1**
LOCATION: SAN ANDREAS, CA 95249		**DATE:**	**12-Oct-22**
CLIENT: STANTEC		**REVISED:**	**14-Oct-22**
DESCRIPTION: R.O.M. OPINION OF PROBABLE COST - SUMMARY			

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL

DEFINITIONS

OPINION OF COST

An Opinion of Cost is prepared from a survey of the quantities of work-items prepared from written or drawn information provided at the Conceptual or Schematic stage of design.

Historical costs, information provided by contractors and suppliers, plus judgmental evaluation by the Estimator are used as appropriate as the basis for pricing.

Allowances as appropriate will be included for items of work which are not indicated on the design documents, provided that the Estimator is made aware of them, or which in the judgement of the Estimator are required for completion of the work.

JYI cannot, however, be responsible for inclusion of items or work of which we have not been informed.

BID

An offer to enter a contract to perform work for a fixed sum, to be completed within a limited period of time.

SPECIAL NOTE - MARKET CONDITIONS

In the current market conditions for construction, our experience shows the following results on competitive bids, as a differential from JYI final estimates:

Number of bids	Percentage Differential
1...........	+ 25 to 50%
2-3.........	+ 10 to 25%
4-5.........	+ 0 to 10%
6-7.........	+ 0 to - 5%
8 or more....	+ 0 to -10%

Accordingly, it is extremely important to ensure that a minimum of 4-5 valid bids are received

PROJECT: CALAVERAS TRANSIT AGENCY		**JYI #:**	**C2633A-R1**
LOCATION: SAN ANDREAS, CA 95249		**DATE:**	**12-Oct-22**
CLIENT: STANTEC		**REVISED:**	**14-Oct-22**
DESCRIPTION: R.O.M. OPINION OF PROBABLE COST - CALAVERAS TRANSIT		**DISPENSER QTY:**	**10**

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
	SUMMARY OF ESTIMATE				**$**
1	CHARGERS & DISPENSERS	10	EA	39,533.00	395,330
2	ELECTRICAL EQUIPMENT, DISTRIBUTION & COMMUNICATIONS	1	LS	530,853.00	530,853
3	EXTERIOR IMPROVEMENTS	1	LS	66,918.00	66,918
	SUBTOTAL				**993,101**
	GENERAL CONDITIONS / GENERAL REQUIREMENTS	15.00%		14,896.52	148,965
	ESTIMATE / DESIGN CONTINGENCY	20.00%		22,841.32	228,413
	MARKET FACTOR	7.00%		9,593.36	95,934
	SUBTOTAL			**146,641.29**	**1,466,413**
	BONDS & INSURANCE	2.00%		2,932.83	29,328
	CONTRACTOR'S FEE	6.50%		9,531.68	95,317
	SUBTOTAL			**159,105.80**	**1,591,058**
	ESCALATION (TO MIDPOINT) - SEE SUMMARY FOR ESCALATION PARAMETERS	23.55%		37,461.55	374,615
	R.O.M. OPINION OF PROBABLE COST			**196,567.35**	**1,965,674**

PROJECT: CALAVERAS TRANSIT AGENCY		**JYI #:**	**C2633A-R1**
LOCATION: SAN ANDREAS, CA 95249		**DATE:**	**12-Oct-22**
CLIENT: STANTEC		**REVISED:**	**14-Oct-22**
DESCRIPTION: R.O.M. OPINION OF PROBABLE COST - CALAVERAS TRANSIT		**DISPENSER QTY:**	**10**

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
1	**CHARGERS & DISPENSERS**				**$**
	PEDESTAL-MOUNTED BEB DISPENSERS				
	60 kW CHARGER W/ DUAL DISPENSERS	5	EA	75,000.00	375,000
	DISPENSER PAD, 3' x 3'				SEE 3.0
	DISPENSER ANCHORAGE	5	EA	300.00	1,500
	MISCELLANEOUS				
	MISCELLANEOUS/TESTING	1	LS	18,830.00	18,830
	SUBTOTAL				**395,330**
2	**ELECTRICAL EQUIPMENT, DISTRIBUTION & COMMUNICATIONS**				**$**
	EQUIPMENT - OVERALL				
	500kW DIESEL GENERATOR W/ BELLY TANK	1	EA	267,000.00	267,000
	500kW ELECTRIC UTILITY TRANSFORMER - BY UTILITY				BY PUD
	ELECTRICAL SWITCHGEAR & DISTRIBUTION (1000 AMPS)	1	EA	70,000.00	70,000
	ATS (600 AMPS)	1	EA	43,195.00	43,195
	600 AMP DISCONNECT SWITCH FOR CHARGER CIRCUITS	5	EA	8,000.00	40,000
	EQUIPMENT GROUNDING	3	EA	750.00	2,250
	NEW ELECTRICAL UTILITY PULLBOX	1	EA	3,500.00	3,500
	NEW SWITCHGEAR PULLBOX	1	EA	3,000.00	3,000
	SITE ELECTRICAL DISTRIBUTION				
	20' POLE MOUNTED LIGHTING W/ SINGLE HEAD, COMPLETE W/ FEEDERS	3	EA	3,075.00	9,225
	100 AMP FEEDER, PVC SWITCHGEAR TO CHARGER HOME RUN + 5 CLUSTER D-BANK	24	LF	136.18	3,268
	100 AMP FEEDER, PVC SWITCHGEAR TO CHARGER HOME RUN + 4 CLUSTER D-BANK	25	LF	115.34	2,884
	100 AMP FEEDER, PVC SWITCHGEAR TO CHARGER HOME RUN + 3 CLUSTER D-BANK	22	LF	94.51	2,079
	100 AMP FEEDER, PVC SWITCHGEAR TO CHARGER HOME RUN + 2 CLUSTER D-BANK	21	LF	84.09	1,766
	100 AMP FEEDER, PVC SWITCHGEAR TO CHARGER HOME RUN + 1 CLUSTER D-BANK	23	LF	75.41	1,734
	3" DIAM. PVC C.O. IN DUCTBANK + CUT & PATCH AC PAVING - INCOMING SERVICE	404	LF	74.05	29,916
	3" DIAM. PVC C.O. IN DUCTBANK + CUT & PATCH A.B. PAVING - INCOMING SERVICE	83	LF	93.11	7,728
	600 AMP PVC FEEDER IN DUCTBANK - XFMR TO ATS	11	LF	238.00	2,618
	600 AMP PVC FEEDER IN DUCTBANK - ATS TO GENERATOR	15	LF	238.00	3,570
	600 AMP PVC FEEDER IN DUCTBANK - ATS TO SWITCHGEAR	15	LF	238.00	3,570
	U/G PULL SECTION AT ELECTRICAL EQUIPMENT	2	EA	650.00	1,300
	COMMUNICATIONS				
	COMM. CONNECTION TO ELECTRICAL ROOM, CHARGERS AND DISPENSERS, COMPLETE	1	LS	6,970.00	6,970
	MISCELLANEOUS				
	MISC. ELECTRICAL UTILITY/TESTING	1	LS	25,280.00	25,280
	SUBTOTAL				**530,853**
3	**EXTERIOR IMPROVEMENTS**				**$**
	BOLLARDS FOR ELECTRICAL EQUIPMENT PROTECTION	38	EA	1,140.00	43,320
	CONCRETE PAVING AROUND ELECTRICAL EQUIPMENT	1447	SF	12.50	18,088
	CONCRETE PAD AROUND CHARGERS, 3' X 3'	5	EA	230.00	1,150
	CONCRETE CURB AROUND ELECTRICAL EQUIPMENT	70	LF	30.00	2,100

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DESCRIPTION: R.O.M. OPINION OF PROBABLE COST - CALAVERAS TRANSIT		**DISPENSER QTY:**	**10**

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
	MISCELLANEOUS				
	MISCELLANEOUS EXTERIOR IMPROVEMENTS	1	LS	2,260.00	2,260
	SUBTOTAL				**66,918**

CALAVERAS TRANSIT AGENCY
COUNTY OF CALAVERAS
State of California
April 5, 2023

RESOLUTION NO. FY 23-8

A RESOLUTION APPROVING THE CALAVERAS TRANSIT AGENCY ZERO EMISSIONS BUS (ZEB) ROLLOUT AND IMPLEMENTATION PLAN AND AUTHORIZING THE EXECUTIVE DIRECTOR TO SUBMIT THE ZEB ROLLOUT PLAN TO THE CALIFORNIA AIR RESOURCES BOARD IN ACCORDANCE WITH THE INNOVATIVE CLEAN TRANSIT REGULATIONS

WHEREAS, Calaveras Transit Agency is a Joint Powers Authority whose Board of Directors is comprised of two elected officials from each member agency, which includes the County Board of Supervisors, and the City of Angels Camp and three Citizen Members-at-large; and

WHEREAS, the Innovative Clean Transit (ICT) regulations were adopted by the California Air Resources Board (CARB) in December 2018 and became effective on October 1, 2019; and

WHEREAS, Title 13 of the California Code of Regulations § 2023 (13 CCR § 2023.1 through 2023.11) requires all public transit agencies to gradually transition their bus fleet to zero-emission technologies; and

WHEREAS, each transit agency is required to adopt and submit to CARB a ZEB Rollout Plan describing how the agency will transition to a zero-emission fleet; and

WHEREAS, CTA's ZEB Rollout Plan is required to be submitted to CARB by July 1, 2023; and

WHEREAS, CTA's goal is to fully transition to zero-emission technologies by 2040, avoiding early retirement of compressed natural gas (CNG) buses, and as can be achieved with available funds; and

WHEREAS, the Board of Directors has approved a Rollout and Implementation Plan as a foundation to guide the implementation of ZEBs and compliance with California Code of Regulations § 2023.2.

NOW THEREFORE, BE IT RESOLVED that the Board of Directors of Calaveras Transit Agency adopts the Calaveras Transit Agency's ZEB Rollout and Implementation Plan, attached hereto.

NOW, THEREFORE, BE IT FURTHER RESOLVED that the Board of Directors of the Calaveras Transit Agency authorize the Executive Director to submit the Calaveras Transit Agency's ZEB Rollout and Implementation Plan, and any other documents or instruments required by CARB for the submittal and adoption of the ZEB Rollout and Implementation Plan, in accordance with the ICT Regulations.

The foregoing Resolution was duly passed and adopted by the Calaveras Transit Agency at a regular meeting thereof, held on 5th day of April 2023, by the following vote:

RESULT:	ADOPTED BY CONSENT VOTE [UNANIMOUS]
MOVER:	Pat Bettinger, Citizen Member
SECONDER:	Tim Muetterties, Citizen Member
AYES:	Muetterties, Catalano, Tofanelli, Broglio, Stopper, Bettinger
ABSENT:	Isabel Moncada

ATTEST

Melissa Raggio, Clerk to the Council
Calaveras Transit Agency

Alvin Broglio, Vice Chair
Calaveras Transit Agency