TAHOE TRANSPORTATION DISTRICT (TTD)
PROGRAM IMPLEMENTATION COMMITTEE

Meeting Agenda

Tahoe Regional Planning Agency
128 Market Street
Stateline, NV 89448

January 7, 2025
3:00 p.m.

The Tahoe Transportation District Program Implementation Committee meeting will be physically open to the public at the Tahoe Regional Planning Agency, Stateline, NV 89449 and in accordance with applicable law, Committee members may be teleconferencing into the meeting via GoToWebinar.

Committee members: Wesley Rice-Chair, Cody Bass, Brian Bigley, Andy Chapman, Brendan Ferry, Nick Speal, Raymond Suarez

To attend the TTD Committee meeting remotely, use the following link:
https://attendee.gotowebinar.com/register/1226533152624371030

After registering, you will receive a confirmation email containing information about joining the webinar.

Members of the public may observe the meeting and submit comments in person at the above location or via GoToWebinar. Please be advised that those participating in the meeting remotely do so at their own risk. Meetings will not be cancelled due to technical difficulties. Members of the public may also provide public comment by sending comments to the Clerk to the Board by email at jallen@tahoetransportation.org. Please note which agenda item the comment pertains to. Comments will be distributed at the meeting and attached to the minutes of the meeting. All comments should be a maximum of 500 words, which corresponds to approximately three minutes of speaking time. Comments for each agenda item should be submitted prior to the close of that agenda item.

Any member of the public who needs accommodations should email or call Judi Allen who will use her best efforts to provide reasonable accommodations to provide as much accessibility as possible, while also maintaining public safety in accordance with TTD's procedure for resolving reasonable accommodation requests. All reasonable accommodations offered will be listed on the TTD website at tahoetransportation.org.

All items on this agenda are action items unless otherwise noted. Items on the agenda may be taken out of order. The Committee may combine two or more items for consideration. The Committee may remove an item from the agenda or delay discussion relating to an item on the agenda at any time.

I. CALL TO ORDER AND GENERAL MATTERS

A. Roll Call and Determination of Quorum
B. *For Possible Action:* Approval of Agenda for January 7, 2025
C. *For Possible Action:* Approval of Minutes of November 6, 2024 **Page #1**

II. PUBLIC INTEREST COMMENTS

All comments are to be limited to no more than three minutes per person for matters not listed on this agenda. Comments made cannot be acted upon or discussed at this meeting, but may be placed on a future agenda for consideration.

III. DISCUSSION ITEMS

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A.	*For Possible Action:* Presentation of the Draft Final Zero Emission Fleet Conversion Plan and Announcement of 30-Day Public Comment Period	**3**
B.	*Informational Only:* Informational Transit System Report for the Fourth Quarter of Fiscal Year 2024	**115**
C.	*Informational Only:* Informational Transit System Report for the First Quarter of Fiscal Year 2025	**117**
D.	*Informational Only:* Informational Update on Tahoe Transportation District Active Capital Improvement Program Projects	**119**

IV. COMMITTEE MEMBER REQUESTS AND COMMENTS

This portion of the agenda is for members to make requests for future agenda items or to make a brief report about personal activities without further deliberation by the committee, although any member may request an item to be placed on a future agenda in response to such remarks.

V. PUBLIC INTEREST COMMENTS

VI. ADJOURNMENT

COMPLIANCE WITH PUBLIC NOTICE REQUIREMENTS

This notice and agenda has been posted at the TTD office and at the Stateline, Nevada post office. The notice and agenda has also been posted at the North Tahoe Conference Center in Kings Beach, the Incline Village GID office, the North Tahoe Chamber of Commerce, and on TTD's website: www.tahoetransportation.org.

For those individuals with a disability who require a modification or accommodation in order to participate in the public meeting, please contact Judi Allen at (775) 589-5502 or jallen@tahoetransportation.org.

Open Meeting Law Compliance

Written notice of this meeting has been given at least seven days before the meeting by posting a copy of this agenda at the principal office of TTD and at three other separate, prominent places within the jurisdiction of TTD no later than the seventh day before the meeting.

Written notice of this meeting has been given by providing a copy of this agenda to any person who has requested notice of the meetings of the Committee. Such notice was delivered to the postal service used by the Committee no later than the seventh day before the meeting for transmittal to the requester by regular mail, or if feasible for TTD and the requester has agreed to receive the public notice by electronic mail, transmitted to the requester by electronic mail sent no later than the seventh day before the meeting.

Supporting materials were provided to any person requesting such materials and were made available to the requester at the time the material was provided to the members of the Committee or, if provided to the members of the Committee at the meeting, were made available to the requester at the meeting and are available on the TTD website: www.tahoetransportation.org. Please send requests for copies of supporting materials to Judi Allen at (775) 589-5502 or jallen@tahoetransportation.org.

TAHOE TRANSPORTATION DISTRICT
PROGRAM IMPLEMENTATION COMMITTEE
MEETING MINUTES
November 6, 2024

Committee Members in Attendance:
Cody Bass, City of South Lake Tahoe
Brian Bigley, Member at Large
Andy Chapman, TNT-TMA
Brendan Ferry, El Dorado County
Sharla Hales, Douglas County
Nick Speal, CA Gov Appointee

Committee Members Absent:
Raymond Suarez, SS-TMA

Others in Attendance:
Carl Hasty, Tahoe Transportation District
Jim Marino, Tahoe Transportation District
George Fink, Tahoe Transportation District
Judi Allen, Tahoe Transportation District

I. CALL TO ORDER AND GENERAL MATTERS

A. Roll Call and Determination of Quorum
The meeting of the Committee was called to order by Mr. Chapman at 1:19 p.m. at the Tahoe Regional Planning Agency and via GoToWebinar. Roll call was taken and it was determined a quorum was in attendance for the Committee.

B. Approval of Agenda of November 6, 2024
Motion/second by Mr. Bigley/Mr. Speal to approve the agenda for today's meeting. The motion passed unanimously.

C. Approval of Meeting Minutes for August, 2024
Motion/second by Mr. Speal/Mr. Bigley to approve the minutes. The motion passed unanimously.

II. PUBLIC INTEREST COMMENTS

There were no public interest comments.

Mr. Bass arrived at 1:23 p.m.

III. DISCUSSION ITEMS

A. Recommend the TTD Board of Directors Authorize the District Manager to Execute a Purchase Order with RO Bus Sales Under the Nevada State Purchasing Division Bid Number 80DOT-S2850 for Transit Vehicles, for the Purchase of Four Transit Vehicles (Two All-Wheel Drive Gasoline Vans and Two Battery-Electric Vans) and Associated Modifications and Equipment, Not to Exceed $595,000
Mr. Fink reviewed this item. Mr. Bass asked if any of the funds for the purchase are from SB125 and asked about transferring the vans to the JPA. Mr. Fink stated SB125 funds are not being used for this purchase and the vehicles would be transferable. Ms.

Hales noted that it seems premature to be discussing transferring anything to the JPA at this time.

Action Requested: For Possible Action

Mr. Ferry moved to recommend the TTD Board of Directors authorize the District Manager to execute a purchase order with RO Bus Sales under the Nevada State Purchasing Division bid number 80DOT-S2850 for transit vehicles, for the purchase of four transit vehicles (two all-wheel drive gasoline vans and two battery-electric vans) and associated modifications and equipment, not to exceed $595,000. Mr. Bigley seconded the motion. The motion passed unanimously.

B. Recommend the TTD Board of Directors Approve Contract Amendment 1 with Parametrix, Inc. to Amend the Existing Contract in the Amount of $160,760 for a Total Amount Not to Exceed $1,026,923 for the Data Aggregation Plan for Lake Tahoe Basin Roadways SMART Grant Program
Mr. Marino reviewed this item.

Action Requested: For Possible Action

Mr. Bass moved to recommend the TTD Board of Directors approve contract amendment 1 with Parametrix, Inc. to amend the existing contract in the amount of $160,760 for a total not to exceed amount of $1,026,923 for the Data Aggregation Plan for Lake Tahoe Basin Roadways SMART grant program. Mr. Bigley seconded the motion. The motion passed unanimously.

C. Informational Update on the Zero Emission Fleet Conversion Plan
Mr. Fink reviewed this item.

Action Requested: Informational Only

IV. COMMITTEE MEMBER REQUESTS AND COMMENTS

Mr. Chapman requested to have an item on the PIC agenda for plowing the East Shore Trail parking lot. Mr. Marino noted the District reached out to a contractor regarding plowing the lot and will bring it to the Board in December.

V. PUBLIC INTEREST COMMENTS

There were no comments.

VI. ADJOURNMENT

The meeting adjourned at 2:04 p.m.

Respectfully Submitted:

Judi Allen
Executive Assistant
Clerk to the Board
Tahoe Transportation District

(The above meeting was recorded in its entirety, anyone wishing to listen to the aforementioned tapes, please contact Judi Allen, Clerk to the Board (775) 589-5502.)

Tahoe Transportation DISTRICT

Connecting our communities

MEMORANDUM

Date: January 2, 2025

To: Tahoe Transportation District (TTD) Program Implementation Committee

From: George Fink, Transportation Services Director

Subject: Presentation of the Draft Final Zero Emission Fleet Conversion Plan and Announcement of 30-Day Public Comment Period

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Action Requested:
It is requested the Committee receive a presentation on the draft final Zero Emission Fleet Conversion Plan (ZEFCP) (Attachment A).

Fiscal Analysis:
All expenditures associated with this item for the fiscal year are in the approved FY25 budget.

Work Program Impact:
All work associated with these efforts is captured under respective elements of the approved FY25 Work Program, with corresponding allotted staff time under respective projects. Transit system reporting aligns with Strategic Goal SG-3 "Fund and operate regional multi-modal transportation systems."

Background:
In December 2022, the Board of Directors directed Staff to achieve a zero-emission bus (ZEB) fleet by 2040. TTD released a Request for Proposals (RFP) on July 17, 2023 seeking assistance to develop a ZEFCP to meet this challenge. The contract was awarded to Stantec Consulting at the September 2023 Board of Directors meeting. A notice to proceed was issued on November 7, 2023.

The RFP included an extensive scope of work that analyzes the planning, scheduling and dispatching bus routes, operations and fleet maintenance, fleet size, funding ZEB procurements, staffing and training personnel, infrastructure needs, fuel/charging cost, regulatory compliance, and maintenance and management. The plan provides TTD, or other operator(s), with the tools to transition to a zero-emission fleet by 2040.

The draft final plan was received in December 2024 and is a road map to full zero emission technology adoption incorporating the entire lifecycle of the vehicles and supporting infrastructure.

GF/ja

AGENDA ITEM: III.A.

Discussion:
TTD provides fixed-route, paratransit, and other transportation related services and capital projects to residents and visitors to the Lake Tahoe basin. In 2022, TTD provided 269,576 unlinked passenger trips with a full-size and cutaway bus fleet.

This plan serves to guide staff through the ZEB transition to achieve a 100% zero-emission (ZE) fleet by 2040 as targeted by the Board. Although TTD is not beholden to the California Air Resources Board (CARB) Innovative Clean Transit (ICT) mandate, their transition timeline and goals are guided by this regulation. This plan provides a detailed roadmap of the technology, needs, and strategies that will help transition to a ZEB fleet.

The previous phases of this project laid the foundation for this plan by assessing existing conditions and modeling the energy and power requirements needed to meet 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 of battery-electric (BE) vehicles only.

The BE vehicle implementation will allow the District to leverage their early investments in battery-electric buses (BEBs) and charging infrastructure at the Lake Tahoe Community College Mobility Hub. This option will expand on-route charging infrastructure, while planning the design of a future operations and maintenance facility that supports overnight charging.

While BE-only implementation is the recommended approach, it is important to understand the inherent risk in relying on a single propulsion type. Adequate system redundancy in terms of fleet capability and charging equipment must be developed so as to not compromise service levels. A close relationship with the utility providers, Liberty Utilities in California and NV Energy in Nevada, should be maintained.

With the preferred fleet composition established, the next steps included determining the facility upgrades and modifications required to support ZEB operations at potential on-route charging locations and a future facility. This assessment was done at a high level to offer flexibility as development strategies evaluated. In addition, a financial model was developed to compare a base case (or business-as-usual case with fossil fuel vehicles plus up to five BE vehicles) and a case with a 100% BE fleet. A phasing and implementation plan was also developed for vehicles and infrastructure.

Overall, implementing the preferred BE-only ZEB fleet will cost $74.3 million (cumulative capital and operating costs) compared to $66.1 million for the base case within a 16-year timeframe (through 2040). Stated otherwise, the transition to ZEBs under the preferred fleet concept adds incremental capital and operating costs of $8.2 million over the 16-year period.

Based on the existing fleet replacement schedule, this plan recommends that the ZEB procurement continues in 2025, maintains replacements through 2034, and ramps up from 2035 through 2040 as fossil fuel vehicles reach the end of their useful lives and are retired. This phased approach allows staff to implement a small number of ZEBs early, building on the existing fleet, and wait until the technology advances to take on larger procurements. The full phasing and implementation plan is outlined in Table 0-1 on page vii of the Plan. With a full transition to ZEBs, TTD can reduce its fleet-related greenhouse gas emissions by approximately 93% (~1,025 tons annually)!

GF/ja AGENDA ITEM: III.A.

This plan is a living document that is intended to provide a practical framework for staff to deploy and transition to ZEBs in response to the Board's goals in alignment with CARB ICT mandates. Like any other strategic plan, the implementation and transition plan should be revisited and adjusted in response to funding realities, changes in service delivery, and ridership, particularly given the long-term outlook. Taken together, this plan provides a prudent and feasible approach for the implementation of ZEBs that allows the District to provide exceptional and cost-effective services that exceed customer expectations.

The public comment period begins January 2, 2025 and comments will be received through January 30, 2025. Comments may be submitted to info@tahoetransportation.org.

Additional Information:
If you have any questions or comments regarding this item, please contact George Fink at (775) 589-5325 or gfink@tahoetransportation.org

Attachment:
A. Draft Final Zero Emission Fleet Conversion Plan

GF/ja

AGENDA ITEM: III.A.

Zero Emission Fleet Conversion Plan

Tahoe Transportation District

Draft Final Report

December 2024

Stantec

ZERO EMISSION FLEET CONVERSION PLAN - DRAFT FINAL

Stantec

Zero Emission Fleet Conversion Plan

Draft Final Report

December 19, 2024

Prepared for:

Tahoe Transportation District

Prepared by:

Stantec Consulting Services Inc.

ZERO EMISSION FLEET CONVERSION PLAN - DRAFT FINAL

Release Version

Rev.	Description	Date
0	Draft Report Issued to TTD	12/6/2024
	Comments received	12/16/2024
1	Draft Final Report Issued to TTD	12/19/2024

Project Team

Stantec Consulting Services Inc.

801 South Figueroa Street Suite 300

Los Angeles CA 90017-3007

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EXECUTIVE SUMMARY

The Tahoe Transportation District (TTD) provides fixed-route, paratransit, and other transportation related services and capital projects to residents and visitors to the Lake Tahoe basin. In 2022, TTD provided 269,576 unlinked passenger trips with a full-size and cutaway bus fleet.

This document serves to guide TTD through its zero-emission bus (ZEB) transition to achieve a 100% zero-emission (ZE) fleet by 2040 as targeted by the TTD Board of Directors. Although TTD is not beholden to the California Air Resources Board (CARB) Innovative Clean Transit (ICT) mandate, their transition timeline and goals are guided by this regulation. This report provides a detailed plan of the technology, needs, and strategies that will help TTD transition to a ZEB fleet.

The previous phases of this project (summarized in this report) laid the foundation for this plan by assessing TTD's existing conditions and modeling the energy and power requirements needed to meet TTD's 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 of only battery-electric (BE) vehicles.[1]

The BE vehicle implementation will allow TTD to leverage their early investments in battery-electric buses (BEBs) and charging infrastructure at the Lake Tahoe Community College Mobility Hub. This option will expand on-route charging infrastructure while planning the design of a future operations and maintenance facility that supports overnight charging.

While the BE-only implementation is the recommended approach, it is important to understand the inherent risk in relying on a single propulsion type. Adequate system redundancy in terms of fleet capability and charging equipment must be developed so as to not compromise service levels. A close relationship with the utility providers, Liberty Utilities in California, and NV Energy in Nevada, should be maintained.

With the preferred fleet composition established, the next steps included determining the facility upgrades and modifications required to support ZEB operations at TTD's potential on-route charging locations and future facility. This assessment was done at a high-level in order to offer flexibility as TTD evaluates development strategies. In addition, a financial model was developed to compare a base case (or business-as-usual case with fossil fuel vehicles plus up to five BE vehicles) and a case with a 100% BE fleet. A phasing and implementation plan was also developed for vehicles and infrastructure.

Overall, implementing the preferred BE-only ZEB fleet will cost $74.3 million (cumulative capital and operating costs) compared to $66.1 million for the base case within a 16-year timeframe (through 2040). Stated otherwise, the transition to ZEBs under the preferred fleet concept adds incremental capital and operating costs of $8.2 million over the 16-year period.

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[1] Other fleet compositions could have been an all-hydrogen fuel cell electric (FCE) fleet or a mixed-fleet comprised of both BE and FCE.

Based on TTD's existing fleet replacement schedule, this plan recommends that the ZEB procurement continues in 2025, maintains replacements through 2034, and ramps up from 2035 through 2040 as fossil fuel vehicles reach the end of their useful lives and are retired. This phased approach allows TTD to implement a small number of ZEBs early, building on their existing fleet, and wait until the technology advances to take on larger procurements. The full phasing and implementation plan is outlined in Table 0-1. With a full transition to ZEBs, TTD can reduce its fleet-related greenhouse gas emissions by approximately 93% (~1,025 tons annually).

This plan is a living document that is intended to provide a practical framework for TTD to deploy and transition to ZEBs in response to its Board of Directors goals in alignment with CARB ICT mandates. Like any other strategic plan, the implementation and transition plan should be revisited and adjusted in response to funding realities, changes in service delivery, and the needs of TTD and its ridership, particularly given the long-term outlook. Taken together, this plan provides a prudent and feasible approach for TTD to implement ZEBs that allows the agency to provide exceptional and cost-effective services that exceed customer expectations.

Table 0-1: ZEB implementation phasing plan, FY2023-2040

Year	Facility Modifications	Vehicle Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2023	None	None	No activity	No activity	$-	$1,612,185	$1,612,185
FY2024	None	4 Diesel Bus 4 Hybrid Bus	Annual refreshers, introductory training for hybrid system operations	Local fire and emergency response department introduction to hybrid technology	$6,012,124	$1,481,774	$7,493,898
FY2025	Facility - 1 60kW dual dispensers	2 BE Van 2 Gas Van	OEM training, training on BEBs for operators, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$747,332	$1,356,583	$2,103,915
FY2026	None	6 Hybrid Bus	Annual refreshers	Retraining for emergency response departments on hybrid and BEB technology	$5,844,030	$1,351,839	$7,195,869
FY2027	None	None	Annual refreshers	Annual refreshers	$-	$1,386,731	$1,386,731

Year	Facility Modifications	Vehicle Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2028	None	None	Annual refreshers	No activity	$-	$1,423,501	$1,423,501
FY2029	None	1 Diesel CU Long	Annual refreshers	Annual refreshers	$310,593	$1,466,805	$1,777,397
FY2030	None	2 BE Van 2 Gas Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$642,488	$1,510,981	$2,153,469
FY2031	None	None	Annual refresher	Annual refreshers	$-	$1,557,495	$1,557,495
FY2032	None	None	Annual refreshers	No activity	$-	$1,605,258	$1,605,258
FY2033	None	3 BE Bus	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$3,407,404	$1,654,547	$5,061,951

Year	Facility Modifications	Vehicle Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2034	Facility - 4 150kW dual dispensers ORC - 1 450kW pantograph, 2 150kW dual dispenser	None	Annual refreshers	Annual Refresher	$2,472,430	$1,704,745	$4,177,175
FY2035	Facility - 5 150kW dual dispensers ORC - 1 150kW dual dispenser	4 BE Bus 2 BE Van 2 Gas Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$7,291,402	$1,609,283	$8,900,686
FY2036	None	9 BE Bus	Annual refreshers	Annual refreshers	$10,757,126	$1,500,948	$12,258,073
FY2037	Facility - 2 150kW dual dispensers	None	Annual refreshers	No activity	$665,598	$1,546,799	$2,212,397
FY2038	None	6 BE Bus	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$7,425,738	$1,607,988	$9,033,726

Year	Facility Modifications	Vehicle Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2039	Facility - 2 Level 2 chargers for vans	None	Annual refresher	No activity	$135,917	$1,657,667	$1,793,584
FY2040	None	4 BE Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$780,073	$1,708,249	$2,488,323

x

Abbreviations

AHJ	Authorities Having Jurisdiction
AHSC	Affordable Housing and Sustainable Communities Program
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ATS	Automatic transfer switch
AVTA	Antelope Valley Transit Authority
BEB	Battery electric bus
BESS	Battery electric storage system
BTM	Behind the meter
CARB	California Air Resources Board
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CMO	Clean Mobility Options
CMS	Charge management system
CPCFA	California Pollution Control Financing Authority
CRRSSA	Coronavirus Response and Relief Supplemental Appropriations Act
CSLT	City of South Lake Tahoe
CTC	California Transportation Commission
DER	Distributed energy resource
EIA	Energy Information Agency
EPA	Environmental Protection Agency
ESS	Energy Storage System
EV	Electric vehicle

FCEB	Hydrogen fuel cell electric bus
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse gas
HVAC	Heating, ventilation, and air conditioning
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program
IC	Internal combustion
ICT	Innovative Clean Transit
JPA	Joint Powers Authority
KPI	Key performance indicators
LCFS	Low Carbon Fuel Standard
LCTOP	Low Carbon Transit Operations Program
LPP	Local Partnership Program
LTF	Local Transportation Fund
MHD	Medium-Heavy-Duty
NFPA	National Fire Protection Association
NREL	National Renewable Energy Laboratory
OCPP	Open Charge Point Protocol
OEHHA	Office of Environmental Health Hazard Assessment
O&M	Operations and maintenance
PG&E	Pacific Gas & Electric
PPE	Personal Protective Equipment
PSPS	Public Safety Power Shutoff
PV	Photovoltaics
RAISE	Local and Regional Project Assistance Program

RFP	Request for Proposal
RTPA	Regional Transportation Planning Agency
SCCP	Solutions for Congested Corridors Program
SGR	State of Good Repair
SOC	State of charge
STA	State Transit Assistance
STEP	Sustainable Transportation Equity Project
STIP	State Transportation Improvement Program
TTD	Tahoe Transportation District
TDA	Transportation Development Act
TIRCP	Transit and Intercity Rail Capital Program
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
ZEV	Zero-emission vehicle

1.0 INTRODUCTION

1.1 ABOUT THIS DOCUMENT

This document compiles information from previous deliverables such as the Existing Conditions report and results from energy and power modeling, and the infrastructure plan. Additionally, it provides information on cost estimation for fleet procurement and infrastructure improvement, workforce considerations, potential funding sources, service planning in disadvantaged communities, and greenhouse gas impacts. It recommends a phasing plan based on all analyses, TTD's goals, and constraints, and is intended to serve as TTD's comprehensive zero emission fleet conversion planning resource.

1.2 ABOUT TAHOE TRANSPORTATION DISTRICT TRANSIT SERVICE

TTD's mission is to deliver outstanding transit service and transportation project improvements to the greater Lake Tahoe Region. The transit vision is to develop an interregional transit system that provides safe, reliable, and attractive transit service for Tahoe residents, visitors, and commuters.

Annual ridership in 2022 was 269,576, which was 80% of their 2019 ridership of 338,726 TTD operates five bus routes and ADA paratransit service. Four of the routes operate year-round – two primarily within South Lake Tahoe and two between Carson City, Minden/Gardnerville, and South Lake Tahoe. The fifth route is seasonal, only operating in the summer months, between Sand Harbor State Park and Incline Village, along Lake Tahoe's east shore. ADA paratransit service is offered within one mile of fixed routes in South Lake Tahoe and also extending to Kingsbury Grade within the Baseline Service Area.

TTD directly operates its fleet of 27 revenue vehicles, including fixed route, commuter, and paratransit. TTD operates a mix of cutaways of various lengths and specialty buses, like open-air trolley vehicles for summer routes, as well as 35-ft. heavy-duty buses. Most vehicles are powered by diesel and gasoline powertrains. They also own three BE Proterra ZX5's.

In 2017, TTD adopted the transportation plan, Linking Tahoe: Corridor Connection Plan (LTCCP) which provides a framework for a long-range transportation plan assuming a change in transit mode share from 1.4% to 20% over the next 10 to 20 years. The 2017 LTCCP served as a guide for the development of the goals, objectives, and policies for future short term transit services in the Lake Tahoe Basin over the next five years, and it is developed within the context of the regional planning process, which is aimed at implementing both the long range transit plan, Linking Tahoe: Lake Tahoe Basin Transit Master Plan, and the Tahoe Metropolitan Planning Organization's Linking Tahoe: Regional Transportation Plan/Sustainable Communities Strategy 2017-2040. Currently, TTD is getting close to adopting its latest short range transit plan (SRTP).

TTD has already made some progress toward a ZE fleet transition, purchasing three 35-ft. Proterra battery-electric buses (BEBs) and successfully engaging the local public utility (Liberty Utilities), and the Lake Tahoe Community College (LTCC) to develop a mobility hub at an LTCC campus. The mobility hub project was funded through three consecutive Low or No Emission federal grants. It delivered two overhead fast chargers for TTD's on-route charging Proterra buses. The facility also has two pedestal chargers for overnight charging as well as passenger amenities such as heated ADA-accessible sidewalks, bicycle storage and maintenance facilities, and passenger notification screens.

1.3 INNOVATIVE CLEAN TRANSIT

In December 2018, the California Air Resources Board (CARB) adopted a regulation requiring all public transit agencies in California to transition gradually to a fully ZEB fleet by 2040. The Innovative Clean Transit (ICT) regulation is in accordance with preceding state policies 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 (CPUC).

TTD, while providing services to California communities, is classified as a Nevada fleet and therefore the ICT regulation does not apply to TTD. Despite this, in late 2023, the TTD Board adopted the ICT as a "target goal for achieving a zero-emission bus fleet." TTD has adopted the 2040 ZEB transition goal outlined by the ICT but will not submit a rollout plan to CARB. This distinction enables TTD to deploy ZEBs more flexibly while still meeting a 2040 target for complete transition.

Table 1-1 below outlines the ZEB purchase schedule for small transit agencies (which TTD would be classified as) for heavy-duty transit vehicles. Specific vehicle types, such as motor coaches, cutaways, double deckers, and 60-ft. buses, 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, when 25% of new bus purchases must be ZE.

Table 1-1: ZEB purchase schedule (as a percentage of total new bus purchases for small transit agencies) for standard buses[2]

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

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

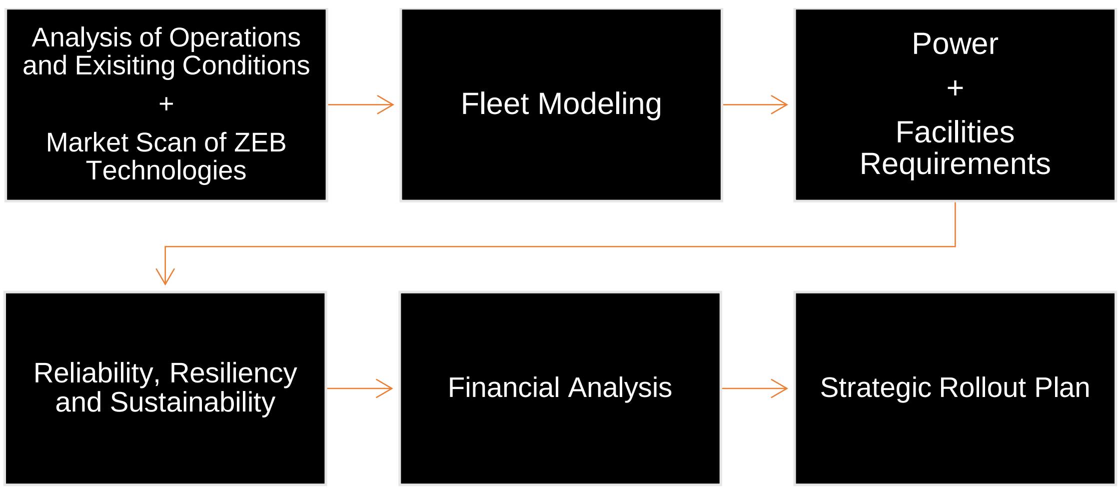
ICT also outlines several flexibility options to comply with ZEB purchase requirements of which transit agencies can take advantage. TTD is not required to adhere to the ZEB purchase schedule but may utilize it as a guide to stay on track to full transition by 2040.

Additionally, CARB outlines the option to form a joint ZEB group, which involves transit agencies working together to collectively comply with ZEB purchase requirements with a joint ZEB rollout plan. Formation of joint ZEB groups is dependent on certain eligibility requirements (agencies must share infrastructure, be in the same air basin, air district, Metropolitan Planning Organization, or Regional Transportation Planning Organization). While TTD does not plan to participate in a joint ZEB group, coordinating efforts within the basin on ZE technology selection will improve resiliency. TTD has already participated in communication within the region’s transit providers around ZEB deployment.

2.0 APPROACH TO ZEB PLANNING

The graphic in Figure 2-1 provides a high-level schematic of the major steps in this project to derive a recommended fleet concept and develop an implementation plan.

Figure 2-1: Schematic representation of the steps in the ZEB planning process



The first step involved a review of existing conditions of TTD's fleet, facilities, and service delivery to provide a foundation and understanding of TTD's operations and business processes that would be impacted by a transition to a ZEB fleet. A summary of these key findings is provided in Section 3.0. An assessment of the facility provided insights into the constraints and opportunities for implementing ZEBs, as well as the condition of the facilities, buildings, and existing service cycle. A market scan was also conducted to analyze the current ZEB technologies, their limitations, and in-development technologies that can help shape TTD's future ZEB fleet.

Next, we used computer modeling to simulate the performance of BEBs on TTD's service blocks and vehicle assignments. The modeling provided predictive performance, including fuel economy, operating ranges, and feasibility of the different ZEB technologies. The analysis revealed that a fleet of BE vehicles would minimize operational changes, and largely could replace fossil fuel vehicles on a 1:1 basis. This includes TTD's decision to reduce its overall revenue vehicle fleet size from 28 (in 2023) to 26 vehicles over the next two years. The optimal fleet size will continue to be analyzed over the transition period. This strategy would also leverage TTD's current investment into BEBs and charging infrastructure. The modeling process and preferred fleet alternative concept is summarized in Section 4.0.

Subsequently, working with TTD staff, we developed a fleet transition/implementation plan that transitions the fossil fuel fleet to BE vehicles, along with a phasing strategy for chargers and facility modifications. Section 5.0 describes the fleet and facility phasing strategy, and Section 6.0 describes the modifications required at the operations and maintenance facility, while keeping in mind that TTD may eventually relocate to another facility, since the current facility is leased and not conducive to long-term operations.

With the facility modifications and impacts on capital and operating costs, Stantec developed a financial analysis for the ZEB rollout through 2040 (Section 7.0). Operating and planning considerations (Section 8.0, 9.0), workforce training (Section 10.0), potential funding sources (Section 11.0), service in disadvantaged communities (Section 12.0), and greenhouse gas (GHG) impacts (Section 13.0) are also reviewed and discussed.

All steps described here, along with others found in this document, provide TTD with a zero-emission fleet conversion plan.

3.0 SUMMARY OF KEY EXISTING CONDITIONS

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

Major findings from the existing conditions report include:

- TTD is shaping its future through an in-progress short range transit plan and pursuit of a new, long-term operations and maintenance facility.
- TTD operates in a large service area that is significantly impacted by topography, elevation, and occasional inclement weather.
- Providing fixed-route service within El Dorado County, Douglas County, Washoe County, and Carson City, TTD operates four fixed routes, a seasonal route in Incline Village, as well as a paratransit service in South Lake Tahoe, El Dorado County, and a small portion of Douglas County.
- TTD's current fleet is comprised of cutaways, 35-ft buses, and a trolley (Table 3-1 and Table 3-2) powered by diesel, gasoline, and battery electric.

As of February 2024, TTD operates a fleet of 27 revenue vehicles, with 23 actively providing fixed route, commuter, and paratransit services, while four are inactive. The fleet includes a mix of cutaways, specialty buses, and 35-ft. heavy-duty vehicles, powered mainly by diesel and gasoline, alongside three battery-electric Proterra buses. Nine vehicles are beyond their useful life, and eight new buses are expected by July 2024.

TTD's Disposal Fleet consists of 10 vehicles, four inactive (in italics) and six still in service, with plans for disposal by the fiscal year's end.[3] Despite challenges in securing consistent funding for replacements, TTD has reduced the average age of its fleet to nine years and utilized grant funding for vehicle overhauls and reliability improvements.

Table 3-1: TTD Current Revenue Fleet

Year	Make	# of Vehicles	Vehicle Type	Seated Capacity	Wheelchair Stations	Length (ft.)	Fuel Type	Transition Plan
2006	El Dorado	1	Cutaway	14	2	26	Diesel	Van in 2025
2007	El Dorado	2	Cutaway	20	2	27	Gasoline	Gillig Hybrid in 2026
2022	Turtle Top	1	Cutaway	24	2	32	Diesel	
2012	Hometown Trolley	1	Trolley Bus	27	2	31	Diesel	Gillig Hybrid in 2026

[3] A Disposal Fleet is a fleet of vehicles that will be sold during the next fiscal year. Current Disposal Fleet vehicles can be active or inactive. Active vehicles are still used in revenue service but are no longer receiving preventive maintenance. Inactive vehicles are no longer being used in revenue service.

2023	Gillig	4	Bus	36	2	29	Diesel	
2008	BlueBird/NABI	2	Bus	36	2	35	Diesel	1 disposed 1 training bus
2009	NABI	3	Bus	27	2	35	Diesel	Gillig Hybrid in 2026
2021	Proterra	3	Bus	36	2	35	Electric	

Table 3-2: TTD Current Disposal Fleet

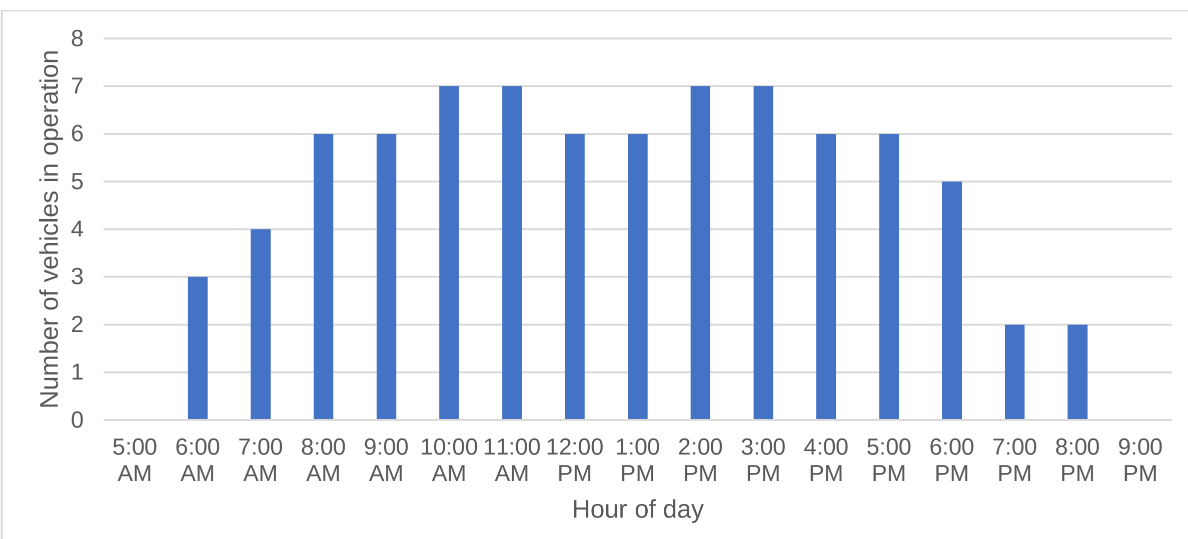
Year	Make	Vehicle Type	Seated Capacity	Wheelchair Stations	Length (ft.)	Fuel Type	Transition Plan
2015	*El Dorado*	*Cutaway*	*16*	*2*	*22*	*Diesel*	Van in 2025
2015	El Dorado	Cutaway	16	2	22	Diesel	Van in 2025
2015	El Dorado	Cutaway	16	2	22	Diesel	Van in 2025
2015	El Dorado	Cutaway	30	2	35	Diesel	Gillig in 2024
2015	*El Dorado*	*Cutaway*	*30*	*2*	*35*	*Diesel*	Gillig in 2024
2015	El Dorado	Cutaway	30	2	35	Diesel	Gillig in 2024
2015	El Dorado	Cutaway	30	2	35	Diesel	Gillig in 2024
2015	El Dorado	Cutaway	30	2	35	Diesel	Gillig Hybrid in 2024
2007	*El Dorado*	*Cutaway*	*20*	*2*	*27*	*Gasoline*	Gillig Hybrid in 2024
2009	*NABI*	*Bus*	*27*	*2*	*35*	*Diesel*	Gillig Hybrid in 2024

Figure 3-1: TTD Vehicles: Diesel Gillig (top), Cutaway (middle) and Proterra BEB (bottom)

TTD has made progress in adopting zero-emission vehicles, acquiring three 35-foot battery-electric Proterra buses, though only one is currently in service due to parts availability issues following Proterra's acquisition by Phoenix Motor Inc. TTD plans to restore all buses as parts become available, but space constraints for maintenance remains a challenge. The buses are charged at the Lake Tahoe Community College Mobility Hub, equipped with overhead fast chargers and pedestal chargers, funded by $4.475M from the Low or No Emission Grant Program.

TTD's buses operate at a limited capacity, utilizing only 60% of the battery's charge to maintain battery health, which reduces the time the buses can stay on route. Ideally, battery-electric buses would match the range of diesel and CNG buses, enabling flexible scheduling and avoiding additional costs due to range limitations.

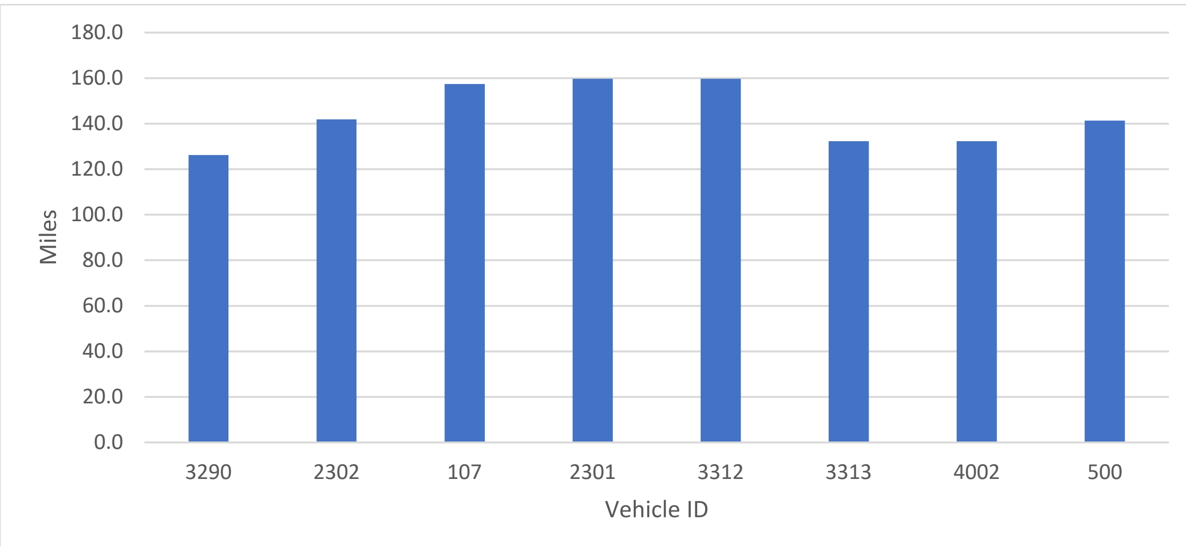
Figure 3-2: Hourly weekday summer peak vehicle requirements (fixed route)



As seen in Figure 3-2, vehicle use peaks during the late morning and early afternoon, with seven vehicles in maximum usage, but is rather steady throughout the midday. A large share of the vehicles is kept in operation all day, creating long daily vehicle assignments.

Combining blocks at the vehicle level for daily assignments provides a complete picture of how TTD operates its service. Shown below in Figure 3-3 are the assigned daily miles by vehicle. These assignments were assumed based on GTFS and posted schedules. Vehicle assignments are fairly long; all greater than 120 miles.

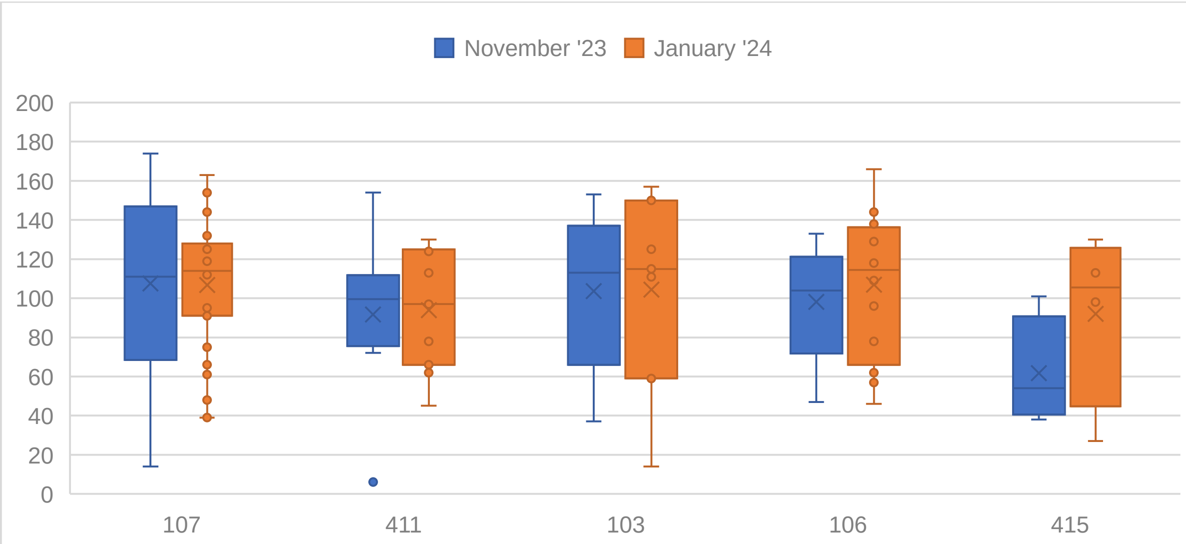
Figure 3-3: Daily assigned vehicle miles



TTD provides paratransit service using cutaways. Paratransit vehicle mileage varies widely as there is no fixed schedule and service is based on demand. Day-level data for November 2023 and January 2024 was analyzed to gain an understanding of the variation of how far the vehicles travel within a day and to ultimately provide a range of expected fuel efficiencies for paratransit transitions to ZEVs (Figure 3-4).

A total of 125 daily vehicle mileages were analyzed from November 2023 and January 2024 with an average distance of 102 miles and a median distance of 109 miles. However, the largest distance traveled in one day by one vehicle is 174 miles. Additionally, on average, Paratransit vehicles had nine miles of non-revenue or deadhead each day. Some vehicles traveled distances that are close to and above the average current operational range of ZE cutaways presenting potential range-related issues with ZEV implementation for paratransit service.

Figure 3-4: Daily revenue mileage for Paratransit vehicles (Nov. '23 and Jan. '24)



TTD's operations and maintenance facility are located at 1663, 1669, and 1679 Shop Street at the west end of South Lake Tahoe. This facility is leased from the City of South Lake Tahoe and consists of three buildings which house bus maintenance, parts storage, along with office space for dispatch, road supervisors, the fleet and facilities manager, and additional operations and maintenance management and staff (Figure 3-5). The paved lot provides employee parking and fleet storage. There are three maintenance bays located in the 1679 building and both a wash bay and maintenance bay located in the 1663 building. There is a leased administration office located at 128 Market Street, Stateline, Nevada. The administration office is about seven miles from the operations and maintenance facility.

Figure 3-5: TTD Operations and Maintenance Facility (Source: TTD Bus Ops., Maint., and Admin. Facility Master Plan)

The facility is outdated, lacks security and protected storage, and does not meet current maintenance capacity needs, let alone allow for needed expansion options due to the relatively small footprint of the property.

Due to stalled negotiations of a long-term lease agreement, necessary site improvements and modifications cannot be undertaken to satisfy ZE requirements. Additionally, any improvements are unlikely to satisfy current and future fleet expansion needs due to limited capacity. As outlined in the Maintenance and Administration Facility Master Plan (MAF) report, this facility could be considered as a supplemental use to a new facility, depending on where the new facility is located[4]. Further discussion of planning efforts for a new maintenance and administration facility can be found in Section 3.1.

[4] TTD DRAFT Basis of Design Report. Bus Operations, Maintenance and Administration Facility Master Plan. July 31, 2023

There have been noted concerns with the facility that have resulted in service cancellations, however, there appears to be no plan to update the facility to accommodate the needs of TTD. This small facility limits the ability of TTD to ensure that the full fleet is available for service as well as limits the ability to recruit maintenance staff because there is a public perception that the facility may have safety concerns. The facility was closed temporarily in February 2020 due to such concerns and an inspection revealed that though there was no structural damage, there were sheetrock replacement issues to be resolved. During this time, TTD temporarily maintained their vehicles at the public works facility.

The ability to manage a maintenance facility that is designed to accommodate the needs of a public transit fleet could help TTD attract and retain maintenance staff based on the perceived improvement in the working conditions. This would also have the benefit of accommodating the switch to ZEBs and their associated maintenance requirements based on new technology.

To optimize the use of the new propulsion technology, an investment into the supporting infrastructure is necessary. The concentration of roof mounted equipment mandates items such as fall arrest apparatus in the maintenance facility. Similarly, safety related personal protective equipment for handling high voltage componentry and other new diagnostic tools are required. The change in propulsion also dictates specific training for inspection, servicing, and repairs. Bus Operator training is a key element to success with this technology to both optimize ride as well as range.

3.1 OTHER FACILITIES AND FUTURE DEVELOPMENT

In addition to the Shop Facility, TTD operates out of the LTCC Mobility Hub which serves as the primary charging location for existing BEBs in addition to a transit stop for routes 50 and 55. In addition to the LTCC Mobility Hub, TTD has plans to participate in construction of another mobility hub at Spooner State Park. As part of TTD's Board's long-term goals, a new Maintenance and Administration Facility is being considered to enable system growth as well as the deployment of ZE technology.

LTCC Mobility Hub

TTD has already made some progress toward a ZE fleet transition, purchasing three 35-ft Proterra BEBs and successfully engaging the local public utility, Liberty Utilities, and the Lake Tahoe Community College to develop a mobility hub at an LTCC campus. The mobility hub project was funded through three consecutive Low or No Emission federal grants. It delivered two 450 kW overhead fast chargers for TTD's on-route charging Proterra buses, shown in Figure 3-6. The facility also has two 60 kW pedestal chargers for overnight charging as well as passenger amenities such as heated ADA-accessible sidewalks, bicycle storage and maintenance, and passenger notification screens.

Figure 3-6: Concept designs for the LTCC Mobility Hub

Spooner Summit Mobility Hub

The design and construction of the Spooner Summit Mobility Hub is a joint project between TTD, the Tahoe Regional Planning Agency, Nevada Department of Transportation, United States Forest Service, and Douglas County, Nevada. The project will deliver a park and ride with 250 parking spaces and restrooms, an Aquatic Invasive Species inspection station, 0.5 miles of multi-use path, and a pedestrian crossing from Spooner State Park to the junction of SR28 and US50 adjacent to the transit mobility hub. The project is currently in the Plans, Specifications, & Engineering phase, and is tentatively scheduled to begin construction in 2026[5].

Maintenance and Administration Facility

TTD commissioned a study and master plan to evaluate all current facilities and begin planning for improvements. Delivered in July 2023 by HDR, the Master Plan addresses short-term and long-term needs based on TTD's existing facility and desire to increase their fleet size while transitioning to ZE technologies[6]. TTD's goal is to upgrade and consolidate all operations and maintenance facilities. The Master Plan outlines planning needs for a short-term, temporary facility and a long-term, new facility.

Planning is still underway in identifying a final location and approach to address the space constraints experienced by TTD. The Bus Operations, Maintenance and Administration Facility Master Plan has identified a Basis for Design, Space Needs Program, and hypothetical site plans. The MAF identified two

[5] https://www.dot.nv.gov/projects-programs/state-route-28-mobility-hub
[6] TTD DRAFT Basis of Design Report. Bus Operations, Maintenance and Administration Facility Master Plan. July 31, 2023

options which, under the same approach utilizing a temporary, satellite, and main facility, paired the Space Needs Program with several potential site, creating hypothetical site plans. The primary distinction between sites boiled down to location, with options in Carson City (off the hill) and locations within Douglas County, closer to TTD's existing facilities.

The MAF planning process operated under the assumption that TTD's goal fleet size was 75 hybrid diesel vehicles. Through the ZEB rollout planning process initiated with this report, Stantec will not only home in on a final number of vehicles needed to operate TTD's service with ZEBs, but also identify if updates will be needed to the hypothetical site plans produced in the MAF to support ZEB operations.

Overall, the Existing Conditions Report revealed that TTD's facility, operations, and service area characteristics provide some challenges for a ZEB transition. Factors like a large service area with dispersed destinations present potential challenges for range and charging needs. In addition, TTD's operations and maintenance facility needs are not met by their current yard and there is still uncertainty about the prospects of a future facility.

On the flipside, TDD has already started their ZEB transition and generally has partner agency and community support for a fleet conversion. A transition to a ZE fleet will result in an increase of capital expenses due to vehicle procurement and purchasing charging equipment and infrastructure. A major hurdle will be securing funding for a long-term facility as well as the capital procurement and operational cost of a ZEB fleet.

3.2 OPPORTUNITIES WITH LOCAL UTILITIES

Stantec and TTD staff met with utilities in the Lake Tahoe Basin area to discuss challenges and opportunities regarding a ZEB transition for transit operations. Key highlights are presented in the following subsections.

NV Energy

NV Energy does not offer any charging infrastructure incentives that apply to TTD currently. However, NV Energy will be instrumental in assessing system capacity for any new charging infrastructure installation at on-route locations and a potential future facility. NV Energy can help estimate the cost of site and system improvements as well. Typical cost categories include: construction (crew, charging padding, civil, trenching, upgrades to subsystem), inspection and scheduling, design and coordination, easement permitting, contracting and asset management, and miscellaneous/contingency estimates. It should be noted that if TTD requires a substantial load to a new site requiring a substation upgrade, they could be responsible for this cost. Different charging strategies should be analyzed including battery energy storage systems in order to implement the most cost effective and reliable charging strategy possible.

Liberty Utilities

This conversion plan does not recommend EV infrastructure improvements in any service areas currently served by Liberty Utilities. Instead, TTD will plan to charge their next set of BEVs (two BE Vans) at Shop

Street using an existing 220V supply. It is recommended to continue the operation of the Lake Tahoe Community College Mobility Hub, which is supported by Liberty Utilities. As TTD's service needs change, it may be prudent to evaluate additional charging infrastructure in the Liberty Utilities service area.

4.0 PREFERRED/RECOMMENDED FLEET COMPOSITION

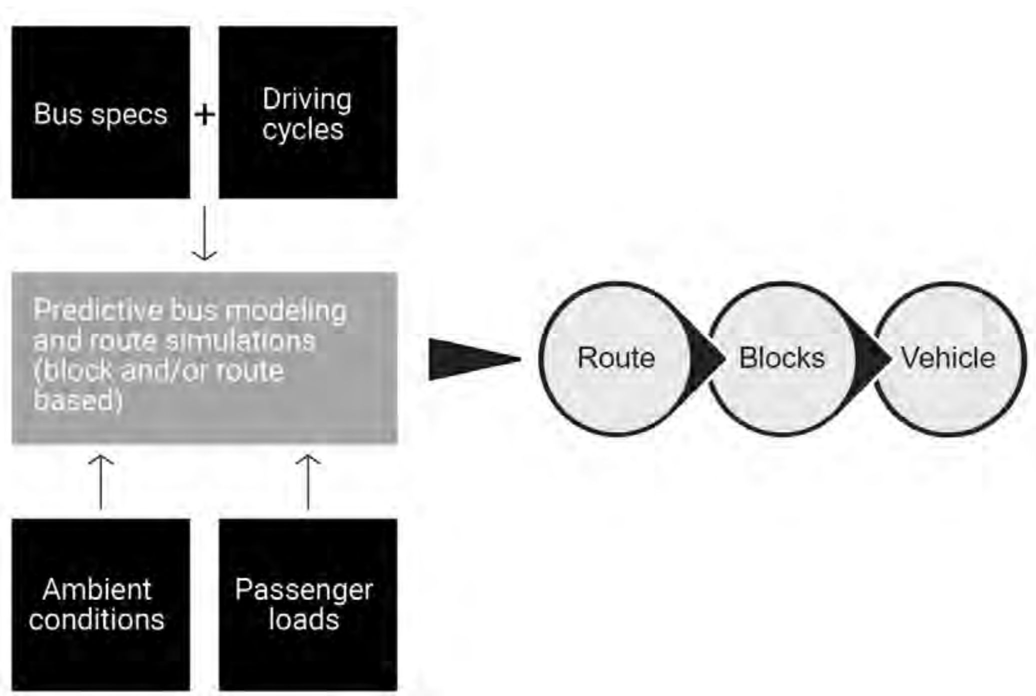
This section describes the modeling and analysis that was used to develop viable fleet concepts and specify a preferred ZEB fleet for rollout planning purposes.

4.1 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 TTD will understand how BEBs perform under TTD's operating conditions, providing a more realistic estimate of operating range and energy consumption, ultimately informing technology selection.

Figure 4-1 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 4-1: Modeling overview

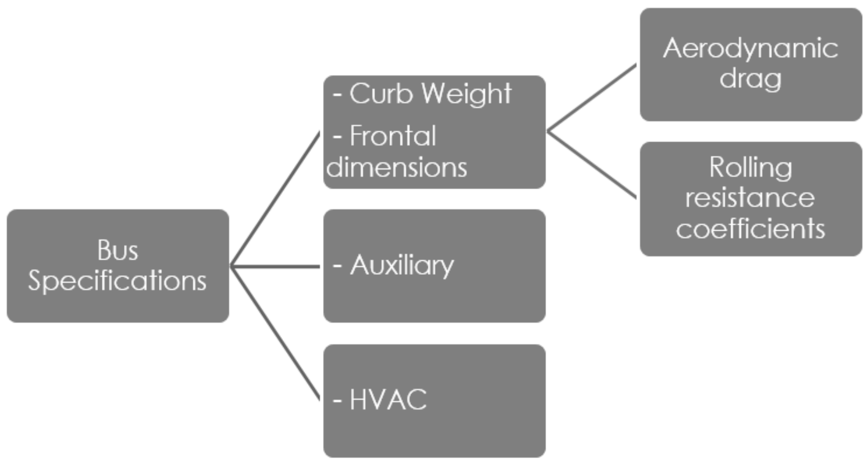


The process for modeling fixed-route services is described first, followed by the modeling process for paratransit services.

Fixed Route Modeling Inputs

ZEVDecide's modeling process predicts ZEB drivetrain power requirements specific to given acceleration profiles. One key component to the modeling is the bus design or bus specifications that include curb weight and frontal dimensions (factors needed to account for aerodynamic drag and rolling resistance coefficients), auxiliary, and HVAC (Figure 4-2).

Figure 4-2: Schematic of the inputs for bus specifications



The following inputs are included in the model to determine the feasibility of different ZEB technologies under TTD's operating conditions.

Bus/vehicle specifications: the key bus specifications used in the modeling process for each service type are detailed in Table 4-1 for BEB models, and in Table 4-2 for FCEB models. As TTD operates cutaways and buses, in the modeling we specified the appropriate vehicle size (for each route and block) to reflect TTD's vehicle assignment practices. It is important to note that on the market today, there are more BE equivalents than FCE equivalents, and both market segments are young. Overall, models and vehicle ranges are limited compared to fossil fuel models.

Table 4-1: BEB specifications for energy modeling

	Electric 35-ft Bus	Electric Cutaway
Battery (kWh)	435	120
Curb Weight (lbs.)	29,700	14,500
Service Type	Fixed route	Fixed route and paratransit
		

Table 4-2: FCEB specifications for hydrogen modeling

	Fuel Cell 35-ft Bus	Hydrogen Cutaway[7]
Tank Size (kg)	37.5	13
Curb Weight (lbs.)	29,700	16,500
Service Type	Fixed route	Fixed route and paratransit
		

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 TTD's operations and observed driving conditions. The driving cycles were created from data collection of real-world operations or from chassis dynamometer tests and have been convened by the National Renewable Energy Laboratory (NREL) in a drive cycle database called DriveCAT [8].

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[9], the model considered a high passenger load at 75% of seated capacity and a low passenger load at 25% of seated capacity.

[7] Hydrogen cutaways are not currently commercially available.
[8] NREL DriveCAT - Chassis Dynamometer Drive Cycles. (2019). National Renewable Energy Laboratory. www.nrel.gov/transportation/drive-cycle-tool
[9] Estimated average passenger weight—170 lbs.

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

Stantec developed a correlation matrix 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 of 34°F [10].

Topography and elevation: TTD's service area is highly influenced by elevation and topography. 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 TTD's routes. Furthermore, the total elevation gains will 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 4-3).

Table 4-3: Elevation analysis

Route	Average slope	Max slope	Weighted average slope
19X North	1.0%	8.1%	2.9%
19X South	1.1%	8.1%	2.9%
22 East	4.4%	13.4%	6.7%
22 West	3.4%	13.1%	5.8%
28 N/S	2.7%	8.8%	4.1%
50 East	1.3%	4.8%	2.2%
50 West	1.5%	7.3%	3.0%
55 East	1.4%	8.4%	3.0%
55 West	1.5%	6.8%	2.7%

Each route shapefile (derived from GTFS data) was downloaded into Google Earth to create an elevation profile and understand the total elevation gains/losses seen for each route in the system. For example, the elevation profile for Route 22 is shown in Figure 4-3. 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.

[10] US Climate Data https://www.usclimatedata.com/climate/south-lake-tahoe/california/united-states/usca1317

Figure 4-3: Elevation profile example (Route 22)

Source: Google Earth

Fixed Route Modeling Process

Using the inputs above, the first step in modeling is obtaining route-level fuel economy and energy use for the ZEBs using the driving cycles assigned to each route/service type. Then, to account for the impacts of interlining, deadheading, etc., the modeling aggregates route-level results to produce a vehicle-level fuel economy and energy use metric. The process of going from a route to vehicle assignment is outlined in Figure 4-4 and Figure 4-5.

Figure 4-4: Relationship between routes, blocks, and vehicle assignments

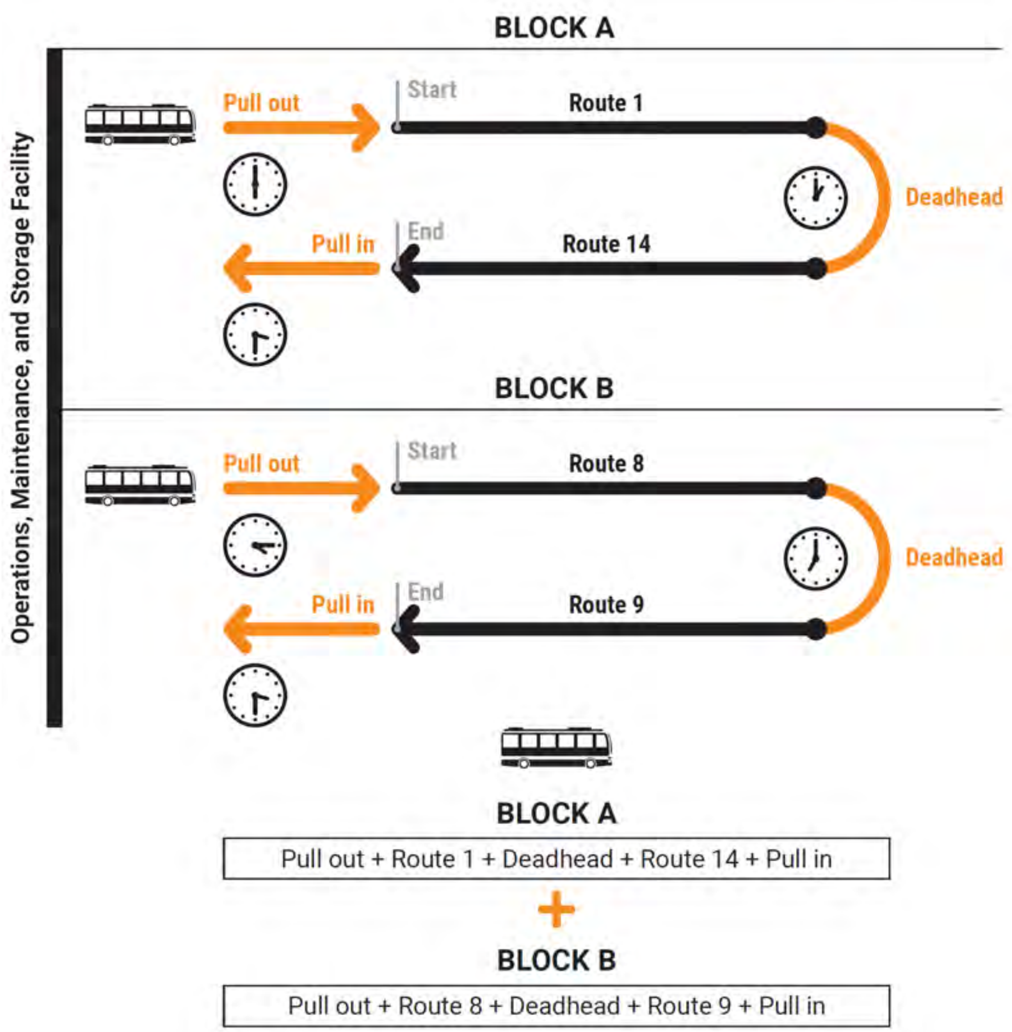
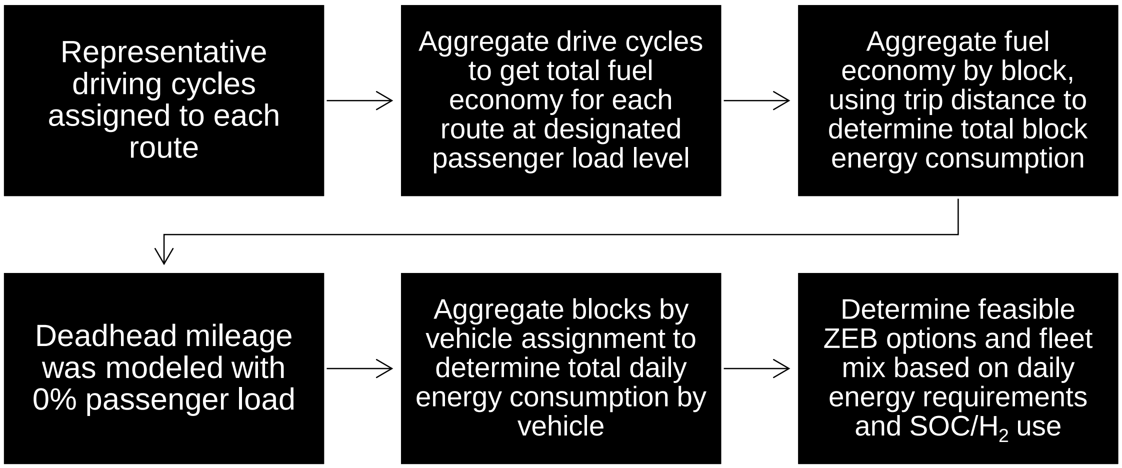


Figure 4-5: ZEVDecide energy modeling process



After the route-level modeling is completed, fuel economies are then aggregated by block using the trip mileage to determine the total energy consumption for each block. Trip data from September 20, 2023 was used for this. Finally, to understand the fuel economy and total daily energy consumption of each vehicle operated on a representative service day, blocks are aggregated at the vehicle level, so that vehicles that are assigned multiple blocks throughout a day are modeled appropriately.

The representative day modeled for TTD, consisted of 16 blocks and eight vehicles. Two vehicles were assigned to one block each and all other vehicles (six) were assigned to two or three blocks. The process of aggregating blocks by vehicle assignment was completed for six of the vehicles, which completes one block of service, has a layover, then completes a second block, so the fuel economy for these two blocks was aggregated at the vehicle level. Two vehicles complete three blocks each and similarly, fuel economy was aggregated at the vehicle level.

The results of the modeling provide insight into:

- Fuel economy and energy requirements.
- Operating range.
- The feasibility of different ZEB technologies/electrification. For BEBs, this is determined through the state of charge (SOC); the vehicle assignment can be successfully completed with a BEB if it can complete its scheduled service with at least 40% battery SOC. For FCEBs, if a bus consumes less than 80% of its tank capacity, the vehicle assignment is counted as successful.

Dial-A-Ride Modeling Inputs

For all TTD's paratransit services, we modeled a BE van and a hydrogen van given that they are lighter and have longer operating ranges than cutaway-type vehicles. The modeled vehicle specifications are outlined in Table 4-4 below. There are a number of smaller EV passenger vans on the market including those built on a Ford Transit chassis and OEM chassis. The only currently existing FCE vehicle is a passenger van based on the Ford Transit chassis, outfitted with a hydrogen fuel cell and a small battery, along with a 13-kg hydrogen tank instead of the internal combustion engine as the power train.

Table 4-4: Cutaway/Van specifications for paratransit modeling

Technology type	Curb weight (lbs.)	Battery (kWh) or tank size (kg)	Example
BE	14,330	120 kWh	
FCE	10,360	13 kg	

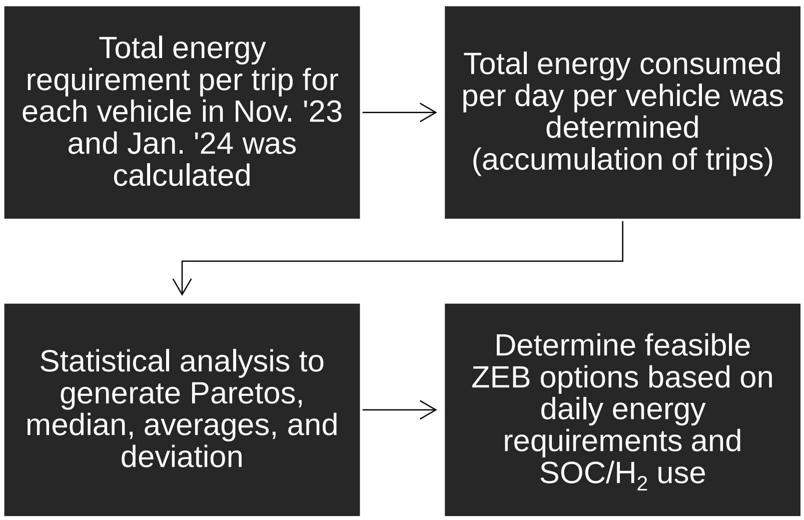
As demand response services do not follow a fixed route and schedule, modeling inputs required adjustment to account for variations in service delivery. Inputs other than the bus specifications for the paratransit modeling include:

- Passenger load: assumes an average of four passengers onboard.
- Topography and elevation: the methodology does not consider topography directly. Instead, the model used driving speed information for all trips in November 2023 and January 2024 to predict the fuel economy.
- Ambient temperatures: the same as fixed route modeling.

Dial-A-Ride Modeling Process

For each vehicle trip record in November 2023 and January 2024, the total energy requirement per vehicle was used to calculate the total energy consumed by each vehicle per day. A statistical analysis was conducted on the entire dataset to determine the average fuel efficiency and daily energy use per vehicle to evaluate success levels under the BE or FCE van options. Furthermore, the energy requirement of each individual trip was then aggregated at the vehicle level to estimate the total energy consumed by each vehicle per day (Figure 4-6).

Figure 4-6: ZEVDecide energy profile process (paratransit services)



The results of the modeling provide insight into:

- Average fuel economy.
- Probability of energy/fuel requirements.
- Probability of operating range.
- The feasibility of different ZEB technologies. For BE cutaways, success is determined through SOC; the vehicle assignment can be successfully completed when a BE vehicle can complete its scheduled service with at least 40% battery SOC. For hydrogen cutaways, if a vehicle consumes less than 80% of its tank capacity, the vehicle assignment is counted as successful.

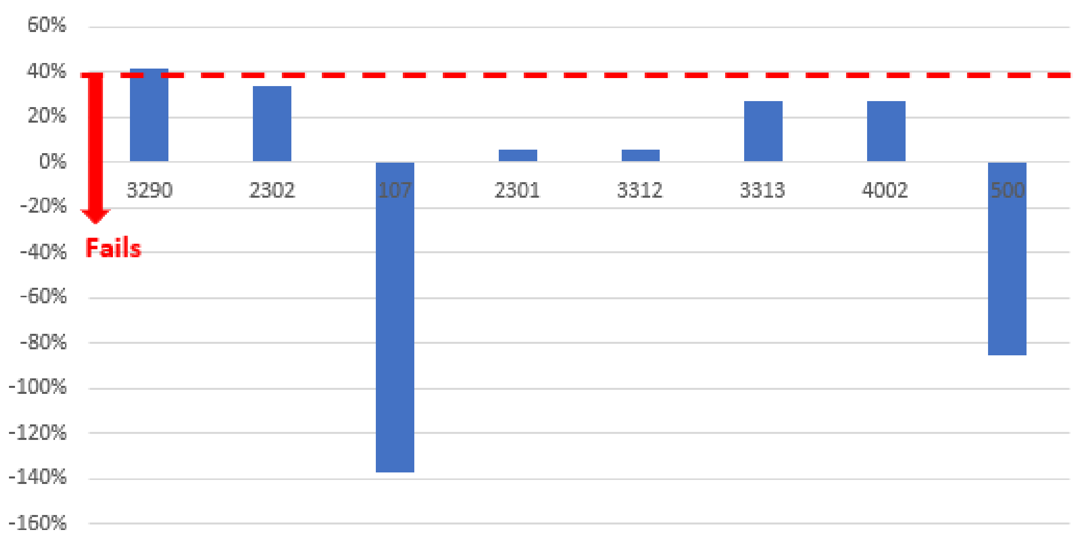
4.2 BEB MODELING RESULTS

Initial modeling of electrification for TTD's fleet included evaluating eight different vehicle assignments as dispatched on a representative service day for the five currently operating fixed routes: Route 19X, Route

22, Route 28, Route 50, and Route 55. Key takeaways are summarized below, and details for the High Passenger results are shown in Figure 4-7.

- Vehicle 3290 (modeled as a 35-ft bus) was **successful** on Route 28 under high and low-passenger loads.
- Vehicle 2302 (modeled as a 35-ft bus) was **unsuccessful** on Route 28 under high and low-passenger loads.
- Vehicle 107 (modeled as a cutaway) was **unsuccessful** interlining on Route 19X and Route 22 under high and low-passenger loads.
- Vehicle 2301 (modeled as a 35-ft bus) was **unsuccessful** on Route 50 under high and low-passenger loads.
- Vehicle 3312 (modeled as a 35-ft bus) was **unsuccessful** on Route 50 under high and low-passenger loads.
- Vehicle 3313 (modeled as a 35-ft bus) was **unsuccessful** on Route 55 under high and low-passenger loads.
- Vehicle 4002 (modeled as a 35-ft bus) was **unsuccessful** on Route 55 under high and low-passenger loads.
- Vehicle 500 (modeled as a cutaway) was **unsuccessful** on Route 19X under high and low-passenger loads.

Figure 4-7: Estimated High Passenger SOC for TTD Fixed-Route Buses



Modeling for fixed-route services used two vehicle configurations: 35-ft buses with 435 kWh batteries and cutaways with 120 kWh batteries. Table 4-5 provides a breakdown of fuel efficiency and maximum range by route for the modeled BEBs. The 35-ft bus has a considerably higher weight at 29,700 lbs. compared to the electric cutaways with a curb weight of 14,500 lbs., contributing to its lower fuel efficiency and range. Cutaways operating on Routes 19X and 22 had the best fuel efficiency (least amount of energy consumed per mile) which can be attributed to vehicle weight, and terrain effects on efficiency.

Table 4-5: Average fuel efficiency for fixed route BEB modeling results

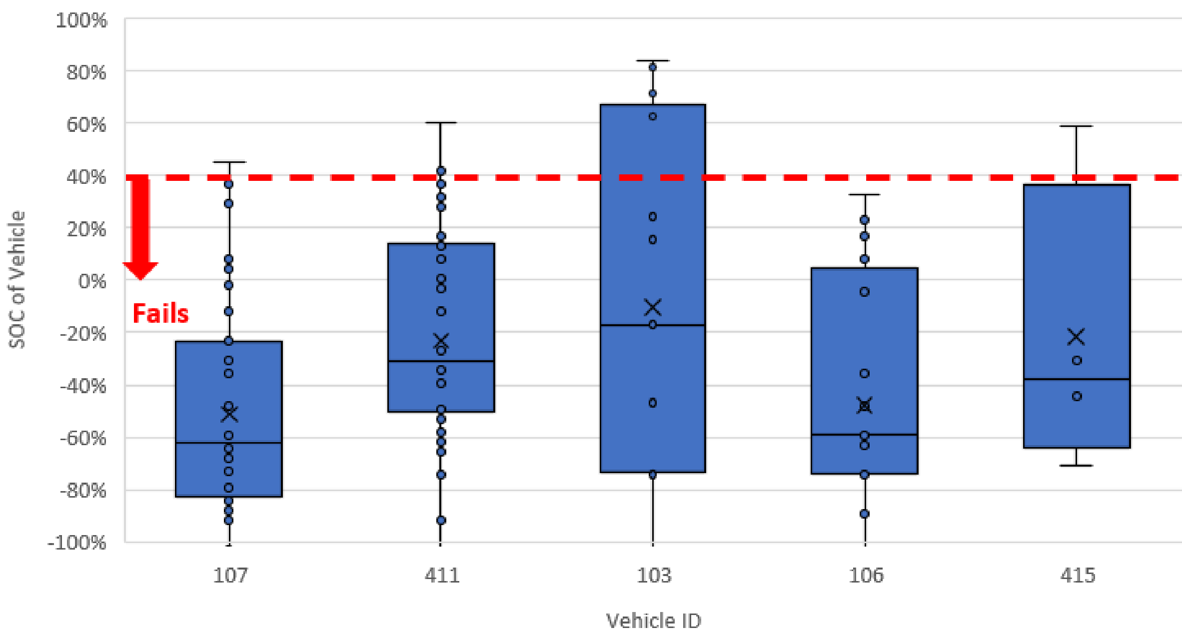
Route	High Passenger – Average fuel efficiency (kWh/mi)	Low Passenger – Average fuel efficiency (kWh/mi)	High Passenger – Max range (mi)	Low Passenger – Max range (mi)
Route 19X (cutaway)	1.63	1.55	73.60	77.28
Route 22 (cutaway)	1.63	1.55	73.63	77.41
Route 28 (35-ft bus)	2.08	1.97	209.50	220.55
Route 50 (35-ft bus)	2.58	2.45	168.72	177.57
Route 55 (35-ft bus)	2.42	2.30	180.04	189.46

As paratransit services do not follow a fixed route and schedule, modeling inputs required adjustment to account for variations in service delivery. Therefore, instead of assigning representative driving cycles or studying a representative day, the model considered the average driving speeds for each individual run; all runs and vehicle assignments from November 2023 and January 2024 were modeled.[11]

The box and whisker plot below (Figure 4-8) is designed to show the variation in daily vehicle mileages traveled by paratransit vehicles. Each vehicle entry in the plot shows different statistics regarding mileage per day: the minimum (bottom whisker), first quartile (bottom of the box), median (line within the box), third quartile (top of the box), and maximum (top whisker). Outliers are displayed as the dots above and below each entry (defined as the number below the lower and upper limits as determined by the interquartile range) and the 'X' in the middle of each box is the mean for that dataset.

[11] 123 total demand response runs in Nov. 2023 and Jan. 2024.

Figure 4-8: BEB modeling results for paratransit vehicle assignments



In the analyzed data, the average vehicle run was 111 miles per day (revenue and deadhead combined), but this varied between a minimum of 13 miles to a maximum of 203 miles. Based on the modeling (Figure 4-8), only 7% of vehicle runs were successful as BEBs, assuming cutaway specifications from current vendors.

To provide paratransit service consistent with current levels, 93% of vehicle assignments would require vehicle swapping throughout the day. For example, paratransit vehicle assignments could be constrained to an upper range of about 72 miles per day; as such, shorter vehicle assignments could be lengthened, while longer ones can be shorted, trying to balance mileage across the active fleet. Another arrangement could see a vehicle that reaches its SOC threshold be exchanged for a fresh, fully charged vehicle during downtime.

4.3 FCEB MODELING RESULTS

Next, the fixed-route service was modeled with hydrogen fuel cell electric buses (FCEBs). Figure 4-9 shows the daily hydrogen use for FCEBs under the High Passenger scenario and Figure 4-10 shows use for FCE cutaways under the High Passenger scenario. Six out of eight (75%) of TTD's fixed-route services and vehicle assignments can be successfully transitioned to hydrogen FCEBs. The FCEB fleet concept was modeled using two different vehicles: a 35-ft. hydrogen bus with a 37.5-kg tank and a hydrogen cutaway with a 13 kg tank.

Figure 4-9: FCE Bus High Passenger Fuel Use

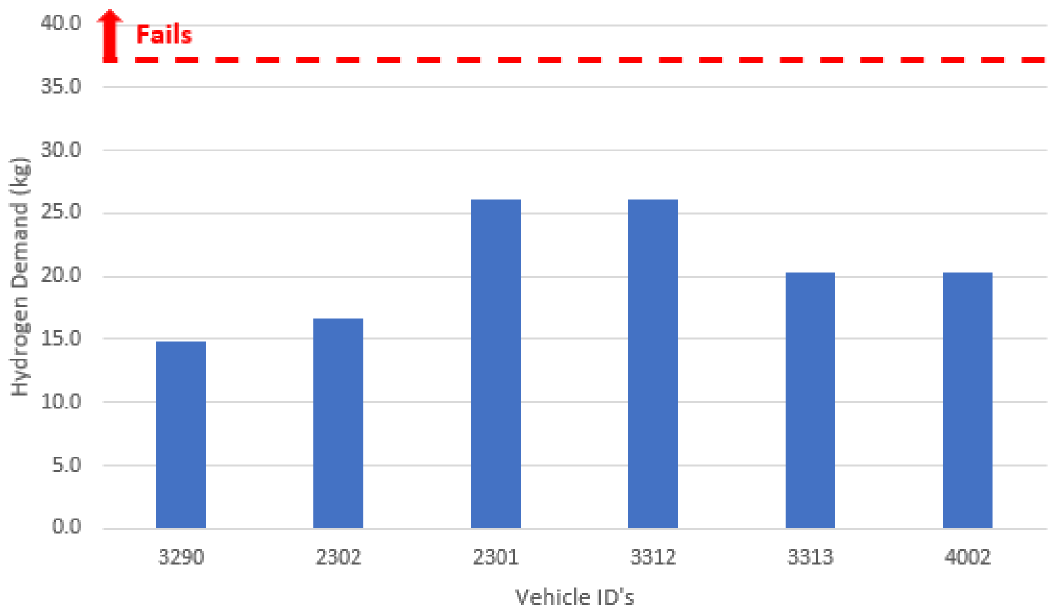
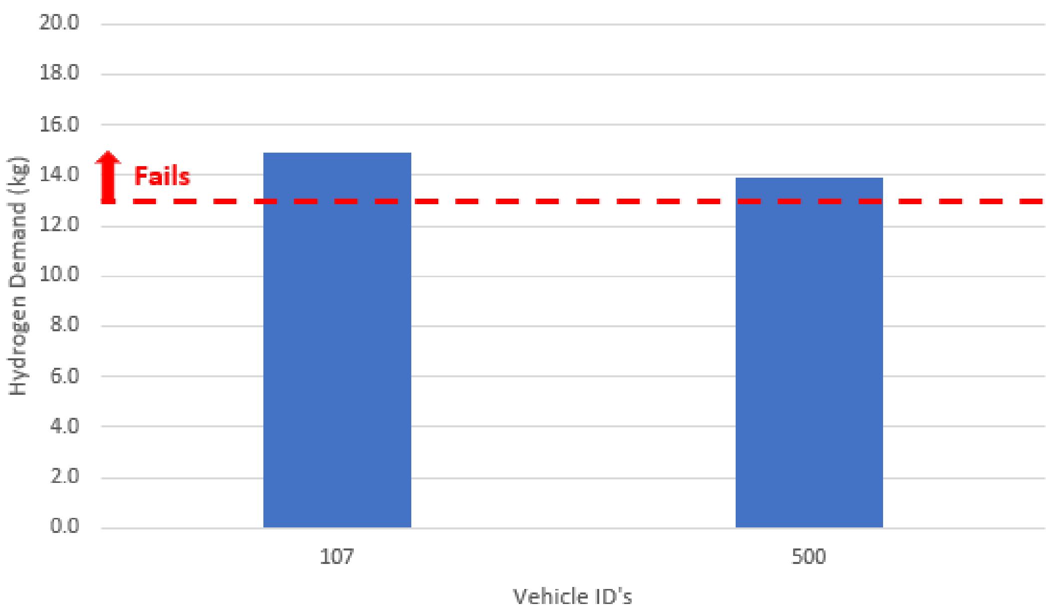


Figure 4-10: FCE Cutaway High Passenger Fuel Use



Of the eight vehicle assignments modeled, vehicles 2301 and 3312 on Route 50 used the most hydrogen at 26.1 kg per day under the High Passenger scenario and 23.5 kg under the Low Passenger scenario. Vehicle 500 operating Route 19X utilized the least amount of hydrogen at 13.9 kg per day under the High

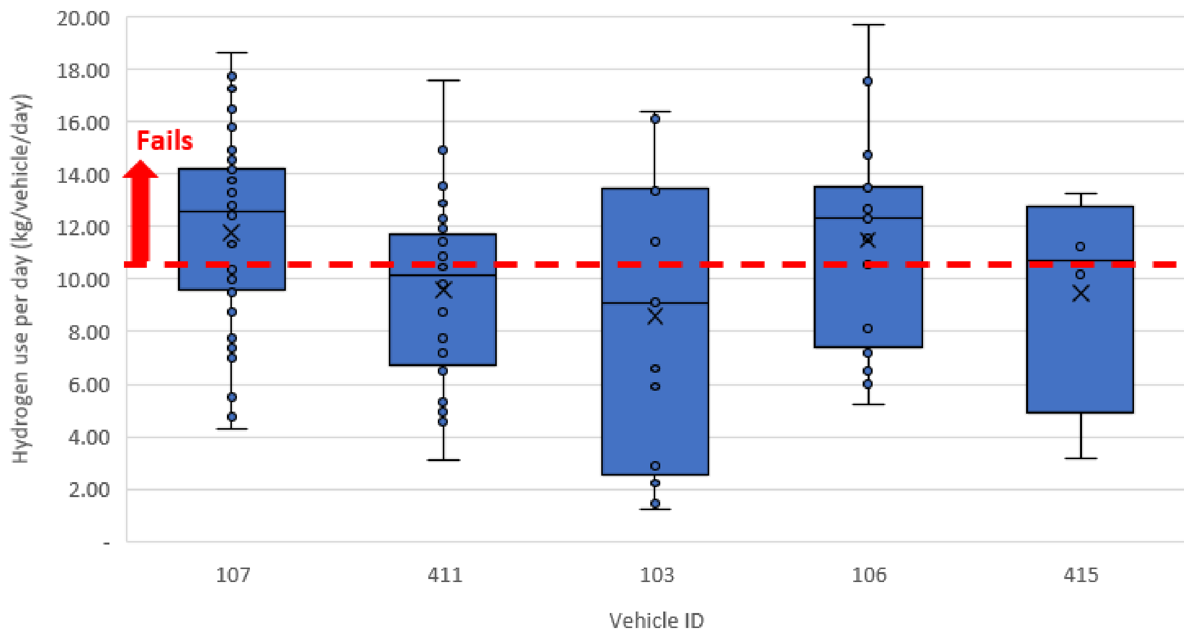
Passenger scenario and 12.9 kg per day under the Low Passenger scenario. Table 4-6 shows the average fuel efficiency of the modeled vehicles under the High and Low Passenger scenarios. The Route 22 cutaway could run a maximum range of 182 miles under a Low Passenger scenario considering the conditions of TTD's service area and had an average fuel efficiency of 14 miles per kg of hydrogen fuel. Given the considerably larger fuel tank capacity of the 35-ft. buses and the average lower efficiency of 7.70 miles per kg for the Low Passenger scenarios, the maximum average range for the Low Passenger scenarios is 289 miles under the modeled conditions.

Table 4-6: Average fuel efficiency for fixed route FCEB modeling results

Route	High Passenger – Average fuel efficiency (mi/kg)	Low Passenger – Average fuel efficiency (mi/kg)	High Passenger – Max range (mi)	Low Passenger – Max range (mi)
Route 19X (cutaway)	9.67	10.74	125.68	139.65
Route 22 (cutaway)	12.59	13.99	163.66	181.84
Route 28 (35-ft bus)	8.17	9.08	306.28	340.46
Route 50 (35-ft bus)	6.11	6.79	229.13	254.65
Route 55 (35-ft bus)	6.51	7.24	244.30	271.37

Modeling paratransit service using trip data from November 2023 and January 2024 projected that 42% of scheduled runs would be successful using FCE cutaways. Trips that utilized more than 10.4 kg (80% of a 13 kg tank capacity) of hydrogen were considered failures and represented 58% of all trips. The box and whisker plot below (Figure 4-11) shows the variation in total consumed hydrogen per day. Modeling for paratransit service with hydrogen technology assumed cutaway specifications provided by current vendors. The maximum usable range modeled for hydrogen cutaways was 107 miles per day.

Figure 4-11: FCEB Paratransit Modeling Results



4.4 ZE FLEET RECOMMENDATIONS AND IMPLICATIONS

The feasibility of ZE implementation depends on many factors, including vehicle specifications, topography, route mileage, and climate. In TTD's case, it is also important to consider previous BE and charging infrastructure investments as well as agency goals. Based on the modeling results and these institutional considerations, it is recommended that TTD implement an all-BE fleet with on-route charging at key locations.

Although TTD has begun their ZE fleet transition with the procurement of three 35-ft Proterra buses and on-route charging, an all-BE approach will require expansion of the fleet size and additional on-route chargers in strategic locations to successfully deliver service, given the failures of some of the fixed-route and paratransit services as modeled with BEBs. Moreover, TTD will likely need to reschedule bus assignments to ensure that BEBs are dispatched according to block mileage, duty, and to account for sufficient on-route charging during layovers.

An all-BE strategy is preferred over an all-FCEB or mixed fleet mainly due to initial investments and support for BE technology in the region. Agencies in both California and Nevada as well as the respective utilities are prepared to support long-term BEB growth. Without plans for developing hydrogen infrastructure at this time, BE technology is a sound choice.

This approach could suit TTD for several reasons, including:

- The BE vehicle and infrastructure market is further developed compared to the FCE market. This means a greater selection of vehicles and equipment available at lower costs.
- BE investments capitalize on previous procurements and site improvements.
- Takes advantage of any Liberty Utilities or NV Energy EV infrastructure programs for deployment of BE vehicles and charging infrastructure (see Section 3.2 for more information).
- Potential to share charging infrastructure with other fleets such as Jump Around Carson (JAC) in Carson City, NV.
- Opportunity to transition some cutaways to smaller BE vans and dedicate them to paratransit operations while running 30 ft and 35 ft buses on all fixed routes. This right-sizes capacity and better matches ridership demand while potentially increasing efficiency.

After careful consideration of the modeling results, operational realities, discussions with agency staff and stakeholders, and logistical considerations, Stantec recommends the proposed fleet concept presented in Table 4-7. The exact fleet mix will depend on service needs and updates per the forthcoming SRTP. This fleet mix includes two different kinds of vehicles: electric buses with 435 kWh batteries and electric vans with 120 kWh batteries.

Table 4-7: Recommended fleet concept – BE fleet

Service Type	Vehicle type	Battery size (kWh)	Vehicles
Route 19X (30-ft bus)	**Battery Electric Bus**	435 kWh	4
Route 22 (30-ft bus)	**Battery Electric Bus**	435 kWh	4
Route 28 (35-ft bus)	**Battery Electric Bus**	435 kWh	4
Route 50 (35-ft bus)	**Battery Electric Bus**	435 kWh	6
Route 55 (35-ft bus)	**Battery Electric Bus**	435 kWh	4
Paratransit	**Battery Electric Van**	120 kWh	4

Pursuing an all BE-fleet is the preferred fleet concept because it allows TTD to capitalize on previous BE investments and continue to benefit from readily available BEBs as soon as possible.

Nonetheless, there are constraints for TTD to consider, particularly related to the requirements for on-route charging infrastructure which inherently removes some flexibility from service design. Although some vehicles are largely dedicated to specific routes, additional attention will need to be paid to route assignments ensuring the correct vehicle is assigned to the correct route. This is especially true if electric vans are being considered for paratransit or even some fixed-route operation as there are none on the market today which support on-route overhead charging. TTD should continue to monitor the market and can adjust its strategy if more BE vehicles that support on-route overhead charging come to market. In addition to overhead on-route charging, plug-in fast charging should be available at on-route charging locations.

4.5 CHARGING STRATEGY

TTD is in the process of evaluating their options for a future operations & maintenance facility where they would store and charge their transitioning BEB fleet. With a 2040 fleet size of 26 BE revenue vehicles (22 BEBs for fixed-route service and 4 BE Vans for paratransit) it is recommended TTD deploy the following EV charging infrastructure at a future depot:

- Two 15kW Level 2 chargers for overnight BE Van charging
- One 60kW dual dispenser charger for fast mid-day or overnight BE Van charging
- 11 chargers at 150kW each with dual dispensers for overnight BEB charging

This configuration equals a connected load of about 1.8MW. It should be noted that if TTD installs overnight chargers at their future facility, they will only need a 150kW charger at Kingsbury Transit Center for on-route charging. However, if BEBs are in operation through Kingsbury Transit Center before overnight facility charging is in place, a potential solution would be for fast charging to be installed at Kingsbury for vehicles to charge at the beginning or end of service. On-route charging locations can be used for revenue (including paratransit) and non-revenue vehicles, although revenue vehicles should be prioritized.

For the operation of a BE-only fleet, the following additional on-route charging stations/dispensers will be required:

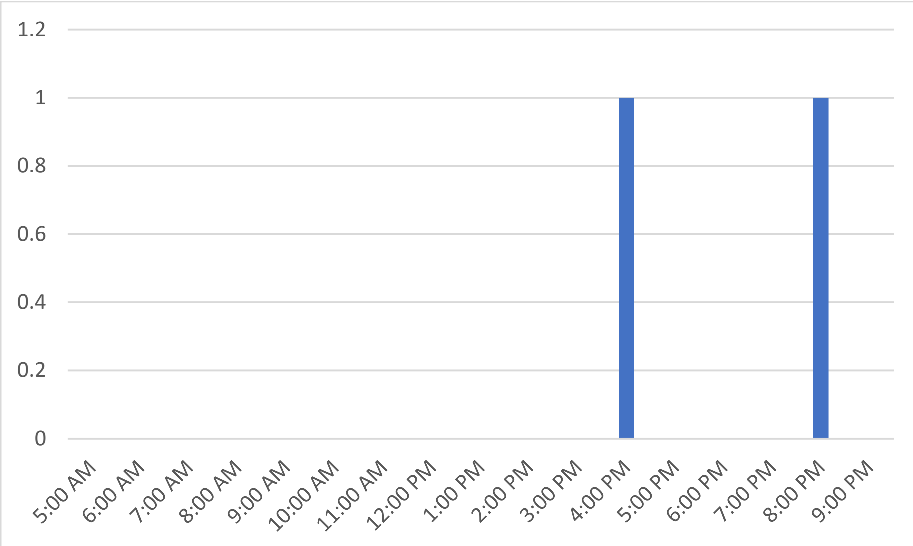
Spooner Summit Mobility Hub

- 1 – 450 kW pantograph
- 1 – 150 kW charger with two dispensers

Spooner Summit is the site of a planned mobility hub which will feature access to recreation and parking as well as on-route charging for Route 28 and a potential future Stateline to Carson City bus route via Highway 50. Today, the seasonal Route 28 does not provide sufficient layover time in its schedule to charge but it is assumed once on-route charging exists at Spooner Summit, bus assignments will align to accommodate on-route charging. Because Route 28 passes through Kingsbury Transit Center, schedules could be designed to allow on-route charging there too.

Per existing energy consumption, Route 28 buses could charge at Spooner Summit at the end of their assignments using 450 kW pantograph chargers as demonstrated in Figure 4-12.

Figure 4-12: Number of Buses Charging at Spooner Summit by Time of Day



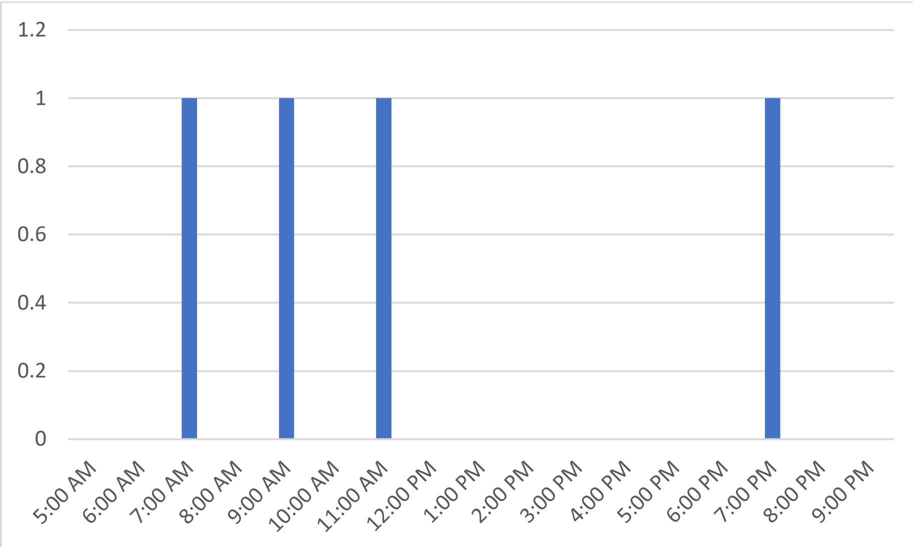
Kingsbury Transit Center

- 1 – 450 kW pantograph (required only if there is no overnight facility charging; this has not been factored into the financial analysis in section 7.0 at this stage)
- 1 – 150 kW charger with two dispensers

Kingsbury Transit Center does not currently have plans to implement on-route charging, but it is a desirable site for improvement because of its central location. It is adjacent to existing Barton Health offices and a new Barton Health hospital campus as well as a Douglas County-owned parking garage. Route 22 (which, today interlines with 19X) could make use of on-route charging at this location. Depending on scheduling, Route 28 and a potential future Stateline to Carson City bus route could charge at Kingsbury as well.

Per existing energy consumption, Route 22 buses could charge at Kingsbury during brief mid-service layovers as well as at the beginning/end of their assignments as demonstrated in Figure 4-13.

Figure 4-13: Number of Buses Charging at Kingsbury Transit Center by Time of Day



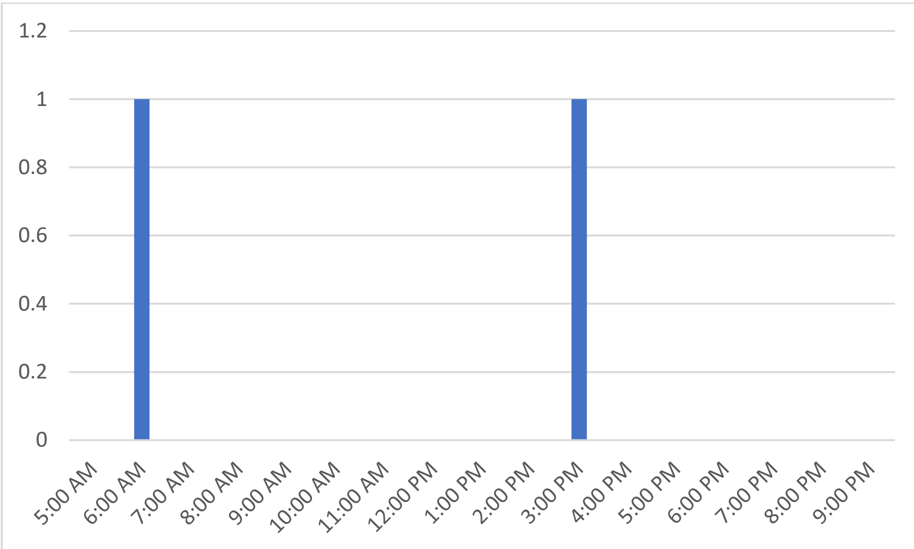
Washington/Plaza

- 1 – 150 kW charger with two dispensers

Washington/Plaza at the Federal Building in Carson City is a shared bus stop for TTD and Jump Around Carson. There are currently no plans or funding to install on-route charging stations at this site, however it is a desirable location as it is served by TTD's Route 19X (which interlines with Route 22) or a potential future Stateline to Carson City via Highway 50 route as well as Jump Around Carson routes. This creates a partnering opportunity between TTD and Jump Around Carson. The site's downtown location and adjacency to various businesses/services, makes it a logical choice for EV improvements.

Per existing energy consumption, Route 19X buses could charge at Washington/Plaza at the beginning/end of their assignments as demonstrated in Figure 4-14.

Figure 4-14: Number of Buses Charging at Washington/Plaza by Time of Day



The described facility and on-route charging strategy would complement the existing on-route chargers at the Lake Tahoe Community College Mobility Hub and provide sufficient operational flexibility for TTD's current service as well as planned service changes per the forthcoming SRTP.

5.0 FLEET PROCUREMENT PLAN

Based on the fleet concept for an all BE-fleet—the preferred concept—we used TTD's fleet replacement schedule to develop a procurement plan for transitioning fossil fuel vehicles to ZEBs. Table 5-1 summarizes the fleet needs for the concept (see Appendix A: Planned Fleet Replacement for fleet replacement chart). Vehicle type breakdown will depend on service needs in the coming years and the forthcoming SRTP.

Table 5-1: Summary of proposed fleet needs for ZEB transition

Vehicle type	Preferred Fleet Concept BEB only
30-ft buses (Routes 19X and 22)	8
35-ft buses (Routes 28, 50, and 55)	14
Passenger Vans (Paratransit)	4
Total vehicles	26

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 25% of all purchases being ZEV. ***Note: This doesn't apply to TTD, however, being a bi-state agency, their Board has chosen to adopt similar targets.***

- For the preferred fleet concept, the adoption of BE buses was prioritized (which TTD started procuring in 2021 and put into service in 2022) to continue in 2025 with two BE vans and replace their first three BEBs in 2033.
- Useful life benchmarks (ULB) of ZEBs must be taken into consideration to ensure that vehicles are safe and in good repair. For this analysis, we assumed the following ULBs: 7 years for long diesel cutaways, 5 years for gas and short diesel cutaways as well as gas and BE vans, and 12 years for BE, hybrid, and diesel buses. These replacement years are developed for planning purposes, leveraging TTD's fleet replacement practices and preferences, and will likely need to be revisited based on actual mileage accumulations as FTA guidance is based on an age and mileage threshold for ULB.

Table 5-2 shows the purchase schedule of diesel/gas and ZE vehicles for the preferred fleet concept, with the timeline extending from 2023 to 2040. Today, TTD has a fleet of 27 vehicles and plans to reduce this to 24 by the end of 2025 before procuring two additional vehicles, bringing their sustained fleet size to 26 vehicles through 2040. Based on the route modeling and analysis, this total fleet size should be able to accommodate TTD's service plan, provided service levels grow modestly, and on-route charging is installed at key locations. The scenario assumes that, as per TTD's fleet replacement plan, three BE Proterra's were introduced into service in 2022 and will be replaced in 2033.

Table 5-3 provides a year-by-year overview of the cumulative number of vehicles of each type and Table 5-4 shows the EV infrastructure phasing. The concept schedule reveals that TTD will meet and exceed the Board of Director's target timeline of 2040 for a full fleet transition. Namely:

- ZEB purchases began in 2021.
- 100% ZE fleet replacement should be completed by 2040, and TTD would meet this requirement by 2040 under the preferred fleet concept. Actual phasing will strongly depend on the ability of TTD to procure competitive funding to finance capital improvements for the transition, as well as supply chain realities related to the delivery of new vehicles.

Table 5-2: Proposed Fleet Purchase Schedule – Preferred Fleet Concept (BEB Only)

FLEET FORECAST	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Diesel Purchases	0	8	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gas Purchases	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0
ZEB Purchases	0	0	2	0	0	0	0	2	0	0	3	0	6	9	0	6	0	4
% of ZEBs in Fleet	11%	12%	21%	19%	19%	19%	19%	19%	19%	19%	19%	19%	35%	69%	69%	92%	92%	100%
ZEB purchase percentage	0%	0%	50%	0%	0%	0%	0%	50%	0%	0%	100%	0%	75%	100%	0%	100%	0%	100%
Added vehicles	0	8	4	6	0	0	1	4	0	0	3	0	8	9	0	6	0	4
Total Vehicles in Fleet	28	25	24	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26

Table 5-3: Proposed Bus Fleet and Charger Summary – Preferred Fleet Concept (BEB Only)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Diesel Bus	11	13	12	8	8	8	8	8	8	8	8	8	4	0	0	0	0	0
Diesel CU Long	6	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
Diesel CU Short	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas CU	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Van	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Hybrid Bus	0	4	4	10	10	10	10	10	10	10	10	10	10	6	6	0	0	0
BE Bus	3	3	3	3	3	3	3	3	3	3	3	3	7	16	16	22	22	22
BE Van	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4
Total ZEBs	3	3	5	5	5	5	5	5	5	5	5	5	9	18	18	24	24	26
Non-ZEBs	25	22	19	21	21	21	21	21	21	21	21	21	17	8	8	2	2	0
Total Fleet	**28**	**25**	**24**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**

Table 5-4: Infrastructure Phasing

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
15kW Level 2 Chargers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
60kW dual dispensers	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150kW dual dispensers	0	0	0	0	0	0	0	0	0	0	0	6	6	0	2	0	0	0
450kW pantograph	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

6.0 MAINTENANCE FACILITY INFRASTRUCTURE MODIFICATIONS

This section outlines a general set of proposed facility modifications for ZEB implementation at TTD's future bus operations and maintenance facility as well as potential on-route charging locations. The current Shop Street facility will not receive any significant improvements; instead, improvements to support a full ZEB fleet will be implemented at one or more to-be-developed locations. In the near-term, infrastructure modifications will focus on on-route charger installation at three new sites – Spooner Summit Mobility Hub, Kingsbury Transit Center, and near the Washington/Plaza bus stop in Carson City, NV. The entire fleet will continue to be stored and maintained at the Shop Street location until a new facility is brought online. At that time, an evaluation to determine the need for ZEB-supportive infrastructure modifications will be required.

As operators currently fuel the BEBs at the LTCC Mobility Hub, work rules do not preclude operators from 'fueling' (charging) and as such, operators would continue to be responsible for plugging in buses or mating the bus and pantograph for charging at LTCC and any new on-route charging locations.

We recognize that TTD's current facility is leased and not owned outright by the agency. As such, any infrastructure investments and alterations to the yard will need to be legally vetted with the City of South Lake Tahoe (CSLT) and the County will need to work together with the CSLT and the utility, Liberty Utilities, when planning for and installing charging equipment. Moreover, while TTD is exploring the possibility of relocating to a new site/facility, the information provided below, particularly in Section 6.1, can be used by TTD 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 TTD for the implementation and deployment of ZEBs.

6.1 PROPOSED FACILITY MODIFICATIONS

The following summarizes the proposed improvements for the BEB-only concept. While it is understood that TTD will likely not improve their existing Shop Street facility to accommodate a full fleet of BEBs, the proposed modifications can provide guidance for TTD at any potential facility.

BEB-Only Fleet Concept (Preferred Concept)

If TTD owns and operates an entirely BEB fleet of full-size buses and vans, on-route chargers and, eventually, overnight chargers will be required.

On-Route Charging Needs

- A minimum of one 150-kW vehicle charger with a 1:2 charger-to-dispenser ratio (SAE J1772-compliant) to serve a maximum of two active (in revenue service) buses at a time at each of the three potential on-route charging locations

- A minimum of one 450-kW pantograph charger to serve one active (in revenue service) bus at a time at the future Spooner Summit Mobility Hub
- Areas for new/expanded utility feeds, potential local energy storage, develop paving and protection bollards

Overnight Charging Needs (Future Facility)

- A minimum of two Level 2 15-kW chargers by 2040 (SAE J1772-compliant) to serve a maximum of two active (in revenue service) BE Vans
- A minimum of one 60kW charger with dual dispensers (SAE J1772-compliant) to serve a maximum of two active (in revenue service) BE Vans
- A minimum of 11 chargers at 150kW each with dual dispensers (SAE 1772-compliant) to serve a maximum of 22 active (in revenue service) BEBs by 2040
- An anticipated connected load of 1.8MW at full build-out for recommended revenue vehicle charging
- A new 2000 kVA transformer to provide adequate additional power to the facility, along with associated equipment pads and bollards
- A new 2000 kW generator with approximately 350 gallons of onsite diesel fuel storage in order to support 100% electric vehicle service for one day; the current calculation assumes fuel needed for approximately two days of outage
- New ATS (automatic transfer switch) between generator and switchgear
- 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 to ensure adequate lighting levels for plugging in vehicles and operation of chargers

6.2 GRID CONNECTION UPGRADES

Existing Facilities

Power to the TTD Shop Street facility and LTCC Mobility Hub is provided from Liberty Utilities lines. Today, the Shop Street facility does not have EV chargers, however, TTD plans to procure two new BE Vans in 2025 and charge them overnight at Shop Street using a new 60kW charger with dual dispensers and the existing 220V supply. Power is fed from overhead lines and pole-mounted transformers to the Office and Dispatch/Shop buildings and is distributed around the site. The existing Liberty Utilities supply lines run on the south side of Shop Street and serve a number of other industrial and commercial customers in the area. The current service is sized to meet the existing operational needs but does not have adequate capacity to support the projected vehicle charging demands at fleet build out.

Should TTD decide to stay at the existing facility long term, the facility will require upgraded or new electrical service connections from Liberty Utilities. 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. Based on publicly available data it is unclear if the local electrical distribution has the capacity to serve the new bus charging equipment. It will be up to the utility to determine if the local power distribution system has the capacity to serve TTD'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 agency's facility and do not include any system upgrades that the service study may identify. The extent and timing of the system upgrades will determine the net cost to TTD, as well as the applicability of any funding programs.

Future Facilities

TTD has set a precedent for on-route charging with their LTCC Mobility Hub. In the near-term, this strategy will serve TTD well, therefore it is recommended to expand the on-route charging network to three new key locations. Each potential on-route charging location is served by NV Energy. In order to determine system capacity, NV Energy is able to conduct a study that will determine available capacity at each site and the cost to bring charging online.

- Spooner Summit Mobility Hub – This location will serve as a strategic on-route charging location for existing and potentially future fixed-route services. Today, Route 28 passes this future mobility hub site twice per day while in revenue service. Buses may also deadhead to this location to recharge.
- Kingsbury Transit Center – This site is in a prime location to provide on-route charging for Routes 28, 22, and potential future services, including paratransit services. While Route 22 and 19X interline, the bus assigned to this block may also benefit from on-route charging at this location.
- Washington/Plaza in Carson City – This site is strategically located at the current terminus of Route 19X. The bus stop is outside of the Federal Building in downtown Carson City and shares curbside access with Jump Around Carson (JAC). On-route charging here could benefit multiple transit systems.

It is recommended for TTD to submit the necessary site and load information to NV Energy in order to begin the planning and cost estimation process. This is the first step to determining the feasibility of building out each on-route charging site and creating a funding strategy.

6.3 NV ENERGY ELECTRIFICATION

As described in Section 3.2, NV Energy does not currently have any programs for which TTD could take advantage. However, NV Energy will be instrumental in assessing system capacity for any new charging infrastructure installation at on-route locations and a potential future facility. NV Energy can help estimate the cost of site and system improvements as well. Typical cost categories include: construction (crew, charging padding, civil, trenching, upgrades to subsystem), inspection and scheduling, design and coordination, easement permitting, contracting and asset management, and miscellaneous/contingency estimates. It should be noted that if TTD requires a substantial load to a new site requiring a substation upgrade, they could be responsible for this cost. Different charging strategies should be analyzed including battery energy storage systems in order to implement the most cost effective and reliable charging strategy possible.

6.4 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 TTD'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 TTD's local network. Additionally, is recommended for TTD 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.

6.5 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 TTD's buses are stored outside at this time. 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.

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. 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 a further evaluation should be given to a long-term operations & maintenance facility.

6.6 FALL PROTECTION AND SAFETY INFRASTRUCTURE CONSIDERATIONS

Fall protection systems are recommended for any vehicle maintenance and inspection shop. Additional fall protection systems should be considered to safely access the rooftop of buses for potential battery inspection and maintenance. Note that not all BEB manufacturers locate the battery packs on the roof of the vehicle. If considerable rooftop access is necessary in the future, TTD should consider installing fall protection systems in the shop.

6.7 EMERGENCY BACK-UP PLANNING

Transit agencies need to consider the portion of service (and thus of their ZEB fleet) that will be deployed or operated during grid-outage conditions. For example, El Dorado and Douglas County, like much of the area, is subject to emergency Public Safety Power Shutoff (PSPS) and ensuring that vehicles can charge during shutdowns is essential not only to maintain transit service but to enable charging for vehicles used during potential emergency evacuation situations.

For site planning and cost estimation purposes, Stantec assumed backup power would be provided by a diesel-fired generator with sufficient fuel storage capacity to support two full revenue days at 100% service levels. The generator size will vary depending on the specific fleet type implemented. See Figure 6-1 for example generator installation.

Figure 6-1: Typical stationary backup diesel generator with belly tank fuel storage.

If TTD 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 get a delivery of diesel fuel, as well as on environmental regulations and local policies.

There will need to be adequate space available on-site for either a new permanent generator or accommodations for a mobile generator with load bank connection. The generator is placed relatively close to its respective distribution panel. The location is determined by attempting to minimize the reduction of parking and minimize disruption to the site. 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) if in California 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 they can be used such as actual or imminent blackouts. Under any scenario TTD should consider close coordination with both the AQMD and CARB in 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 stationary batteries (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.

7.0 FINANCIAL EVALUATION AND IMPACTS

The financial evaluation for TTD's ZE Fleet Conversion Plan consisted of modeling a Base Case (assuming continued use of fossil fuel vehicles plus existing and planned BEBs, or 'business-as-usual') and one scenario to transition the fleet to 100% ZEB operations.

It should be noted TTD's Base Case includes five BE vehicles – three existing BEBs and two soon-to-arrive BE Vans. To support the addition of two BE Vans, there is a capital infrastructure cost for a charger included in the analysis to be installed at the Shop Street facility for both the Base Case and ZEB Case. Construction, permitting, and other costs to install equipment are not included in this analysis for either scenario, however, NV Energy is in the process of assessing installation costs for three potential on-route charging locations discussed in section 4.5 for the ZEB Case. This information will be available in early 2025.

For the purposes of financial modeling, it is important to understand the inherent limitations of modeling since it is largely based on assumptions around cost inputs, service levels, operations, asset life cycles, and other factors that are difficult to predict so far into the future. Nonetheless, the financial modeling helps provide a comparative analysis of the cost and effort required to transition from a fossil fuel fleet and can help provide an indication of budget and funding requirements for capital and operating costs. Note that the categories modeled here are focused on the impacts of a change in propulsion type—they do not account for service delivery costs as these costs would be largely comparable in all scenarios.

The main assumptions for the cost modeling are:

- Financial modeling was completed in real 2024 dollars (2024$).
- A 3% inflation rate was used where applicable.
- A discount rate was not applied.
- The chief sources of information to inform the financial assessment inputs were fleet and fuel data provided by TTD and TTD's NTD profile, as well as information provided via meetings with TTD staff and NV Energy.
- Annual average vehicle mileage assumptions for each vehicle type are shown in Table 7-1[12]:

Table 7-1: Annual average vehicle mileage by vehicle type

Vehicle Type	Annual Average Vehicle Mileage
Diesel Bus	23,687
Diesel CU Long	22,103
Diesel CU Short	26,216

[12] Based on TTD fleet data. Diesel buses and all cutaway mileages represent weighted averages. Gas Van and BE Van mirror mileage for the vehicle type they will replace (i.e., Diesel CU Short). BE Bus mileage represents a weighted average of all vehicle mileage except vehicle types that will transition to Vans. Hybrid bus mileage mirrors BE Bus mileage as they will be used similarly during the transition period.

Vehicle Type	Annual Average Vehicle Mileage
Gas CU	9,139
Gas Van	26,216
Hybrid Bus	18,335
BE Bus	18,335
BE Van	26,216

- Average fuel efficiency assumptions are shown in Table 7-2. This was based on TTD existing fleet fuel data and Stantec modeling for ZEBs.

Table 7-2: Average fuel efficiency by vehicle type

Vehicle Type	Average Fuel Efficiency
Diesel Bus	5.20 mpg
Diesel CU Long	5.88 mpg
Diesel CU Short	5.88 mpg
Gas CU	7.75 mpg
Gas Van	16.00 mpg
Hybrid Bus	5.90 mpg
BE Bus	0.43 mi/kWh
BE Van	0.64 mi/kWh

- The Preferred ZEB Case (BE-only fleet) included the operation of diesel, gas, hybrid, and BE vehicles during the transition period until fossil fuel vehicles are phased out.
- The model was completed using a consistent format for the Base Case and Preferred ZEB Case to facilitate clear comparisons between them. The modeling was developed on an annual basis from 2023 to 2040.

More details about the assumptions and inputs can be found in Appendix B: Financial Modeling Inputs and Assumptions.

7.1 BASE CASE APPROACH

Stantec developed the forecast for the Base Case (business-as-usual) scenario, assuming the currently planned fleet replacement schedule (see Appendix A: Planned Fleet Replacement), including the existing three bus BE fleet, is maintained and renewed through 2040. 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 fleet replacement data provided by TTD. Vehicle maintenance costs were also derived from information provided by TTD and costs were developed as a cost per mile expense. Similarly, fuel costs are based on data provided by TTD and forecasted based on US Energy Information Agency (EIA) trends for the respective energy types.

7.2 PREFERRED ZEB CASE (BE-ONLY) APPROACH

The Preferred ZEB Case foresees a gradual transition to 100% ZEB operations by 2040. The transition follows the fleet replacement schedule presented in Table 7-3. Based on these assumptions, the fleet would be 100% ZE by 2040.

Table 7-3: Proposed Fleet Purchase Schedule – Preferred ZEB Case (BE-Only)

FLEET FORECAST	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Diesel Purchases	0	8	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gas Purchases	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0
ZEB Purchases	0	0	2	0	0	0	0	2	0	0	3	0	6	9	0	6	0	4
% of ZEBs in Fleet	11 %	12 %	21 %	19 %	19 %	19 %	19 %	19 %	19 %	19 %	19 %	19 %	35 %	69 %	69 %	92 %	92 %	100 %
ZEB purchase percentage	0%	0%	50 %	0%	0%	0%	0%	50 %	0%	0%	100 %	0%	75 %	100 %	0%	100 %	0%	100 %
Added vehicles	0	8	4	6	0	0	1	4	0	0	3	0	8	9	0	6	0	4
Total Vehicles in Fleet	28	25	24	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26

The fleet phasing plan assumes that TTD will procure two BE Vans in 2025, replace their existing three bus BE fleet in 2033, and procure additional BE vehicles in 2035, 2036, 2038, and 2040 and will stop purchasing diesel and gas vehicles after 2035 to achieve a full ZEB transition by 2040. The assumed life cycles are as follows: 7 years for long diesel cutaways, 5 years for gas and short diesel cutaways as well as gas and BE vans, and 12 years for BE, hybrid, and diesel buses.

Modeled capital expenses consist of fleet acquisition information from TTD and market information for ZEBs; battery replacements are not included as we assumed they are not needed based on the short lifespan and warranties of the vehicles.

Vehicle maintenance costs for BE vehicles were generated based on TTD's current costs for its fossil fuel fleet and Stantec's understanding of potential savings and TTD's O&M model. 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 meetings and information from TTD and NV Energy. They represent usage costs ($/kWh) and do not include demand charges or other fees.

Infrastructure phasing should be used for illustrative purposes only as it has not yet been determined when or if TTD will build-out a new operations and maintenance facility. Additionally, the suggested on-route charging procurement schedule can be modified according to updates in TTD's service delivery, route prioritization, regional partnerships, etc. Infrastructure costs are for the capital costs of four different types of chargers:

- 15kW Level 2 chargers including concrete pad and pipe bollards (facility charger)
- 60kW DCFC with dual dispenser (facility charger)
- 150kW DCFC with dual dispenser (facility and on-route charger)
- 450kW pantograph (on-route charger)

Utility side infrastructure has not been modeled. As noted above, NV Energy is in the process of assessing installation costs for three potential on-route charging locations discussed in section 6.2 for the ZEB Case. This information will be available in early 2025. See section 6.0. for additional infrastructure information.

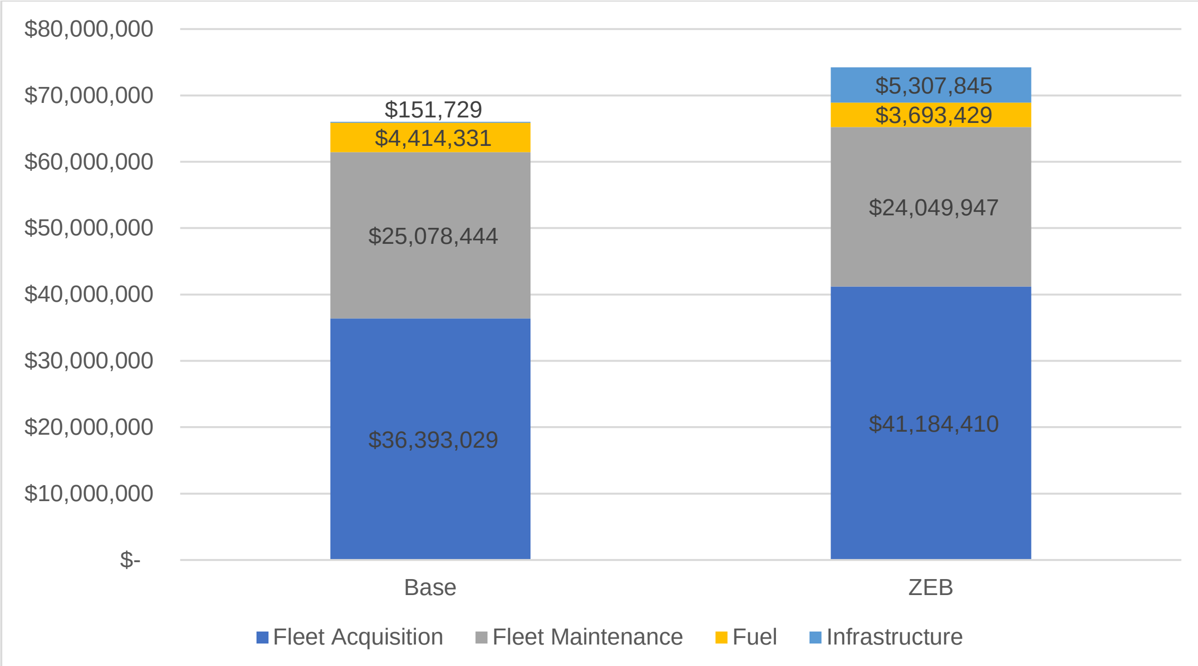
7.3 COMPARISON AND OUTCOMES

The cost comparison between the fossil fuel Base Case and the preferred ZEB Case transition scenario is presented in Table 7-4 and Figure 7-1, incorporating both capital (orange) and operating (blue) expenses. The Preferred ZEB Case has a total cumulative cost of $74,235,632 versus $66,037,534 for the Base Case, a difference of $8,198,098 or a 12.41% increase. 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. Potential funding sources are discussed in section 11.0. Also, the assessment does not consider operational costs (i.e., bus operators, service levels, etc.) that would be the same in both scenarios—the assessment is focused on *relative* differences between the two scenarios and the elements that would be most impacted by a change in propulsion technology.

Table 7-4: Cost Comparison 2023-2040, Preferred ZEB Case

	Base Case	Preferred ZEB Case	Cost difference (ZEB - Base)
Fleet Acquisition	$36,393,029	$41,184,410	$4,791,381
Fleet Maintenance	$25,078,444	$24,049,947	$(1,028,497)
Fuel/Electricity	$4,414,331	$3,693,429	$(720,901)
Infrastructure	$151,729	$5,307,845	$5,156,116
Total	**$66,037,534**	**$74,235,632**	**$8,198,098**

Figure 7-1: Breakdown of Cost Categories for the Base Case and Preferred ZEB Case



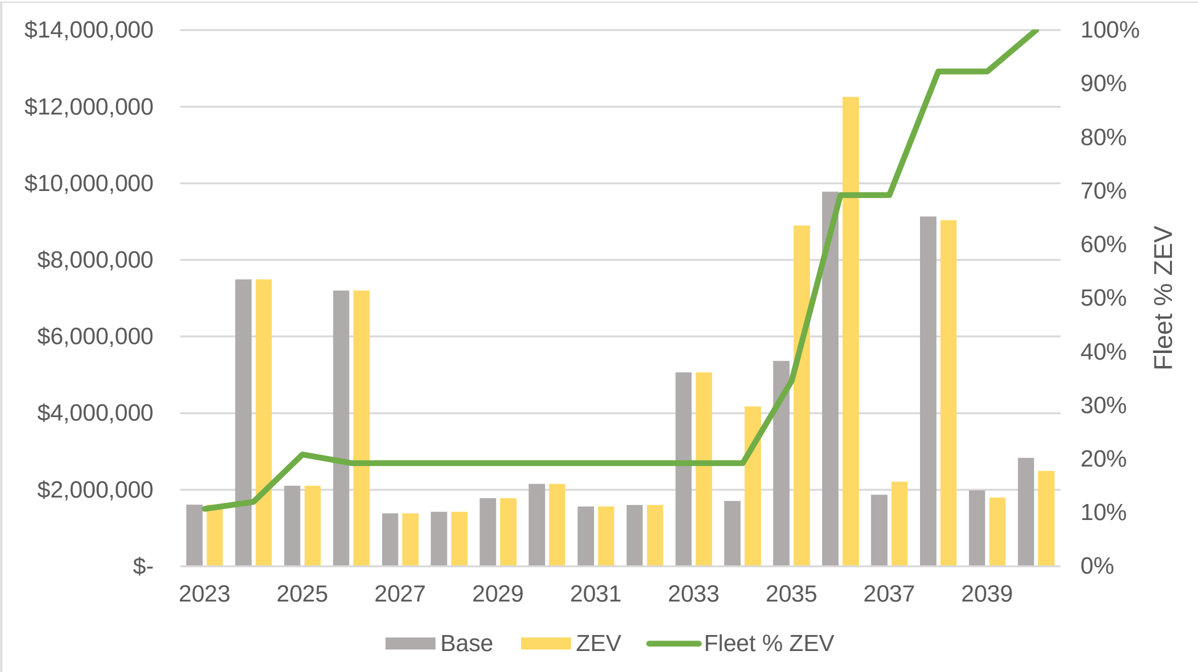
The procurement of BEBs represents $4,791,381 more in expenses due to the higher purchase price of BE vehicles compared to fossil fuel vehicles. The procurement of chargers for a future facility and on-route adds a cost of $5.2 million, not including the cost of construction, permitting, etc.

The simplicity of BEB propulsion systems means that maintenance costs can be lower for BE vehicle technology compared to fossil fuel engine components. This should translate to lower maintenance costs for the BE fleet, a potential savings of $1,028,497. In TTD's experience to date, their three bus BE fleet has seen significant maintenance issues partly exacerbated by Proterra's bankruptcy and following acquisition. TTD is in the process of bringing their BE fleet back online and will then be able to track a more accurate annual maintenance cost.

Lastly, the use of electricity as 'fuel' represents an economic benefit of $720,901 when compared to existing diesel and gasoline refueling. These savings are a direct reflection of the improved efficiency that BE vehicles have with respect to legacy technologies, with the added benefit of eliminating emissions.

Figure 7-2 shows the year-to-year total cost comparison between the Base Case and the Preferred ZEB Case. The higher costs for the ZEB scenario occur during the years that charging equipment is procured for the facility and/or on-route as well as when a greater number of vehicles are purchased.

Figure 7-2: Annual Total Cost Comparison



8.0 OPERATIONAL AND PLANNING CONSIDERATIONS

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

8.1 PLANNING, SCHEDULING, AND RUNCUTTING

Key considerations for BEB planning and scheduling include the fact that the useable energy of the battery is 60% of the nameplate capacity. In other words, while TTD may purchase buses that have a 120-kWh battery, for instance, it should plan for 60% of that capacity or ~72 kWh. This fact, together with the modeling conducted by the Stantec team in this study, will help guide the deployment and charging parameters for BEBs in TTD's operations scheduling.

Developing a guide like the depot planning tool from Siemens below (Figure 8-1) 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 8-1: Depot planning tool to understand scheduling and operations of BEBs (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 TTD'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 TTD's scheduling software provider to account for hybrid deployments of ZEB and fossil fuel buses, and finally an entirely-ZEB 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 6 to 12 years[13]. With an estimated 2% battery degradation per year, TTD 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.

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

8.2 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—mastering regenerative braking and handling during slick conditions—and have practice on how to do so 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 significantly between operators). Operators should become knowledgeable on the principles of regenerative braking, mechanical braking, hill holding, and roll back. Operators should 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 through rewards like priority parking in the employee lot, certificates, or other incentives. The Antelope Valley Transit Authority (AVTA) in Lancaster, California, an early adopter of 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.

The presence of hydrogen gas and the safety issues that relate to this must be addressed as well as any differences to gauges and instrumentation. An overview of the technology must be included during training. An additional increment of time beyond just the vehicle layout and driving characteristics needs to be added to training sessions to address the technology and unique safety considerations. Additional training time for different start-up and shut-down procedures and proper procedures regarding what to do if there is a failure on route should be accounted for as well.

Finally, ZEBs are much quieter than conventional fuel buses. Operators should be aware of this and that pedestrians or people around the bus may not be aware of its presence or that it is approaching. Agencies

[13] 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.

have also stated that due to the vehicle's lack of noise, some operators forget to turn off the bus after parking. Operator training should include a process for ensuring that this happens.

8.3 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 TTD to coordinate spare parts procurement needed for ongoing ZEB 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 (IC) 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 TTD 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.

8.4 VEHICLE PROCUREMENT GUIDANCE

Currently, TTD operates a fleet of cutaways, buses, and a trolley. The ZEB transition will likely see the addition of vans along with the retirement of cutaways and the trolley. The BEB market is still limited and can impact procurement options and timelines.

The most developed BE transit market is for 35-ft buses. TTD has already begun procurement of this platform and complementary charging infrastructure. TDD may wish to consider the procurement of 30-ft BEBs in the future to replace some of their longer fossil fuel cutaways. BYD makes a 30-ft BEB called the K7M. It has a 213-kWh battery and has a range up to 158 miles. BYD also produces an extended range version with a 313-kWh battery and 196 miles of range. Both platforms are HVIP-eligible.

There is a clear and growing need for more ZE van alternatives with longer ranges for agencies that operate in small communities and offer demand-response services, like TTD. Currently, three BE vans are on the market but have not been Altoona-tested. Our modeling assumed that Altoona testing will be completed prior to any TTD procurements. A key assumption is that battery capacity will improve enough to meet the needs of TTD's service. This assumption is based on the growing demand for ZE vans in the past few years and improved efficiencies in batteries.

The GreenPower EV Star has a 118-kWh battery with a range of up to 150 miles. The vehicle is eligible for a $60,000 incentive per vehicle under the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP) program[14]. Lightning Systems makes a BE passenger van with configurable battery options and up to 170 miles of range. US Hybrid also makes a BE van based on the Ford eTransit platform with up to 210 miles of range. These vehicles can typically 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.

TTD 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.

Currently, there are two OEMs that manufacture fully electric trolleys and one manufacturer that retrofits existing BYD electric buses to look like trolleys. If TTD is interested in continuing operation of a trolley, Motiv Power Systems manufactures the Epic F-53 trolley[15] based on the Ford F-53 chassis with a battery capacity of 127 kWh and an OEM-stated range of 105 miles. Hometown Manufacturing produces the MT50E Villager trolley with a battery capacity of 226-kWh and an OEM-stated range of 150-170+ miles[16]. The larger Streetcar trolley by Hometown Mfg. has a 320-kWh battery capacity and an OEM-stated range of 140-200 miles[17]. Lastly, Cable Car Classics in partnership with BYD—an electric bus manufacturer—uses the K9S model of a 35-ft electric bus and retrofits it to make it look like a trolley.

Some example vehicles are summarized Table 8-1, and these provide illustrative examples only. TTD should develop a competitive tendering process for its fleet procurement and use programs like the CalACT/MBTA Purchasing Cooperative to streamline procurement. TTD should also leverage APTA's Standard Bus Procurement Request for Proposal (RFP) which contains language about charger specifications, data logging and telematics, and other information that would be useful to include for vehicle and charger procurements[18]. To help offset the capital costs of these BEBs, TTD can apply for vouchers through the California HVIP program[19], as well as take advantage of other grant opportunities summarized in Section 11.0.

[14] https://californiahvip.org/vehicles/lightning-systems-lev110e-bus-ford-e-450-with-lightning-powertrain/
[15] https://californiahvip.org/wp-content/uploads/2021/05/Motiv_M214_DS_EPICF53_Trolley_20210120.pdf
[16] https://hometown-mfg.com/sites/default/files/2022-04/MT50E%20Electric%20Villager%20Brochure.pdf
[17] https://hometown-mfg.com/sites/default/files/2022-04/Electric%20Streetcar.pdf
[18] https://www.apta.com/research-technical-resources/standards/procurement/apta-bts-bpg-gl-001-13/
[19] https://californiahvip.org/vehicle-category/medium-duty-bus/

Table 8-1: Summary of vehicle options

Vehicle type	ZEB type	Make and model	Battery size (kWh) or Tank size (kg)	Range (miles)	Notes	Example Vehicle Photos
Full Size Bus	BE	BYD K7M and K7M-ER	213-313	158-196	Eligible for $85,000-$120,000 HVIP voucher. Potential cutaway replacement platform.	
Passenger Van	BE	Lightning Systems Electric Zero Emission Transit Passenger Van	80-120	140-170	***May no longer be 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.	
	BE	US Hybrid by Ideanomics Ford Transit T-350HD DRW[20]	180	210	Supports both Level 2 and DC fast chargers.	

[20] https://www.ushybrid.com/wp-content/uploads/2022/05/USH_eVan_Productsheet_2022_V8.pdf

Vehicle type	ZEB type	Make and model	Battery size (kWh) or Tank size (kg)	Range (miles)	Notes	Example Vehicle Photos
	BE	GreenPower EV Star	118	150	Eligible for $60,000 HVIP voucher.	
Trolley	BE	Motiv on F-53 Platform – Hometown Trolley	127	105	Eligible for $85,000 HVIP voucher.	

8.5 O&M CONTRACTOR PROCUREMENT GUIDANCE

Today, TTD handles all of their own bus operations and most of their maintenance (aside from BEB and charger warranty issues). It is common for smaller transit agencies, like TTD, to outsource operations and/or maintenance to a third-party. Operations and maintenance (O&M) contractors provide an all-inclusive billing rate for operations based on scheduled vehicle hours 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. Savings under this arrangement are likely to be small but if TTD ever decides to pursue third-party operations and/or maintenance, Stantec recommends that procurement documents stipulate language for conditions to ensure that any cost savings realized by the O&M contractor is passed on to TTD. 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 and Hydrogen 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 TTD to ensure that if it goes out to procurement, that protections are built in such that any cost benefits the O&M contractor accrues due to ZEB operations is passed along to TTD.

8.6 FUELING NEEDS

BEB recharging is substantially different than fueling a diesel or fossil fuel bus. As part of the recommendations, plug-in chargers (15, 60, and 150 kW) and pantographs (450 kW) are proposed for BEB charging at the various on-route charging locations and TTD's O&M facility. During layovers or at the beginning/end of a shift, the driver would plug-in the vehicle to the dispenser or position the vehicle under the pantograph. Smart charging software, described in Section 9.0 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 8-2: A BE passenger van plugged into a charger

8.7 BATTERY DEGRADATION

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

Following the recommendations of the manufacturer is 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 can help expand the lifespan of the batteries (below 300 kW), however in order to deliver service, it has been recommended that TTD continue their investment in fast charging.

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 vans are also assumed to be available but might not be necessary to go beyond the warranty given the short utilization cycle that vans will have at TTD (five years). Actual experience may differ, and TTD will need to work with its vendors to understand warranty terms.

9.0 TECHNOLOGY

Technology for ZEBs will help TTD 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 TTD make informed decisions.

9.1 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. However, if bus C is scheduled for dispatch after three hours, it would not be adequately charged.

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

Another implementation is to mitigate energy demand when possible. For example, if two buses, each requiring 300 kWh of energy, are connected to individual 150 kW chargers and don’t need to be dispatched for five hours, the system will charge them one at a time. This approach keeps the demand at just 150 kW while still fully charging both buses within 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, Evenergi, and Siemens.

Additionally, the charger manufacturers all have their own native charge management software and platforms. These platforms offer advanced management capabilities and integration that often surpass those of other systems, delivering data and functionality comparable to third-party solutions, especially when BEBs are connected to chargers in the yard. 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 $100 per bus per month, depending on the number of buses, and type of package procured.

Three leading charge management system (CMS) providers have been evaluated as shown in Table 9-1. Information within this table was given by the providers. This table reflects the current 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 9-1: Charge Management System Vendor Comparison

Item No.	Criteria Description	Amply Power - OMEGA	Viriciti - Agnostic Management Platform	ChargePoint - CMS
1	Number of installations (facilities) with multiple HVDC 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

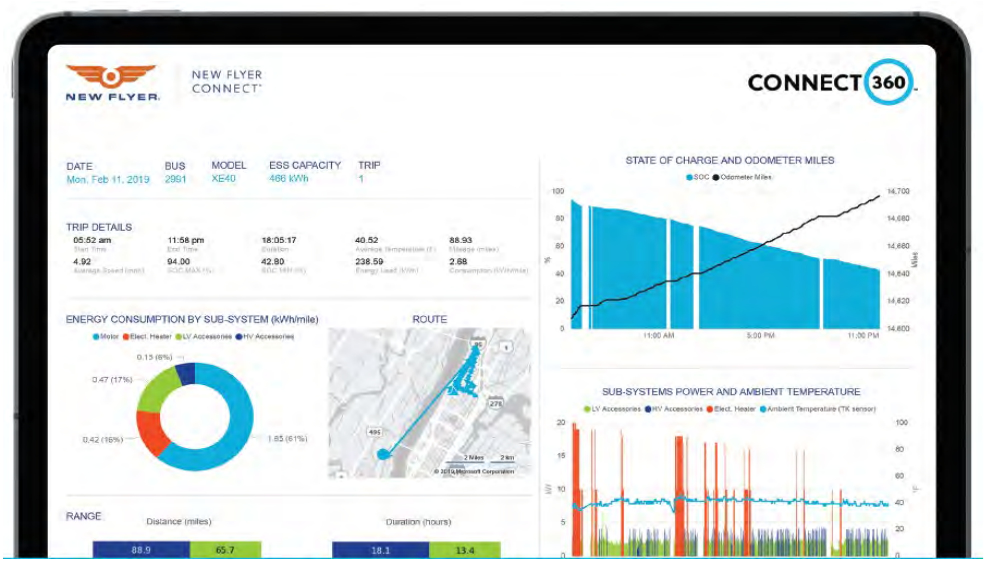
Item No.	Criteria Description	Amply Power - OMEGA	Viriciti - Agnostic Management Platform	ChargePoint - CMS
15	Manual override (computer/HMI input) for selection of (bus) charging sequence	Yes. Manual override button located within UI accessible by a specific user creditable. Override can also be performed 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

9.2 FLEET TRACKING SOFTWARE

Software like Fleetwatch provides 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).

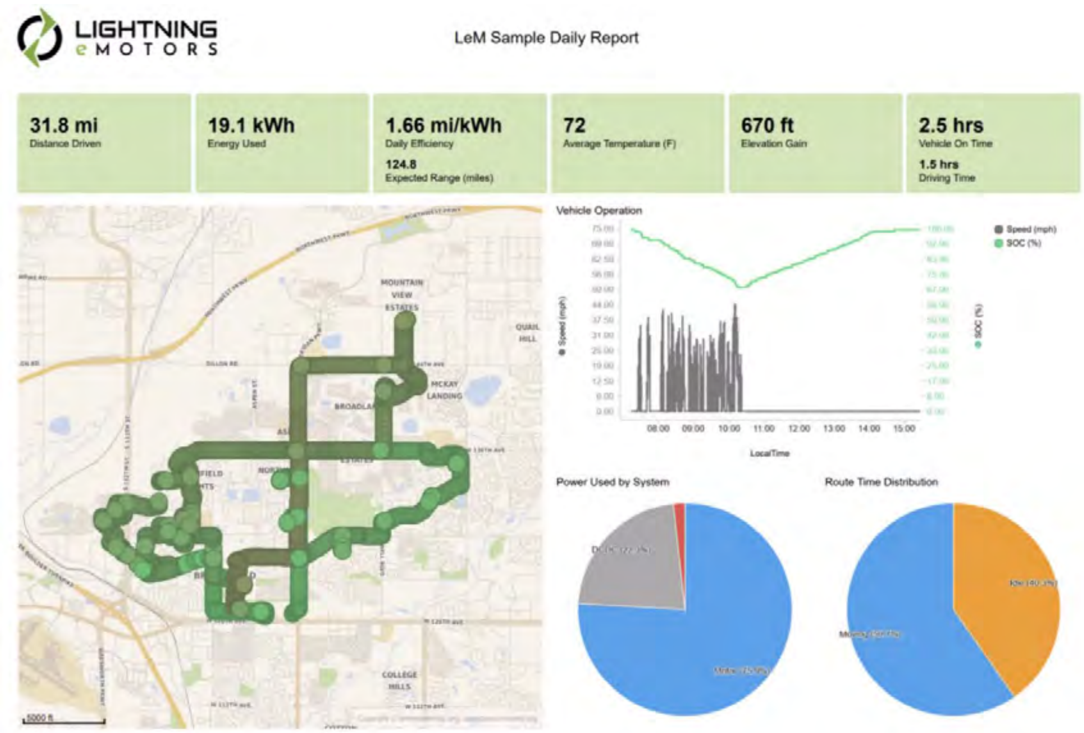
The screenshot below is an example of New Flyer's tool (New Flyer Connect 360; Figure 9-1), Lightning's dashboard (Figure 9-2), while other OEMs also offer similar tools (like ViriCiti) all depending on an agency's preference.

Figure 9-1: Example of New Flyer Connect 360.[21]



[21] https://www.newflyer.com/tools/new-flyer-connect/

Figure 9-2: 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 KPIs can help compare a vehicle's performance on different routes, under different ambient conditions, and even by different operators.

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 TTD to track utility usage data from TPPA to understand energy and power demand and costs.

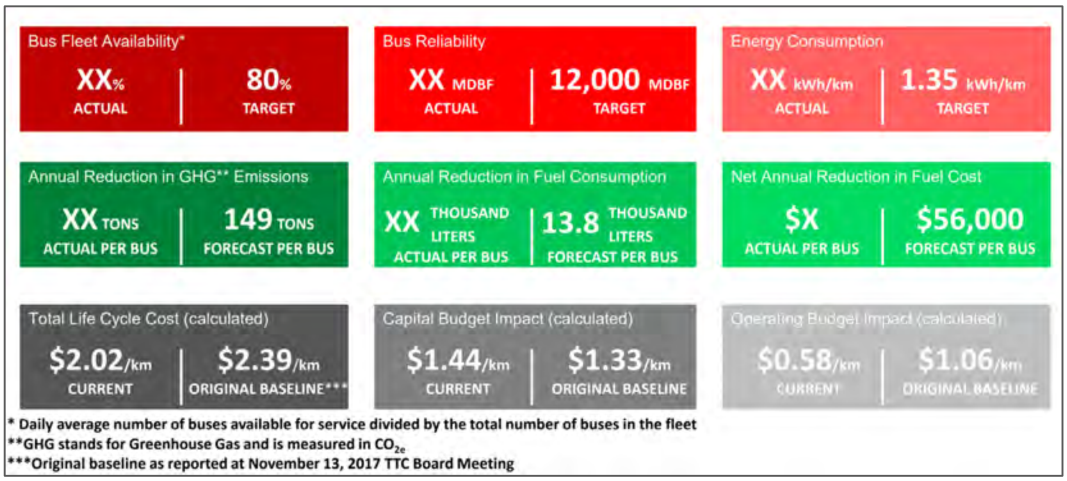
As TTD transitions from a fossil fuel fleet to ZEB fleet, it will be important to collect and compare data between the fleet types to understand the benefits (and costs) of the transition. Example key performance indicators (KPIs) can include:

- 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
- ZEB vs. non-ZEB fleet availability

The Toronto Transit Commission (TTC) 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 9-3).

Figure 9-3: Example of TTC eBus KPIs.[22]



All ZEB equipment should be connected to TTD'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.

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

10.0 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 for the adoption of BEBs.

10.1 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. TTD leadership needs 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, additional 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 10-1 below provides a framework of potential training methods and strategies to bolster TTD's workforce development and successfully transition to a 100% ZEB fleet.

Table 10-1: 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.
Bus vendor training and fueling vendor	OEM training provides critical, equipment-specific operations and maintenance information. Prior to implementing ZEB technology, TTD 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 TTD staff.
ZEB training from other transit agencies	TTD 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	TTD 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 TTD'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.

Finally, it is highly recommended that all local fire and emergency response departments be given training as to the 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. In addition, agencywide orientation to familiarize the agency with the new technology should also be conducted prior to the first BEBs deployment.

10.2 IMPLICATIONS OF BEBS ON WORKFORCE

Early data suggest that BEBs may require less preventative maintenance than their diesel counterparts since they have fewer moving parts. However, ZEBs (particularly smaller, non-heavy-duty transit buses) are so new that there is not enough data to provide detailed insights into long-term maintenance practices for large-scale ZEB deployments in North America.

Because ZEBs 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 is related to a possible reduction in the number of maintenance staff required for a ZEB fleet vs. a traditional diesel or gasoline fleet.

Nonetheless, while a future 100% fleet of ZEBs may require a smaller complement of maintenance staff, during the transition period, it is highly improbable that a reduction in staff would be warranted. Generally, fewer maintenance practices may be needed, such as oil and lube changes, but 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, but also on components that require computer and diagnostic skills.

10.3 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. It would be prudent for TTD to form a steering committee or task force to guide the transition to ZEBs and this may require additional TTD staff to serve as a program or project manager. 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 TTD to promote its climate and clean air commitments.

11.0 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 TTD 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 11-1.

Table 11-1: Grants and potential funding options for ZEB transition

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
Federal	Federal Transit 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 FY2024 the FTA awarded $1.1 billion.[23]
		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.	FY2024 funding totaled $400 million in grants.
		Grants for Rural Areas (5311)	5311 grant funding makes federal resources available to rural areas for transit capital, planning 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% for capital projects.	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.
		Enhanced Mobility of Seniors & Individuals with Disabilities (5310)	5310 formula funding provides resources to help meet the transportation needs of older adults and people with disabilities. Eligible subrecipients (from the State for rural areas) include public transit operators. Eligible activities include capital investments in buses and vans, wheelchair lifts and harnesses, and other equipment. The federal share is not to exceed 80% for capital projects.	For small urban and rural areas, the State is the direct recipient and distributes these funds as it wishes. Agencies can allocate these funds for the purchase of ZEBs.

[23] https://www.transit.dot.gov/about/news/investing-america-biden-harris-administration-strengthens-transit-manufacturing-industry

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program (CMAQ)	The 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.[24]	FY2024 provided $1.8 billion in RAISE grants to 148 projects. In FY2025, $1.5 billion in funding was announced for the RAISE Grant Program to be shared between two rounds of applications. [25]
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. Voucher rebates vary by vehicle type and model.[26]	There is currently $99 million in Standard HVIP funding available and $49 million in Transit HVIP funding.[27] Hydrogen fuel cell vehicles are eligible for HVIP but must not have plug-in capacity.[28]
		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.

[24] https://www.transportation.gov/RAISEgrants/about
[25] https://www.transportation.gov/sites/dot.gov/files/2024-10/RAISE%202025%20NOFO_%20Signed.pdf
[26] https://californiahvip.org/vehiclecatalog/
[27] https://californiahvip.org/funding/
[28] 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.	$130 million available to replace older, high-polluting transit, school, and shuttle buses with ZEBs.[29] Applications are open for transit agencies and are processed on a first come, first serve basis. Maximum of $3,250,000 total funding per agency.[30]
	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.[31]	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.[32]
		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: $480,000,000 for FY22-23[33]
	California Department of Transportation (Caltrans)	SB1 State of Good Repair (SGR)	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.

29 https://ww2.valleyair.org/grants/vw-mitigation-trust/
30 http://vwbusmoney.valleyair.org/documents/FAQ.pdf
31 https://catc.ca.gov/programs/sb1/local-partnership-program
32 https://www.vcstar.com/story/news/local/2021/10/22/group-proposing-transit-sales-tax-measure-countys-2022-ballot/5988391001/
33 https://www.grants.ca.gov/grants/solutions-for-congested-corridors-program/

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
		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.[34]	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 received $38,743,000 to procure 11 hydrogen fuel cell buses, designed a hydrogen fueling station, and designed and constructed an intermodal transit and housing center.[35]
		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. [36]	ZEB procurement could compete for STIP funding. The 2024 STIP was adopted in March 2024 and included $2.865 billion in available funding over the five year period.[37] Funding is distributed via a formula for a variety of projects.
		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 (LTF) and the State Transit Assistance (STA) fund.[38]	Funding opportunities include transportation program activities, pedestrian and bike facilities, community transit services, public transportation, and bus and rail projects.

[34] https://calsta.ca.gov/subject-areas/transit-intercity-rail-capital-prog
[35] https://calsta.ca.gov/-/media/calsta-media/documents/tircp---program-of-projects-as-of-july-2022---cycle-5-only-a11y.pdf
[36] https://catc.ca.gov/programs/state-transportation-improvement-program
[37] https://catc.ca.gov/-/media/ctc-media/documents/programs/stip/2024-stip/2024-adopted-stip-final.pdf
[38] https://dot.ca.gov/programs/rail/transportation-development-act

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	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 (AHSC)	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.	$675 million in available funds was announced in 2024. The maximum award amount is not to exceed $15 million per project.[39] 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.[40] Funding is limited.	As of 2024, CMO has awarded $55 million to 73 communities.[41]
	California Pollution Control Financing Authority (CPCFA)	Zero-Emission Heavy-Duty Programs	The CPCFA has developed a purchasing assistance program for ZEV fleets. This will provide financial support and technical assistance to fleet managers deploying ZEV fleets.	CPCFA will designate high priority fleets based on implications for climate change, pollution, environmental justice, and post-COVID economic recovery.[42]

[39] https://www.hcd.ca.gov/sites/default/files/docs/grants-and-funding/ahsc/ahsc-nofa-r8.pdf
[40] https://cleanmobilityoptions.org/about/#
[41] https://cleanmobilityoptions.org/awardees/
[42] https://www.treasurer.ca.gov/cpcfa/calcap/zero-emission/general_info.asp

Type	Agency	Fund/Grant/Program	Description	Applicability & Details
	State of California	Local Transportation Fund (LTF)	Local Transportation Fund (LTF) is derived from a ¼ cent of the general sales tax collected statewide. The State Board of Equalization, based on sales tax collected in each county, returns the general sales tax revenues to each county's LTF. Each county then apportions the LTF funds within the county based on population.	Eligible activities include planning, capital, operating, and the acquisition of public transportation services.[43]
Other		Low Carbon Fuel Standard (LCFS credits)	LCFS credits are not necessarily 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 2022 and 2024 was between $45 and $150 per credit.[44]
		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.[45]	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.[46]
	NV Energy	Charging Station Incentives for Government Buildings	Incentives are available to cities, counties, state and federal agencies, military, police departments, national parks, library districts and public-school districts not applying for charging infrastructure in the electric school bus incentives program.[47]	Incentive is for a minimum of two and a maximum of four Level 2 charging ports. $10,000 per charging port, 100% of project costs up to $40,000. ***Note***: Applications that have not already received a reservation notice will instead receive a conditional reservation notice upon application approval. Projects may begin construction upon receiving a conditional reservation notice, but funds are not guaranteed until a reservation notice has been issued.

[43] https://www.tahoetransportation.org/wp-content/uploads/2023/03/Funding-Overview.pdf
[44] https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard
[45] https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0010121-toll-credit-fact-sheet.pdf
[46] https://dot.ca.gov/-/media/dot-media/programs/rail-mass-transportation/documents/f0009899-2-toll-credits-fact-sheet-a11y.pdf
[47] https://www.nvenergy.com/cleanenergy/electric-vehicles/government-charging

In addition to the funding sources listed above, TTD has been accumulating some capital funding. In 2022, TTD's capital funding saw a significant boost, primarily due to a $3.8 million injection from federal sources. Historically, state funding has been the only consistent source, contributing between 67% and 90% of the capital from 2018 to 2021. Despite a 273% increase in state funding from 2021 to 2022, it still only accounted for 7% of the total capital. Additionally, directly generated revenue contributed $481,000, representing 10% of the capital funding in 2022. Moving forward, TTD will need to diversify its funding sources by seeking both traditional federal and state grants, along with newer programs designed to support ZEB transitions and environmental sustainability. These funding opportunities will be crucial in helping to offset the costs associated with TTD's transition to a zero-emission fleet.

One chief source of capital funding is the Low-No and Bus and Bus Facility Grant. The Tahoe Transportation District was awarded three consecutive years of Low-No funding, most recently $7.9M in FY24 to buy hybrid diesel-electric buses to replace aging diesel buses. The project will expand TTD's low-emissions bus fleet and decrease the impact on Lake Tahoe's environmentally sensitive region, and improve safety, reliability, and mobility for transit riders in the Lake Tahoe Basin.[48]

TTD may wish to compete for Bus and Bus Facility funding as well using their ZE Fleet Transition Plan which can be updated with information from this report. The FTA Zero-Emission Fleet Transition plan includes six major elements, presented in Table 11-3. Moving forward, to qualify for these funding opportunities, a transit agency must include a transition plan with these elements.

Table 11-2: 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

[48] https://www.transit.dot.gov/funding/grants/fy24-fta-bus-and-low-and-no-emission-grant-awards

Element	Description
	exiting workers of the applicant to operate and maintain ZEVs and related infrastructure and avoid displacement of the existing workforce.

Lastly, TTD could also explore leasing programs with OEMs. New Flyer, for example, has a leasing program for their buses[49] that agencies can use to help reduce the upfront expenses of ZEBs. Moreover, certain federal grant programs can be used to lease buses, including Low-No and Bus and Bus Facilities.

[49] https://www.newflyer.com/2023/09/nfi-delivers-strongest-fta-low-no-and-buses-and-bus-facilities-grant-performance-ever-as-named-partner-on-more-than-200-million-in-grants

12.0 SERVICE IN DISADVANTAGED COMMUNITIES

The Climate and Economic Justice Screening Tool, created by the Council on Environmental Quality, uses census tract data to identify regions across the U.S. that are overburdened and underserved in eight key areas: climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. Communities that are disproportionately affected in any of these categories are classified as disadvantaged. This tool was developed to support the Justice40 Initiative, which aims to allocate 40% of the benefits from climate and clean energy investments to these disadvantaged areas.

Figure 12-1 and Table 12-1 summarize the multiple census tracts that are classified as 'disadvantaged communities' and 'partially disadvantaged' according to the Justice40 tool in TTD's service area.

Figure 12-1: Justice40 Disadvantaged Census Tracts

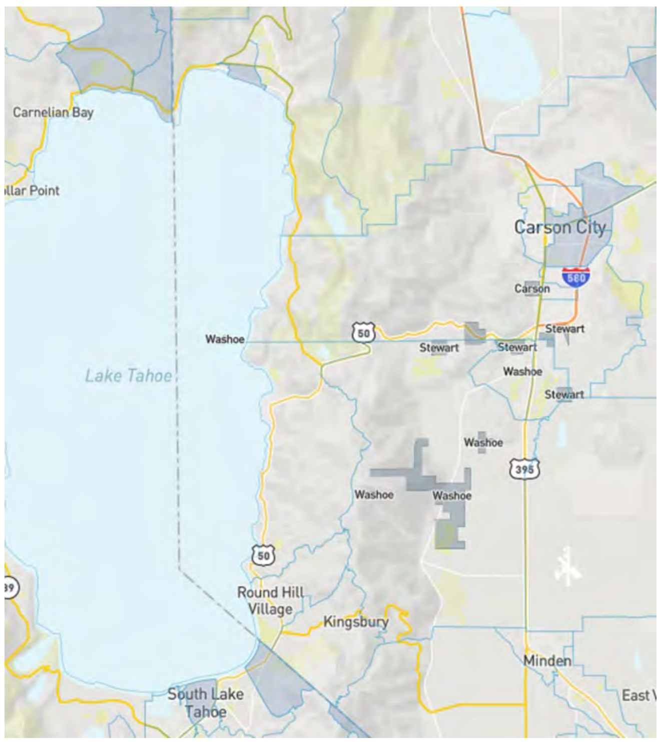


Table 12-1: List of Disadvantaged Census Tracts

Location of Disadvantaged Census Tracts
Census Tract 06017031600, El Dorado County, California
Census Tract 06017030302, El Dorado County, California
Census Tract 32510000600, Carson City County, Nevada

Location of Disadvantaged Census Tracts
Census Tract 32510000502, Carson City County, Nevada
Census Tract 32510001001, Carson City County, Nevada
Census Tract 32510000900, Carson City County, Nevada
Census Tract 32031003306, Washoe County, Nevada
Location of Partially Disadvantaged Census Tracts
Census Tract 32510000300, Carson City County, Nevada
Census Tract 32510000800, Carson City County, Nevada
Census Tract 32005001900, Douglas County, Nevada
Census Tract 32005002100, Douglas County, Nevada
Census Tract 32005002200, Douglas County, Nevada
Census Tract 32005002000, Douglas County, Nevada

The partially disadvantaged census tracts include land belonging to Federally Recognized Tribes that are classified as disadvantaged. However, the Climate and Economic Justice Screening Tool does not specify which categories these Tribal communities are disadvantaged in.

These census tracts will be critical for TTD to prioritize during the ZEB rollout. Ensuring that these areas are adequately served aligns with the goal of addressing underserved communities and supporting equitable access to clean transportation solutions. Prioritizing these tracts will help deliver meaningful benefits to disadvantaged communities as part of the overall transition to zero-emission buses.

13.0 GHG IMPACTS

One of the chief reasons for transitioning to ZEBs is to reduce pollution by removing the harmful byproducts of fossil fuel combustion from transit operations. While ZEBs eliminate all tailpipe emissions, there may still be upstream carbon emissions associated with the production of energy sources that power ZEBs. This section assesses the overall impacts of ZEB transition on harmful emissions.

Based on the ZEVDecide modeling of greenhouse gas (GHG) emissions, TTD's diesel/gasoline fleet emits 1,136 tons of GHGs in an average year for the transition period 2023-2040.[50] The GHG analysis was completed for the preferred concept (BE-only fleet) as well.

This fleet option dramatically decreases TTD's annual emissions. While BEBs do not have tailpipe emissions, upstream emissions are associated with BE vehicles resulting from the carbon-intensity of the electric grid. The full BEB fleet would emit 72 tons annually based on upstream emissions after full fleet conversion in 2040.

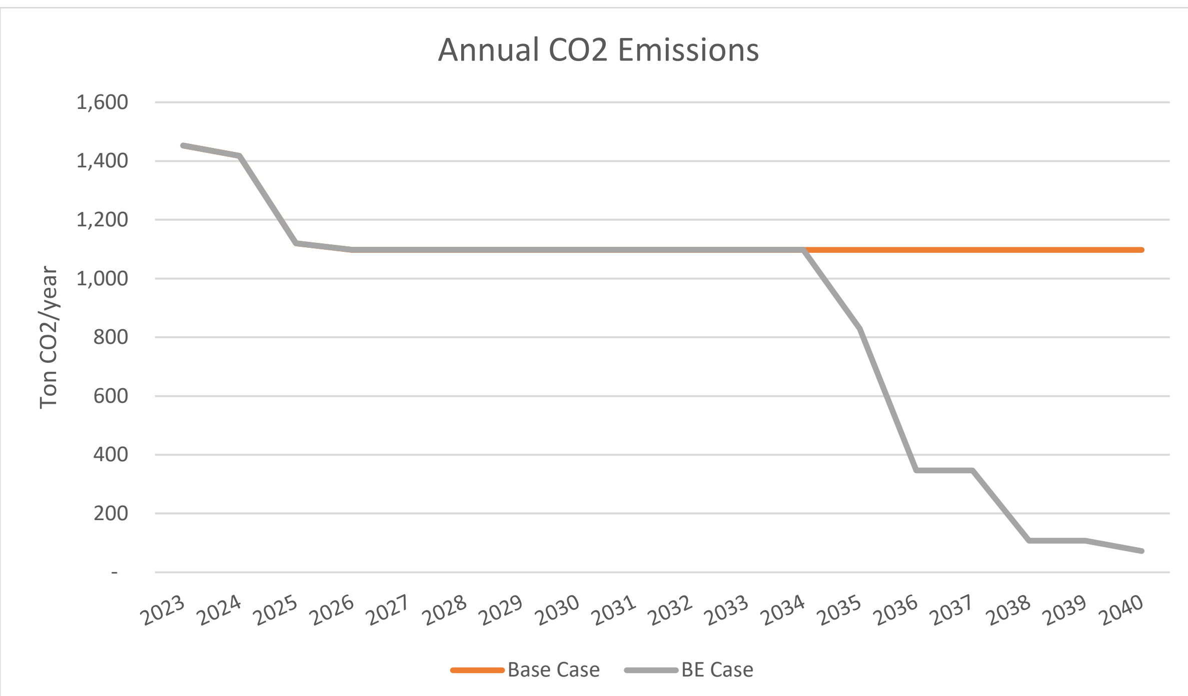
[50] All GHG calculations are presented in tons (not metric tons) of CO_2 equivalent, which is calculated using the short-term 20-year global warming potential of CO_2, methane, black carbon, and particulate matter.

As modeled, the BEB fleet can reduce TTD's GHG footprint by 93% annually starting in 2040 or 23% each year on average during the transition period. Table 13-1 shows the annual emissions in 2040 of the Base case and BE-only case and Figure 13-1 represents the annual total emissions by fleet graphically over the transition period. GHG emissions for each case mirror one another until 2035 when more significant BE investments are slated to take place. This is when annual GHG emissions from each case drastically diverge at the average annual rate of 796 tons of CO_2.

Table 13-1: Annual Emission in Tons of CO_2 in 2040 for TTD's fleet by service type

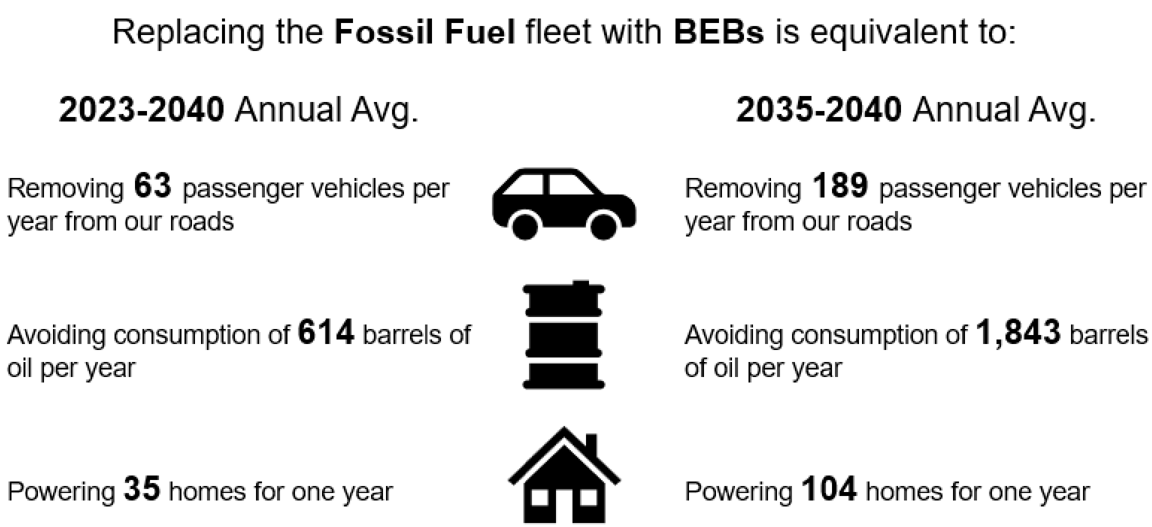
	Base Fleet	Preferred Fleet (BEB-only)
Fleet tailpipe emissions (ton CO_2/year)	784	-
Upstream emissions (ton CO_2/year)	314	72
Total Ton CO_2/year	**1,097**	**72**

Figure 13-1: Annual GHG emissions comparisons



Using the Environmental Protection Agency's (EPA) GHG equivalent calculator[51], we used the average annual emissions over the transition period (2023-2040) that will be displaced by the BEB fleet to create relative comparisons to the benefits of GHG reduction. As presented in Figure 13-2, implementing an all BEB fleet is equivalent to removing 63 gasoline-powered passenger vehicles from the road every year, diverting 614 barrels of oil being consumed every year, or powering 35 homes for one year. A starker contrast is observed between transition years 2035-2040 when fossil fuel buses retire and new BEBs are deployed. During this period, fleet replacement is equivalent to removing 189 gasoline-powered passenger vehicles from the road every year, diverting 1,843 barrels of oil being consumed every year, or powering 104 homes for one year.

Figure 13-2: Equivalent benefits of implementing a BEB fleet at TTD



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

14.0 OTHER TRANSITION ITEMS

14.1 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 Tahoe Transportation District (TTD) is a bi-state transportation district and CARB ICT regulation only applies to the state of California. TTD's service area is located within the El Dorado County AQMD, Douglas County, Washoe County, and Carson City. Table 14-1 lists the agencies that operate transit services within the same region. While TTD 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 14-1: Other bus transit agencies in the TTD service area

County	Agency	Total revenue vehicles[52]	ZEB Choice	Notes
El Dorado	***Tahoe Transportation District***	***27***	***BEB***	
El Dorado	El Dorado County Transit Authority	54	BEB	
Nevada	Town of Truckee	8	BEB	
Douglas	Douglas Area Rural Transit	22	TBD	
Carson City	Carson Area Metropolitan Planning Organization (Jump Around Carson)	19	TBD	TTD and JAC share bus stops in Carson City at the Federal Building.
Washoe	Regional Transportation	487	BEB	Currently has 38 BEBs[53]

[52] Based on 2023 NTD data, except TTD data which was provided by TTD.
[53] https://rtcwashoe.com/planning/advanced-mobility-plan/

County	Agency	Total revenue vehicles[52]	ZEB Choice	Notes
	Commission (RTC) Washoe			

TTD could potentially partner with any of these transit agencies to form a joint ZEB group and could share in the costs associated with BE technologies.

Regardless of whether it makes sense to explore formation of a joint ZEB group or not, TTD 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, TTD could join with any of the agencies outlined above to produce common specifications for ZEBs, thus potentially driving down the purchase costs of ZEBs. Leveraging joint procurement through the CalACT/MBTA purchasing cooperative is a prudent approach, as the Cooperative offers a variety of ADA compliant vehicles like vans and cutaways. Currently, ZE options are limited. Most judiciously, TTD and other operators may wish to encourage OEMs to develop vehicles with longer ranges, especially for vehicle types like cutaways and vans.

15.0 PHASING AND IMPLEMENTATION

Table 15-1 provides an overview of the phasing plan for TTD's ZEB rollout strategy for the preferred BE-only fleet alternative. See Section 5.0 for more details regarding the fleet procurement plan.

This plan is a living document that is intended to provide a practical framework for TTD to deploy and transition to ZEBs in response to their Board of Directors' directive and using CARB's mandate as a guide. Like any other strategic plan, the implementation and transition plan should be revisited and adjusted in response to funding realities, changes in service delivery, and the needs of TTD and its ridership, particularly given the long-term outlook.

Table 15-1: ZEB implementation phasing plan, FY2023-2040

Year	Facility Modifications	ZEB Fleet Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2023	None	None	No activity	No activity	$-	$1,612,185	$1,612,185
FY2024	None	4 Diesel Bus 4 Hybrid Bus	Annual refreshers, introductory training for hybrid system operations	Local fire and emergency response department introduction to hybrid technology	$6,012,124	$1,481,774	$7,493,898
FY2025	Facility - 1 60kW dual dispensers	2 BE Van 2 Gas Van	OEM training, training on BEBs for operators, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$747,332	$1,356,583	$2,103,915
FY2026	None	6 Hybrid Bus	Annual refreshers	Retraining for emergency response departments on hybrid and BEB technology	$5,844,030	$1,351,839	$7,195,869
FY2027	None	None	Annual refreshers	Annual refreshers	$-	$1,386,731	$1,386,731

Year	Facility Modifications	ZEB Fleet Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2028	None	None	Annual refreshers	No activity	$-	$1,423,501	$1,423,501
FY2029	None	1 Diesel CU Long	Annual refreshers	Annual refreshers	$310,593	$1,466,805	$1,777,397
FY2030	None	2 BE Van 2 Gas Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$642,488	$1,510,981	$2,153,469
FY2031	None	None	Annual refresher	Annual refreshers	$-	$1,557,495	$1,557,495
FY2032	None	None	Annual refreshers	No activity	$-	$1,605,258	$1,605,258
FY2033	None	3 BE Bus	OEM training, BEB operator training, advanced maintenance training on	OEM training for all other staff, local fire and emergency response department	$3,407,404	$1,654,547	$5,061,951

Year	Facility Modifications	ZEB Fleet Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
			electrical/electronic systems	training on BEB layout and safety			
FY2034	Facility - 4 150kW dual dispensers ORC - 1 450kW pantograph, 2 150kW dual dispenser	None	Annual refreshers	Annual Refresher	$2,472,430	$1,704,745	$4,177,175
FY2035	Facility - 5 150kW dual dispensers ORC - 1 150kW dual dispenser	4 BE Bus 2 BE Van 2 Gas Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$7,291,402	$1,609,283	$8,900,686
FY2036	None	9 BE Bus	Annual refreshers	Annual refreshers	$10,757,126	$1,500,948	$12,258,073
FY2037	Facility - 2 150kW dual dispensers	None	Annual refreshers	No activity	$665,598	$1,546,799	$2,212,397

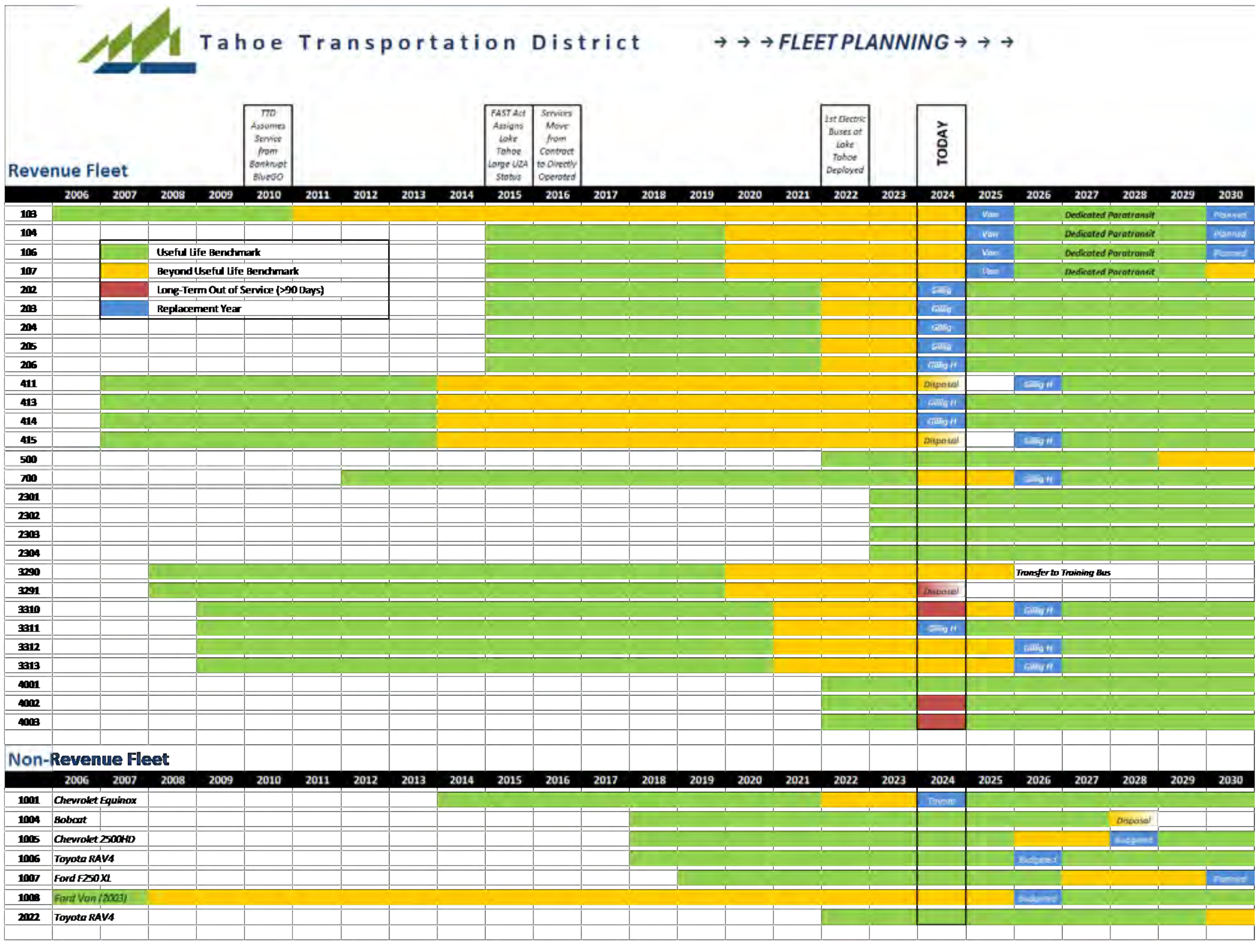
Year	Facility Modifications	ZEB Fleet Procurements	Training: operators, maintenance staff, technicians	Training - other	Capital Expenses (2024$)	Operating Expenses (2024$)	Total Expenses (2024$)
FY2038	None	6 BE Bus	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$7,425,738	$1,607,988	$9,033,726
FY2039	Facility - 2 Level 2 chargers for vans	None	Annual refresher	No activity	$135,917	$1,657,667	$1,793,584
FY2040	None	4 BE Van	OEM training, BEB operator training, advanced maintenance training on electrical/electronic systems	OEM training for all other staff, local fire and emergency response department training on BEB layout and safety	$780,073	$1,708,249	$2,488,323

APPENDICES

APPENDIX A: PLANNED FLEET REPLACEMENT

Figure 0-1 represents TTD's planned fleet replacement schedule under current conditions. This is discussed further in Section 5.0.

Figure 0-1: TTD Planned Fleet Replacement



APPENDIX B: FINANCIAL MODELING INPUTS AND ASSUMPTIONS

Table 0-1 presents a description as well as the sources for the cost inputs (in 2024$) of the Base Case and the ZEB Case.

Table 0-1: Summary of cost inputs

Main Category	Item	Description	Inputs for Base Case	Inputs for ZEB Cases	Sources and comments
Fleet Acquisition	Bus purchase price	Purchase price of a bus/vehicle inclusive of options and taxes and extended warranty.	Diesel Bus: $561,256 Diesel CU Long: $276,496 Hybrid Bus: $941,775 Gas Van: $136,406 BE Bus: $1,035,953 BE Van: $157,549	Diesel Bus: $561,256 Diesel CU Long: $276,496 Hybrid Bus: $941,775 Gas Van: $136,406 BE Bus: $1,035,953 BE Van: $157,549	TTD data based on most recent purchase prices. Price trend applied to Diesel CU Long to bring to 2024$. Escalation of 3% annually applied to BE Bus.
Infrastructure	Infrastructure Modification Costs	Includes equipment capital cost including concrete pads and pipe bollards for 15kW Level 2 chargers	60kW DCFC: $147,310	15kW Level 2 charger: $43,620 60kW DCFC: $147,310 150kW DCFC: $226,620 450kW pantograph: $480,000	Engineer's cost estimate in 2024$
Fuel	Vehicle fuel	Cost of fuel (energy) commodity for revenue vehicles.	Diesel: $4.26 per gallon Gasoline: $4.29 per gallon Electricity: $0.09409 per kWh	Diesel: $4.26 per gallon Gasoline: $4.29 per gallon Electricity: $0.09409 per kWh	TTD data and NV Energy data in 2024$
Maintenance	Vehicle maintenance costs	Maintenance costs (per mile) inclusive of labor and parts for scheduled and unscheduled maintenance.	Diesel Bus: $2.17 Diesel CU Long: $1.64 Diesel CU Short: $1.39 Gas CU: $3.98 Hybrid Bus: $2.17 Gas Van: $1.39 BE Bus: $2.06 BE Van: $1.25	Diesel Bus: $2.17 Diesel CU Long: $1.64 Diesel CU Short: $1.39 Gas CU: $3.98 Hybrid Bus: $2.17 Gas Van: $1.39 BE Bus: $2.06 BE Van: $1.25	Based on TTD information and industry research of potential savings (10%) for BEBs. All in 2024$.

Tahoe Transportation DISTRICT

Connecting our communities

MEMORANDUM

Date: January 2, 2025

To: Tahoe Transportation District (TTD) Program Implementation Committee

From: George Fink, Transportation Services Director

Subject: Informational Transit System Report for the Fourth Quarter of Fiscal Year 2024

Action Requested:
It is requested the Committee members receive this informational report on the transit system for the fourth quarter of fiscal year 2024. No action is requested.

Fiscal Analysis:
All expenditures associated with these items for the fiscal year are in the approved FY25 budget.

Work Program Impact:
All work associated with these efforts is captured under respective elements of the approved FY25 Work Program, with corresponding allotted staff time under respective projects. Transit system reporting aligns with Strategic Goal **SG-3** "Fund and operate regional multi-modal transportation systems."

Background:
Staff are reporting on the key metrics of the transit system.

Discussion:
Below are the key metrics and statistics for the transit system. Of note are the increases in ridership, revenue hours, and revenue miles which reflect TTD's stabilizing labor pool and new fleet assets. However, when compared to Year over Year (YoY) passengers per vehicle revenue hour, TTD's most productive routes dropped. This indicates that the additional hours of service are not yielding additional passengers. Rather, the passengers are experiencing a higher level of service and convenience.

On-time performance (OTP) has greatly improved with increased Operator availability. The long distance routes serving the Douglas County and Carson City often have the greatest variability. The community routes (50/55) have increased OTP substantially. While there is room for improvement, the trend is positive.

GF/ja

AGENDA ITEM: III.B.

Miles between roadcalls measures the overall health of the fleet. It is a function of how far the buses travel before needing an unplanned repair. This YoY comparison highlights the dismal state of the former fleet and how the new buses have moved the needle on reliability.

Ridership	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Route 19X	1,014	1,858	83%
Route 22	2,053	3,240	58%
Route 28	342	260	-24%
Route 50	27,369	34,187	25%
Route 55	12,704	15,029	18%
Paratransit	3,243	3,697	14%
System	**46,725**	**58,271**	**25%**

Passengers/Vehicle Revenue Hour	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Route 19X	3.2	3.6	13%
Route 22	3.0	4.0	35%
Route 28	34.9	8.2	-77%
Route 50	23.1	18.1	-22%
Route 55	8.0	7.2	-10%
Paratransit	2.3	2.6	9%
System	**9.0**	**8.6**	**-5%**

Revenue Hours	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Route 19X	318.6	514.5	61%
Route 22	688.3	803.4	17%
Route 28	9.8	31.9	226%
Route 50	1,182.8	1,888.5	60%
Route 55	1,586.9	2,083.8	31%
Paratransit	1,387.9	1,446.2	4%
System	**5,174.3**	**6,768.3**	**31%**

On-Time Performance	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Route 19X	n/d	56%	-
Route 22	n/d	59%	-
Route 28	n/a	n/a	n/a
Route 50	53%	81%	52%
Route 55	68%	80%	18%
Paratransit	n/a	n/a	n/a
System	**66%**	**77%**	**17%**

Revenue Miles	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Route 19X	8,349	13,880	66%
Route 22	16,950	22,970	36%
Route 28	185	663	258%
Route 50	15,433	26,688	73%
Route 55	18,215	24,103	32%
Paratransit	17,543	18,496	5%
System	**76,675**	**106,800**	**39%**

Miles Between Roadcalls	April - June		
	FY 23 - Q4	FY 24 - Q4	% +/-
Average Miles Between Roadcalls	1503	7120	374%

Notes: Route 28 (East Shore Express) statistics vary widely as this report only extends to June 30 and the number of days the East Shore Express operates in June varies from year to year. Also note that paratransit is a demand responsive service based on reservations and does not report OTP.

Additional Information:

If you have any questions or comments regarding this item, please contact George Fink at (775) 589-5325 or gfink@tahoetransportation.org

GF/ja

Tahoe Transportation DISTRICT

Connecting our communities

MEMORANDUM

Date: January 2, 2025

To: Tahoe Transportation District (TTD) Program Implementation Committee

From: George Fink, Transportation Services Director

Subject: Informational Transit System Report for the First Quarter of Fiscal Year 2025

Action Requested:
It is requested the Committee members receive this informational report on the transit system for the first quarter of fiscal year 2025. No action is requested.

Fiscal Analysis:
All expenditures associated with these items for the fiscal year are in the approved FY25 budget.

Work Program Impact:
All work associated with these efforts is captured under respective elements of the approved FY25 Work Program, with corresponding allotted staff time under respective projects. Transit system reporting aligns with Strategic Goal **SG-3** "Fund and operate regional multi-modal transportation systems."

Background:
Staff are reporting on the key metrics of the transit system.

Discussion:
Below are the key metrics and statistics for the transit system. Of note are persistent increases in ridership, revenue hours, and revenue miles which reflect TTD's increased reliability and new fleet assets. However, when compared to Year over Year (YoY) passengers per vehicle revenue hour on TTD's most productive routes dropped. This indicates that the additional hours of service are not yielding additional passengers. Rather, the passengers are experiencing a higher level of service and convenience.

For Route 28, the summer of 2024 was the first season operated without providing parking at 771 Southwood Blvd. and 915 Northwood Blvd. Passengers were instructed to use the parking at the East Shore Trailhead or to find their own parking, transit connections, or rideshare solutions. The result was a modest increase in ridership despite having more service on the road. The productivity of Route 28 also dropped by 14%, again indicating that more service does not equal a corresponding increase in ridership.

GF/ja

AGENDA ITEM: III.C.

On-time performance (OTP) continues to improve with increased Operator availability. However, TTD's commuter routes (19X and 22) tend to suffer from long distances and interlined vehicles creating opportunities to fall behind schedule. Note that 13.3% of Route 19X trips were *early* and 9.6% of Route 22 trips were *early.* Early departures from time points are considered worse than late departures, in that a late bus eventually arrives whereas an early bus departed before the passenger arrived. Staff is working with Bus Operators, Supervisors, and Dispatchers to convert the early departures to on-time departures. While there is room for improvement, the trend remains positive.

Miles between roadcalls measures the overall health of the fleet. It is a function of how far the buses travel before needing an unplanned repair. This YoY comparison highlights the dismal state of the former fleet and how new buses have moved the needle on reliability. As more of the fleet is replaced, staff expect miles between roadcalls to continue increasing.

Ridership	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Route 19X	1,554	2,508	61%
Route 22	2,733	3,992	46%
Route 28	22,053	22,584	2%
Route 50	31,249	36,765	18%
Route 55	12,733	14,725	16%
Paratransit	3,139	3,715	18%
System	**73,461**	**84,289**	**15%**

Passengers/Vehicle Revenue Hour	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Route 19X	4.2	4.5	6%
Route 22	3.3	4.4	36%
Route 28	24.7	21.2	-14%
Route 50	21.9	16.6	-24%
Route 55	7.8	6.6	-15%
Paratransit	2.4	2.7	13%
System	**11.3**	**10.0**	**-11%**

Revenue Hours	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Route 19X	369.5	562.1	52%
Route 22	838.9	903.2	8%
Route 28	891.9	1,067.4	20%
Route 50	1,428.5	2,212.7	55%
Route 55	1,640.7	2,244.2	37%
Paratransit	1,332.9	1,399.5	5%
System	**6,502.4**	**8,389.1**	**29%**

On-Time Performance	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Route 19X	n/d	53%	-
Route 22	54%	60%	11%
Route 28	n/a	n/a	n/a
Route 50	43%	70%	63%
Route 55	65%	79%	21%
Paratransit	n/a	n/a	n/a
System	**62%**	**67%**	**9%**

Revenue Miles	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Route 19X	9,829	15,309	56%
Route 22	19,213	25,446	32%
Route 28	11,192	20,314	82%
Route 50	18,634	30,617	64%
Route 55	18,126	26,481	46%
Paratransit	17,479	18,840	8%
System	**94,473**	**137,007**	**45%**

Miles Between Roadcalls	July - September		
	FY 24 - Q1	FY 25 - Q1	% +/-
Average Miles Between Roadcalls	1075	6054	463%

Notes: Route 28 (East Shore Express) statistics vary widely as the number of days the East Shore Express operates varies from year to year. Also note that paratransit is a demand responsive service based on reservations and does not report OTP.

<u>Additional Information:</u>

If you have any questions or comments regarding this item, please contact George Fink at (775) 589-5325 or gfink@tahoetransportation.org

GF/ja

Tahoe Transportation DISTRICT

Connecting our communities

MEMORANDUM

Date: January 2, 2025

To: Tahoe Transportation District (TTD) Program Implementation Committee

From: Tara Styer, Capital Program Manager

Subject: Informational Update on Tahoe Transportation District Active Capital Improvement Program Projects

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Action Requested:
It is requested the Committee members review the Project Update Table (Attachment A*)* regarding TTD's Capital Improvement Program (CIP) Active Projects. No action is requested, but Staff welcomes any feedback at the contact information below.

Fiscal Analysis:
All expenditures associated with these items for the fiscal year are in the approved FY25 budget.

Work Program Impact:
All work associated with these efforts is captured under respective elements of the approved FY25 Work Program, with corresponding allotted staff time under respective projects. Time associated with developing project funding opportunities is captured to the extent feasible within the limited General Fund. Projects align with Strategic Goal SG-3 Increase the connectivity and reliability of a regional multi-modal transit system around the Basin, which includes micro-transit and other support components; and SG-4 Effectively deliver TTD operations and implement the Regional Transportation Plan by actively seeking sustainable funding resources for capital projects, staff, operations, and planning.

Background:
TTD has a multitude of active projects within the current work program across several functional areas. Transit Hub Projects (Incline Village Mobility Hub, Spooner Mobility Hub/AIS), Corridor Projects (NV SR28, US 50), Facilities Project (Maintenance and Administration Facility), and Intelligent Transportation Projects (SMART Grant- Stage 1).

Each project has been funded in whole or partly with a variety of federal, state, local, and private funds. They are highlighted in this report for the purpose of providing a general overview and status of the program and to provide consistent updates to the Committee, including upcoming funding opportunities for relevant projects.

TS/ja

AGENDA ITEM: III.D.

Discussion:
The Project Update Table reports the status of major active projects led by TTD. For the purposes of this report, active projects are defined as projects that have been funded in part or whole and are moving forward in phase (Planning, Design, Construction).

The Project Update Table provides basic project status update information and staff encourages discussion should Committee members have questions. The table will be updated and provided to the Committee at each meeting.

Additional Information:
If you have any questions or comments regarding this item, please contact Tara Styer at (775) 567-3228 or tstyer@tahoetransportation.org.

Attachment:
A. Project Update Table

TS/ja

AGENDA ITEM: III.D.

TAHOE TRANSPORTATION DISTRICT

CAPITAL PROGRAM

PROJECTS UPDATE – January 2025

This report serves to provide brief project updates to the Program Implementation Committee for purposes of understanding current project status, upcoming milestones, schedule, and any issues or constraints affecting the project. This document is for informational purposes only.

SR 28 Corridor Projects - Nevada

Project:	**North Trailhead Parking and Water Quality Project**
Description	The SR28 North Parking, Sidewalk, and Water Quality Improvements include environmental analysis, final design and construction of up to 45 parking spaces (depending on design) at Sweetwater Road, north of the existing Tahoe East Shore trailhead parking; a connecting pedestrian path from the new parking areas to the trailhead, elimination of informal parking at Rocky Point, two to three parking spaces for operational employee parking at the trailhead, and water quality improvements within the existing NDOT right-of-way.
Status	Project design is underway. Discussions with NDOT underway.
Upcoming Milestones	• Initial contact with adjacent property owners in coordination with NDOT– January 2025 • TTD to submit 90% design to NDOT for review – March 2025
Schedule Status	Slight delay (Geotech delayed until spring 2025)
Budget Status	On budget and within grant appropriation.
Issues/Constraints	1) Obtaining NDOT approval for paid parking in their ROW. 2) Rocky Point parking proposed to be eliminated. 3) Collaboration with nearby property owners pending.

Project:	**Central Corridor – Thunderbird Cove to Secret Harbor**
Description	The project includes design of transit, trail, and parking improvements at Chimney Beach (approximately 130 spaces – USFS) and Secret Harbor (up to 120 spaces). Chimney Beach parking area will include a pedestrian actuated signalized crossing on SR 28, 0.9 miles of trail, a prefabricated bridge at Marlette Creek, and vista points. A transit pullout at Secret Harbor and signage extension of the No Parking Zone from just north of the IVGID pump station to the chain control sign/pullout south of Secret Harbor are included.
Status	Preliminary design for the Secret Harbor parking lot and trail is underway by TTD. TTD and USFS are preparing for phase 2 of construction at Chimney Beach (ped crossing, restrooms, and parking kiosks).
Upcoming Milestones	• 30% design package for trail and Secret Harbor parking to NDOT – January 2025 • Chimney Beach ped crossing design and encroachment permit to NDOT – January 2025 • Phase 2 of Chimney Beach parking lot – spring 2025 • O&M partnership responsibilities outlined in interlocal agreement amendment – spring/summer 2025
Schedule Status	On schedule; USFS initiated construction in 2024

Budget Status	Funded for design. TTD added $5M in Congressionally Directed Spending appropriation to the project construction phase. TTD staff coordinating with Washoe County, Douglas County, and Carson City on an MOU for Conserve Nevada funding ($2M proposed for this project).
Issues/Constraints	1) Ensuring close coordination with USFS on parking facility design at Chimney Beach and Secret Harbor. 2) Ensuring transit stop is integrated into design at Secret Harbor. 3) Construction implementing agency needs to be defined. 4) Defining O&M agency responsibility via interlocal agreement update.
Project:	**Central Corridor – Sand Harbor to Thunderbird Cove**
Description	The project includes design and construction of 1.75 miles of multi-use path between Sand Harbor State Park and Thunderbird Cove, vista pullouts, and safety improvements.
Status	Local Public Agency (LPA) agreement to begin preliminary design of the project with NDOT has been secured. TTD was awarded $24.1M RAISE grant for construction.
Upcoming Milestones	• Award design services – February 2025 • Execution of RAISE grant after completion of NEPA – summer 2025
Schedule Status	Design services were delayed due to LPA agreement processing and NDOT review of RFP.
Budget Status	Design is 100% funded at this time. Construction funding is approximately 70% funded. Staff applied for Federal Active Transportation Infrastructure Investment Program (ATIIP) grant funds in the amount of $7.5M for construction funding. TTD will seek Construction Management At Risk (CMAR) or design/build delivery method. TTD staff coordinating with Washoe County, Douglas County, and Carson City on an MOU for Conserve Nevada funding ($2M proposed for this project).
Issues/Constraints	1) Additional construction funding required. 2) Design will need to include creative alternatives to lessen project costs (e.g. value engineering analysis). 3) Sand Harbor State Park connection will be coordinated with the State Parks Master Planning process. 4) TTD will likely be the construction implementing agency. This is an expanded role for TTD and will likely require additional resources. 5) Defining O&M agency responsibility via interlocal agreement update.

SR89/SR28 Corridor Projects - California

Project:	**SR 89/Fanny Bridge Community Revitalization Project**
Description	The project includes replacing the signalized "wye" intersection with a single lane roundabout and replacement of the Fanny Bridge with a new, single span bridge.
Status	This project is being led by the Central Federal Lands Highway Division. Construction bids for the project were received in December 2023 by the Federal Lands Division. Bids received were twice as much as the Engineer's Estimate ($25M vs. $13M). FHWA entered negotiations with low bidder in February 2024 and was successful in negotiating the costs to a fair and reasonable amount for the construction contract. Construction is likely to occur in the summer and fall of 2025.
Upcoming Milestones	Construction- summer 2025
Schedule Status	Delayed.
Budget Status	TBD
Issues/Constraints	1) FHWA negotiation with low bidder (Thompson Builders) pushed the project to start in 2025. 2) This project has been reduced to the replacement of Fanny Bridge . The remainder of the project (final Wye roundabout) will need to be planned and executed by Placer County as a local agency project.

US50 Corridor Projects – Nevada/California

Project:	**US50/ South Shore Community Revitalization Project**
Updated Description	The project is being reimagined with a focus on multi-use paths and sidewalks. The primary goal is to improve pedestrian safety and mobility.
Status	Components of the conceptual plans previously drafted will be used to advance the multi-use trails and pedestrian safety components of the project.
Upcoming Milestones	• Venue Transportation Operations Plan site walk – January 2025 • Re-apply for Safe Street and Roads for All (SS4A) grant - May 2025 • Present reimagined project to City of South Lake Tahoe City Council – TBD
Schedule Status	Delayed and being re-scoped. Note: On November 15, 2021, BIL repealed the 10-year PE Rule by striking 23 U.S.C. 102(b), thus eliminating any possibility of TTD having to pay back any federal funds expended on this project to date.
Budget Status	On budget and contained within budget appropriation for design phase.
Issues/Constraints	1) Cost/Benefit Analysis low score may compromise grant funding. 2) Potential environmental document update pending final scope of project.

Mobility Hub Projects

Project:	**Incline Village Mobility Hub**
Description	Project addresses SR28 Corridor Management Plan, Washoe County Tahoe Transportation Plan, Washoe County Tahoe Area Plan and Linking Tahoe Transit Master Plan to construct a mobility hub within the Incline Village limits. Project would provide mobility hub facilities, parking, and multi-modal appurtenances.
Status	This project has been delayed while the TTD team focuses on the feasibility analysis. Staff expects draft site feasibility report to be completed March 2025. TTD staff are preparing an RFP for a hazardous materials survey and assessment and demolition plan for the 771 Southwood facility for purposes of site safety and risk mitigation.
Upcoming Milestones	• Release RFP for hazardous materials survey and assessment and demolition plan – January 2025 • Draft feasibility report – March 2025 • Create LPA with NDOT for use of Nevada STBG funds for demolition of facility - TBD • Temporary use permit from TRPA for parking for East Shore Express- TBD
Schedule Status	Delayed
Budget Status	On budget and within grant appropriation limits for conceptual site feasibility analysis.
Issues/Constraints	1) Community response 2) Limited alternatives for sites 3) Risk concerns with existing OES facility

Project:	**Spooner Summit AIS/ Mobility Hub**
Description	The project includes design and construction of a transit mobility hub with up to 250 parking spaces with restroom(s), permanent aquatic invasive species inspection station, connections with the multi-use path and a pedestrian crossing from Spooner State Park to the transit mobility hub.
Status	TTD, TRPA, NDOT and USFS have begun design meetings. TTD is leading coordinated efforts for post construction O&M planning. TTD drafted a special use permit proposal for USFS review and consideration. NDOT has provided 60% site plans for stakeholder review. TTD, TRPA, and NDOT met in September 2024 to review plans and revise drawings to minimize impact. NDOT is proposing intersection improvements, which may include a roundabout on SR28 at Spooner State Park and the mobility hub entrance.
Upcoming Milestones	• Special use permit submittal – January 2025 • Public outreach is planned – spring 2025 • O&M partnership responsibilities outlined in interlocal agreement amendment – spring/summer 2025
Schedule Status	Slight delay to August 2025 per NDOT.
Budget Status	On budget and contained within funding appropriation
Issues/Constraints	1) Post construction O&M agency responsibilities need to be determined as a separate parallel process. Douglas County Parks and Recreation Committee approved O&M role and the item will progress to Board of County Commissioners through an interlocal agreement amendment. 2) Special use permit type being determined by USFS (e.g., Grainger-Thye).

3) Pedestrian crossing (SR28) from this project to Spooner State Park.
4) Water and sewer needs analysis.
5) Parking management fee structure relating to transit users.

Facilities Projects

Project:	**Maintenance and Administration Facility**
Description	This project is for the acquisition, environmental, design, and construction of a new all-weather maintenance and administration facility (MAF) to serve 75 buses at full capacity. The MAF is envisioned to be a phased project, ultimately housing buses indoors and includes an automated vehicle wash, fuel islands, electric charging infrastructure, repair bays, fabrication shop, operations center, administrative offices, dispatch center, training facilities, meeting space, and storage areas. The project may also provide partnering opportunities with local agencies for shared space.
Status	This project is in the preliminary planning phase. Consultant and TTD are evaluating the feasibility of eight parcels for possible consideration for a project site. The feasibility study is an internal analysis to determine the top two or three sites prior to engaging the public. Consultant is in the process of developing conceptual plans for each site and order of magnitude construction costs.
Upcoming Milestones	• Deliver draft site analysis report – TBD
Schedule Status	On schedule for site scoping and feasibility analysis.
Budget Status	On budget and within appropriated grant funding for site scoping and feasibility analysis phase. Project received $2M in Congressionally Directed Spending to further design. An additional $2M in Congressionally Directed Spending is pending review. TTD will work with FTA to identify funding opportunities to support a design/build delivery method.
Issues/Constraints	1) Five-to-seven-year temporary site requirement until this project is funded and ready. Remain at the current City- owned site for the duration pending renewed lease agreement or seek alternative site. 2) Previously unknown deed restrictions were discovered through feasibility analysis for one of the top ranked sites. TTD is researching the impact of these restrictions with the USFS. 3) Large funding need of approximately $100M.

Technology Projects

Project:	**SMART Sensors and Data Aggregation Project**
Description	This project intends to provide the planning, design, prototyping, and evaluation of a single cloud-based open source or interface for pertinent transportation and traveler related information. This information will be used by TTD and TRPA, partners, commuters, and travelers within the Tahoe Basin and adjoining areas to provide integrated infrastructure to collect vehicle data and incorporate it into a database for a variety of stakeholders. The system will provide a platform for future expansion, command, control, and configuration.
Status	Slightly delayed due to DOT's permitting processes. Consultant procured process servers and related equipment through Derq – a leading provider of real-time intelligent transportation system (ITS) solutions. TTD and Consultant are engaging with NDOT and Caltrans regarding the use of existing State-owned structures and power to support the temporary sensor deployment. TTD and Consultant have several NDOT signal cameras online and are acquiring data as of May 2024. Staff met with Caltrans and eight signal cameras will be online in January 2025. Staff applied for SMART Stage 2, Implementation Grant in August 2024, but recently learned it was not awarded. Staff will reapply for Stage 2 funding in 2025.
Upcoming Milestones	• Finalize test sensor locations – January 2025 • Temp sensors deployed and began collecting data – June 2024 • Data collection through March 2025 • Final Implementation Report to USDOT – April 1, 2025
Schedule Status	Slightly delayed, but within grant timeline. Due to the short grant timeline, TTD may request an extension from US DOT.
Budget Status	On budget and within grant appropriation limits
Issues/Constraints	1) Short grant timeline 2) Encroachment permit process with Caltrans proved unfeasible within the grant timeline. TTD and Consultant concentrated on using existing DOT closed-circuit television (CCTV) which feeds to a video process server. 3) Data privacy issues for the DOT's. 4) Coordination delays with DOT's. 5) Stage 2 grant was not awarded and Stage 1 grant ends on March 15, 2024 (if not extended).

Pending Capital Projects (Likely to be Funded or Seeking Funding)

Project:	**Corp Yard (1669 Shop Street) Renovations**
Description	This project proposes to utilize two fiscal years of SB125 funds to provide much needed renovations to the existing transit maintenance and operations facility leased from the City. Renovations will be limited by budget, but may include safety upgrades, renovating the bus wash facility, installing EV charging infrastructure for bus maintenance, correcting drainage and flooding issues impacting the facilities, installation of an additional restroom, and minor renovations to administrative space. This project is dependent upon the appropriation of SB125 funds.
Status	Delayed – SB125 funding initially frozen by the State of California. TMPO is currently developing the funding agreement. Upon receipt of funding, TTD staff will develop an RFP for architectural engineering.
Upcoming Milestones	• Anticipated TMPO agreement execution – January 2025 • Release RFP for Architectural and Engineering design – TBD
Schedule Status	Delayed, pending outcome of JPA and lease agreement.
Budget Status	Requesting $1,550,000 over two fiscal years
Issues/Constraints	1) Ten-year lease agreement from the City of South Lake Tahoe. 2) Budget dependent scope.

Project:	**Purchase Microtransit Vans - Re-obligated**
Description	The SB125 funds ($4,165,000) for this project were reallocated to South Shore Transit Operations support to address the loss of FTA 5307 funding and upcoming funding shortfall.

Project:	**E.V. Charging Infrastructure**
Description	This project proposed to utilize two fiscal years of SB125 funding to support the design and construction of EV charging infrastructure to support transit and microtransit electric vehicles.
Status	Delayed – SB125 funding initially frozen by the State of California. TMPO is currently developing the funding agreement. Upon receipt of funding TTD will meet with local South Shore jurisdictions to determine possible locations for the infrastructure.
Upcoming Milestones	• Anticipated TMPO agreement execution – January 2025 • Local agency discussions and agreements – spring 2025
Schedule Status	Delayed, pending appropriations by State of California and TMPO agreement.
Budget Status	Requesting $1,188,816 over two fiscal years.
Issues/Constraints	1) Local agency agreements. 2) Liberty Utilities front of meter improvements to support electrical requirements.

Project:	**NV Stateline to Stateline Bikeway South Demonstration Project – Phase 1A - Laura Drive to Stateline Avenue**
Description	The Project proposes a Class 1 path along Lake Parkway and the north side of US Hwy 50 between Laura Drive and Stateline Avenue and a sidewalk along the southeast side of US Hwy 50 between Kingsbury Grade and Lake Parkway (Tahoe Blue Events Center) to create the final southernmost link of the Tahoe East Shore Trail. The multi-use path and sidewalk will provide a safe alternative mode of transportation allowing bicycle and pedestrian traffic to utilize a separated and lighted path and sidewalk. The full length of this path will be ADA accessible, expanding access to users of all abilities and providing an important safe linkage between the Kingsbury Transit Center and parking to the Tahoe Blue Event Center. This project scope was originally contained within the US Hwy 50 Community Revitalization Project, but was determined to be a stand-alone high priority Vision Zero safety project. TTD staff consulted with TRPA and decided to separate this project from the larger US 50 Community Revitalization Project to expedite pedestrian and cycling safety benefits in this very unsafe segment of US Hwy 50. TTD was not awarded the 2024 Safe Streets and Roads for All (SS4A) grant, but will reapply in 2025.
Status	Pending – TTD is seeking funding for this project.
Upcoming Milestones	TTD staff coordinating with Washoe County, Douglas County, and Carson City on an MOU for Conserve Nevada funding.
Schedule Status	Pending
Budget Status	Seeking grant funds. The Conserve Nevada funding will serve as a local match to federal funding ($1M proposed for this project).
Issues/Constraints	1) TTD was not awarded the 2024 Safe Streets and Roads for All (SS4A) grant.

CIP Grant Applications – 2024/2025

Rebuilding American Infrastructure with Sustainability and Equity **(RAISE)**	**$25M** application for final design and construction funding for the SR28 Sand Harbor to Thunderbird Cove Project – Submitted February 2024.
Status	Awarded - $24.1M
Safe Streets and Roads for All **(SS4A)**	**$5.4M** application for design and construction funding for the Laura Drive to Stateline Avenue Multi-Use Trail Project – Submitted May 2024.
Status	Not Awarded
Active Transportation Infrastructure Investment Program **(ATIIP)**	Estimated **$7.5M** application to support construction of the SR28 Sand Harbor to Thunderbird Cove Project - Submitted June 2024. Expected results of application – January 2025
Status	In Review
Transit and Intercity Rail Capital Program **(TIRCP)**	**$30M** application to support construction of the Maintenance and Administration Facility - Submitted July 2024.
Status	Not Awarded
Strengthening Mobility and Revolutionizing	Upcoming- **$8.8M** Stage2 application to support implementation of ITS sensor infrastructure, data collection and warehousing, and program development of Stage 1 planning and testing. Submitted August 2024.

Transportation Program **(SMART)**	
Status	Not Awarded
Lake Tahoe License Plate Fund	$1M application to help close the construction funding gap on the Sand Harbor- Thunderbird Cove segment of trail- Submitted November 2024. Expected results of application- spring 2025
Status	In Review
Conserve Nevada	$5M set aside for Lake Tahoe Path System to support three projects: Sand Harbor to Thunderbird Cove, Thunderbird Cove to Secret Harbor, and Phase 1A -Laura Drive to Stateline Avenue.
Status	Awarded $5M; pending MOU with local jurisdictions
FY25 Congressionally Directed Spending (CDS)	Requested $5M for the TTD Maintenance and Administration Facility project. A partial funding amount of $2M is in review. Pending federal budget adoption.
Status	In Review
FY26 Congressionally Directed Spending (CDS)	Requested $5M for the Sand Harbor to Thunderbird Cove segment of trail – Request due January 3, 2025.
Status	In Review

CIP Grant Awards – 2024

Project	Grant Program	Phase	Amount
US 50 Revitalization Project	TRPA Regional Grant Program	ROW/CON	$2.9M
SR28 Sand Harbor to Thunderbird Cove	RAISE	PSE/CON	$24.1M
SR28 Thunderbird Cove to Secret Harbor	Congressionally Directed Spending	CON	$5M
Maintenance and Administration Facility	Congressionally Directed Spending	PS&E	$2M
Bus and Fleet Replacement	5339(c) LoNo	Acquisition	$7.9M
Lake Tahoe Path System: distributed amongst three projects	Conserve Nevada	Construction	$5M
		Total	**$46.9M**