Solano Transportation Authority

DRAFT
Countywide Electrification Transition Plan

July 2022

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Solano Transportation Authority

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Acronyms and Terms

Acronym or Term	Description
AC	Alternating Current
BAAQMD	Bay Area Air Quality Management District
BEB	Battery-Electric Bus
BIL	Bipartisan Infrastructure Law
CARB	California Air Resources Board
CNG	Compressed Natural Gas
DAC	Disadvantaged Community
DC	Direct Current
EV	Electric Vehicle
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse Gas
GVWR	Gross Vehicle Weight Rating
HVAC	Heating, Ventilation, and Air Conditioning
ICEB	Internal Combustion Engine Bus
kW	Kilowatt
kWh	Kilowatt-hour
LCTOP	Caltrans Low Carbon Transit Operations Program
MW	Megawatt
MWh	Megawatt-hour
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PG&E	Pacific Gas and Electric
SOC	State-of-charge
SRTP	Short Range Transportation Plan
TIRCP	CalSTA Transit and Intercity Rail Capital Program
YOE	Year of Expenditure
ZE	Zero-Emission
ZEB	Zero-Emission Bus

EXECUTIVE SUMMARY

ES1 Background

The California Air Resource Board's (CARB) Innovative Clean Transit (ICT) regulation has mandated that all transit agencies in California must transition internal combustion engine buses (ICEBs) with a gross vehicle weight rating (GVWR) exceeding 14,000 pounds to zero-emission buses (ZEBs) by 2040. The Solano Transportation Authority (STA) is developing the Countywide Electrification Transition Plan to guide Solano County transit agencies in their transitions to all battery-electric bus (BEB) fleets. This Transition Plan is a comprehensive final report from a series of technical analyses that are included as appendices.

STA serves as the congestion management agency for Solano County. STA is responsible for countywide transportation planning, programming transportation funds, managing and providing transportation programs and services, delivering transportation projects, and setting transportation priorities. There are five transit agencies operating in Solano County: Dixon Readi-Ride, Fairfield and Suisun Transit (FAST), Rio Vista Delta Breeze, SolTrans, and Vacaville City Coach. It should be noted that FAST and its associated service and facilities was not analyzed in this plan. FAST developed the Fairfield Transit Fleet Electrification Final Business Plan Report, an independent study to develop the framework for the electrification of FAST's fleet (conducted by Willdan Energy Solutions), which was already in development when the Transition Plan was initiated. Despite the separate studies, it is important to understand FAST's transition in the context of other Solano County agencies; therefore, the Transition Plan incorporates findings from FAST's report in some sections (vehicle procurement and costs). The FAST report is appended to this document for reference and further context (Appendix G).

All agencies provide both fixed-route and demand response and/or paratransit services, with the exception of Dixon Readi-Ride, which only provides demand response service. Agencies in Solano County operate a wide range of vehicle types to meet service requirements, which include standard buses (35- and 40-foot), cutaways of varying lengths, vans, and motorcoaches. The current fleet is powered by several fuel types: diesel, diesel hybrid, compressed natural gas (CNG), gasoline, and battery electric. All vehicles, except the vans with GVWR lower than required by the regulation, are subject to the CARB ICT regulation.

Appendix A: *Existing Conditions Report* provides in-depth discussions on the agencies' existing services and facilities. Table ES1 summarizes agencies, yard locations, the number of blocks and routes served, and the total number of vehicles.

Table ES1 Solano County Service Summary

Agency	Yard Address	No. of Blocks	No. of Routes	Total Number of Vehicles
Dixon Readi-Ride	285 E. Chestnut Street, Dixon	N/A	N/A	10
Rio Vista Delta Breeze	3000 Airport Road, Rio Vista	4	2	5

Agency	Yard Address	No. of Blocks	No. of Routes	Total Number of Vehicles
SolTrans	1850 Broadway Street, Vallejo	42	14	59
Vacaville City Coach	1001 Allison Drive, Vacaville	2	2	25

Source: Each agency's Short Range Transit Plan Fiscal Year 2021 – Fiscal Year 2030, and GTFS Data

ES2 Service Modeling

Lightning Bolt is a proprietary modeling tool developed by WSP to evaluate the feasibility of operating BEBs within a transit agency's existing bus schedule. The tool considers and analyzes several factors that may impact the performance of a BEB, including the specific operating conditions of an agency (topography, climate, and bus service schedule), charging and battery capacity parameters, and the extent to which all these factors would improve or reduce performance. Lightning Bolt uses these inputs to determine the percent of service that can be completed under two scenarios: "typical" and "conservative." The outputs are on a block-level scale which is a set of trips assigned to a single-vehicle during a service day.

Vehicle ranges will decline as batteries degrade over time. Additional analysis is also included to show block completion rates under end of warranted life (EWL) battery conditions.

Table ES2 summarizes the initial findings for each agency. For all the failing blocks in the fixed-route services, the following mitigation measures can be considered:

- Strategic procurement phasing to allow advancements in BEB technology
- Service changes (splitting blocks; additional pull-outs)
- Additional vehicles
- Selecting a bus model with a higher capacity than the average in the model
- Opportunity charging

The *Service Modeling Technical Report* (Appendix B) provides a more in-depth review of the data inputs and methodology used to conduct the analysis.

Table ES2 Summary of Modeling Result

Agency	Fixed Route		Demand Response
	Typical Scenario	Conservative Scenario	
Dixon Readi-Ride	• No fixed-route service	• No fixed-route service	Assumed BEB replacement is expected to meet the existing range of 83 to 103 miles
Rio Vista Delta Breeze	• 1 of 4 blocks failed • EWL: 1 block failed	• 1 of 4 blocks failed • EWL: 1 block failed	Assumed BEB replacement is expected to meet the existing range of 93 to 113 miles

Agency	Fixed Route		Demand Response
	Typical Scenario	Conservative Scenario	
SolTrans	• 4 out of 42 blocks failed • EWL: 15 blocks failed	• 15 failing blocks • EWL: 24 blocks failed	Assumed BEB replacement is expected to meet the existing range of 75 to 93 miles
Vacaville City Coach	• 1 out of 2 blocks failed • EWL: All blocks failed	• All blocks failed • EWL: All blocks failed	Assumed BEB replacement is expected to meet the existing range of 104 to 130 miles

Source: WSP

ES3 Facility, Power, and Energy Improvements

Electric bus charging systems require a significant amount of electrical power. Most facilities require moderate to significant upgrades to their existing electrical infrastructure, and Pacific Gas &Electric (PG&E) must also upgrade equipment to supply the necessary power to the site. The final load demand and equipment upgrades depend on the fleet size, detailed site design, number of chargers, and the electrical contractor's analysis.

The facility analysis finds that each facility can accommodate the charging infrastructure needed to support a fully electric bus fleet based on each agency's current and future fleet make-up. The facility upgrade recommendations will be refined and further evaluated in subsequent stages of design implementation.

Moreover, to ensure service delivery and energy resiliency during emergency outages, all sites can benefit by installing a permanent battery storage generator. Solar PV might be considered for Rio Vista Delta Breeze and Vacaville City Coach.

Appendix C: *Power and Energy Report* provides in-depth energy and resiliency analysis for each site, while Appendix D: *BEB Facility Concepts Report* provides the detailed facility concept for each site.

Table ES3 summarizes the facility upgrades needed for Solano County's transit agencies to accommodate the maximum number of vehicles expected in the future fleet.

Table ES3 Summary of Site Upgrades Required

Upgrade	Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans	Vacaville City Coach
New Electrical Service	Yes	Yes	Yes	Yes
Utility System Upgrades	No	No	Yes	Maybe
Charging Equipment*	• Five 150 kW DC charging cabinets • Seven cable retractors	• Four 150 kW DC charging cabinets	• Twenty-one 80 kW AC charging system • Twenty-five 150 kW DC charging cabinets • Seventy cable retractors	• Sixteen 150 kW DC charging cabinets • Thirty-one cable retractors

Upgrade	Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans	Vacaville City Coach
Charging Strategy	• Three ground-mounted plug-ins • Seven overhead-mounted plug-ins • One plug-in dispenser in maintenance area	• Eight ground-mounted plug-ins • One plug-in dispenser in maintenance area	• Forty-nine overhead-mounted plug-ins w/ option for future overhead pantograph • Twenty-one plug-in AC dispensers	• Thirty-one overhead-mounted plug-ins • Two plug-in dispensers in maintenance area
New Electrical Equipment Required	• Utility transformer • Main switchboard and meter • Underground conduit to chargers	• Utility transformer • Main switchboard and meter • Underground conduit to chargers	• Utility transformer • Main switchboard and meter • Underground conduit to chargers	• Utility transformer Main switchboard and meter • Electrical subpanels • Large underground duct bank and conduit to chargers • Likely upgrades to utility-owned distribution equipment.

Source: WSP

ES4 ZEB Transition Plan

The following section contains an overview of the construction timelines, vehicle procurements, and costs and funding necessary for STA's ZEB transition. Detailed analyses of the construction and vehicle procurement schedules are discussed in Appendix E: *Phasing Strategy and Transition Report*, while detailed costs and funding analysis are provided in Appendix F: *Cost and Funding Report*.

Construction Schedule

Each agency's construction schedule varies based on the size of the facility, its upgrade requirements, as well as the particular goals of the agency. All agencies are anticipated to have the required infrastructure installed and constructed in advance of the CARB ICT regulation's first purchase requirements in 2026 (which requires 25% of all new purchases to be ZEB). Table ES4 provides an overview of each agency's construction schedule along with the number of proposed construction stages.

Table ES4 Construction Summary – All Agencies

Agency	No. of Stages	Timeline
Dixon Readi-Ride	1	July 2022 – Sept 2024
Rio Vista Delta Breeze	1	July 2022 – Sept 2024
Solano County Transit	2	March 2022 – May 2025
Vacaville City Coach	2	March 2022 – Feb 2024

Source: WSP

Vehicle Procurement Schedule

These procurement schedules are based on future fleet projections. The assumed delivery dates of vehicles were developed with special consideration to vehicles' useful life, construction completion dates, and reducing impacts to maintenance staff. Table ES- 5 shows the procurement schedule for each agency by year for all vehicle types. The table also includes FAST's proposed vehicle procurement schedule.

Table ES5 Vehicle Procurement Schedule – All Agencies

Year	Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans	Vacaville City Coach	FAST	Total
2022	-	-	-	-	-	**-**
2023	-	-	7	10	10	**27**
2024	4	2	7	5	8	**26**
2025	4	2	10	5	6	**27**
2026	-	-	4	5	-	**9**
2027	-	-	4	-	8	**12**
2028	-	-	4	-	-	**4**
2029	-	-	-	-	4	**4**
2030	-	-	-	-	6	**6**
2031	-	-	-	-	3	**3**
2032	-	-	-	-	-	**-**
2033	-	-	-	-	15	**15**
Total	**8**	**4**	**36**	**25**	**60**	**133**

Source: WSP & Willdan

Cost and Funding

Overall, the cost analysis shows that the full lifecycle cash cost of a transition to BEBs is higher than the continued reliance on ICE vehicles, mostly due to the higher capital costs (Table ES6). However, keeping the current fleet would result in a larger emission generation over the lifecycle of the ICE fleet in comparison to the operations of a full BEB fleet. Table ES- 6 does not include the costs for FAST's transition. Since FAST's cost analysis was conducted under a different project, the specific output are not identical to those developed in the Transition Plan. The FAST report analyzed the costs for maintaining an ICE fleet as well as transitioning to a BEB fleet through 2040. Meanwhile, the rest of STA's agencies were analyzed through 2030. The net expenditures for all STA agencies (including FAST) are $254M for an ICE fleet and $330M for a BEB fleet, yielding an additional $76M in costs to transition all agencies. Please refer to Appendix G for more detail regarding FAST's costs and methodology.

Table ES6 Lifecycle Costs Summary (in millions of Year of Expenditure YOE$)

Cost Categories	Dixon Readi-Ride		Rio Vista Delta Breeze		SolTrans		Vacaville City Coach		STA Countywide Costs	
	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet
Capital, O&M, and Disposal Costs	$5	$8	$3	$4	$58	$80	$33	$45	**$99**	**$137**
Environmental Costs	$0.60	$0.30	$0.30	$0.10	$4	$2	$3	$1	**$8**	**$3**
Total Lifecycle Costs	$6	$8	$3	$5	$62	$82	$36	$46	**$107**	**$141**
Total Lifecycle Costs per Mile	**$2**	**$4**	**$3**	**$4**	**$6**	**$8**	**$4**	**$5**	**N/A**	**N/A**

Source: WSP & Willdan

Notes: *Does not include FAST's cost analysis. FAST's lifecycle costs are $147M for an ICE fleet and $190M for a BEB fleet. FAST's lifecycle costs are through 2040 and do not include environmental and capital, O&M, or Disposal costs. The net expenditures for all STA agencies are $254M for existing ICE fleets and $330M for a BEB fleet, yielding an additional $76M in costs to transition all agencies

Rounded to the nearest hundred thousand when costs were less than one million dollars. Otherwise, it was rounded to the nearest million

Based on the capital costs identified in the lifecycle cost analysis and the funding analysis, it is concluded that some of these fleet electrification investments can be funded through existing capital revenues outlined in each agency's FY 2021-2030 Short Range Transit Plans (SRTP) adopted in 2020. However, STA and member agencies will also need to pursue additional funding through federal, state, regional, and other formula and discretionary grant opportunities to fill the estimated funding gap (Table ES7) to carry out the full scope of the *Solano Countywide Electrification Transition Plan*. It should also be noted that Table ES- 7 does not include FAST's funding surplus/gap since FAST's cost analysis was conducted under a different project and used a different methodology from this report. As noted in the FAST report, the cost to electrify FAST's fleet including incentives is $163.68M. The net funding gap for all STA agencies (including FAST) is -$201.79M. Please refer to Appendix G for more information regarding FAST's cost/funding analysis.

Table ES7 Estimated Funding Gap by Agency by Year (in millions of YOE$)

Agency	Funding Surplus/Gap										
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Dixon Readi-Ride	$0.29	$0.29	-$1.94	-$1.64	$0.23	$0.31	$0.20	$0.28	$0.11	$0.24	**-$1.65**
Rio Vista	$0.00	$0.98	-$1.41	-$1.05	$0.00	$0.45	$0.00	$0.12	$0.00	$0.00	**-$1.80**
SolTrans	$3.78	-$17.20	-$15.80	-$6.08	$0.58	$2.23	$0.59	$0.61	$2.13	$0.47	**-$28.69**
Vacaville City Coach	$0.15	-$11.76	-$7.12	-$4.44	-$1.49	$10.00	$4.40	$0.15	$1.00	$3.15	**-$5.97**
STA Countywide	$4.22	-$27.69	-$26.27	-$13.21	-$0.68	$12.99	$5.19	$1.16	$3.24	$3.86	**-$38.11**

Source: WSP & Willdan

Notes: *Does not include FAST's cost analysis. The cost to electrify FAST's fleet, including incentives, is $163.68M. FAST's analysis is through 2040 and does not use the same methodology as STA's other agencies. The net funding gap for all STA agencies is -$201.79M. Rounded to the nearest ten thousand

Several federal, state, regional, and other funding opportunities have a high potential to fund Solano County's transit agencies' capital projects. The federal Bipartisan Infrastructure Law (BIL) recently passed has significantly increased funding for formula programs that can be used to fund capital projects, including procurement of ZEBs, and construction of charging/fueling infrastructure and/or associated maintenance facilities. Several available funding opportunities on the state and regional levels include CalSTA Transit and Intercity Rail Capital Program (TIRCP), Caltrans Low Carbon Transit Operations Program (LCTOP), Caltrans/State Controller's Office SB1 State of Good Repair (SGR) Program, and Bay Area Air Quality Management District Carl Moyer and Community Emission Reduction Grant Programs. Solano County transit agencies can also apply for the PG&E Electric Vehicle (EV) Fleet program.

ES5 Staffing and Training

One of the essential factors for a smooth transition to a full BEB fleet includes ensuring that the whole workforce, especially operators and technicians, is comfortable handling the new technology that can be achieved by workforce evaluation and training. Moreover, workforce evaluation is currently one of the key elements in the Zero Emission Fleet Transition Plan required for federal grants funding. A workforce evaluation tool released by FTA can be used to help identify the impact of the transition to a zero-emission fleet on the current workforce.

Based on peer transit agencies' experiences, BEB transition will not greatly disrupt current staffing and training requirements or yard management. In large, BEB maintenance follows a "bus is a bus" philosophy, indicating that many bus repairs will be standard regardless of the powertrain. However, to ensure fleet maintainers are supported throughout the life of the BEBs, it is recommended that a substantial share of the OEM training budget be reserved for the tail end of subsystem warranties to ensure maintenance staff is prepared to service components as needed.

Staff training required to support a BEB fleet will require the development of new training materials, which should be supported by BEB OEMs. Additionally, while the OEM provides training modules for both maintenance technicians and operators, some training may need to be developed for other staff. Everyone should have a high-level understanding of high voltage safety, even if that message for other job classifications is simply to be able to recognize it and stay away from it.

Just as the broader ZEB industry is in a state of constant change, so is BEB training. Educators are in the process of developing additional training curricula and resources for transit agencies. Bus manufacturers are working to improve and update their training modules, manuals, and training materials to keep up with the fast pace of product development. The lessons learned discussed in this section should be treated as "snapshots in time" of the state of the industry. It is recommended for Solano County's transit agencies to review training guidance and resources as they are developed continually.

1 INTRODUCTION

The following section provides the project overview of STA Countywide Electrification Transition Plan, the purpose and approach of the project, and the structure of the report.

1.1 Study Overview

The California Air Resource Board's (CARB) Innovative Clean Transit (ICT) regulation has mandated that all transit agencies in California must transition internal combustion engine buses (ICEBs) to zero-emission buses (ZEBs) by 2040[1]. According to CARB's ICT regulation, all vehicles with a gross vehicle weight rating (GVWR) exceeding 14,000 pounds are subject to replacement. The Solano Transportation Authority (STA) is developing the Countywide Electrification Transition Plan to guide Solano County transit agencies in their transitions to all battery-electric bus (BEB) fleets.

This document is a comprehensive final report from a series of technical analyses that are included as appendices, including:

- Existing Conditions Analysis
- Service Modeling Analysis
- Power and Energy Analysis
- BEB Facility Concepts Analysis
- Phasing Strategy and Transition Analysis
- Costs and Funding Analysis

The Countywide Electrification Transition Plan captures all required elements to be analyzed and reported for a CARB-approved ICT Rollout Plan. Rollout Plans are state-mandated documents that Solano County agencies – along with many other "small" transit agencies – will need to submit to CARB by July 2023.

There are five agencies that operate in Solano County: Dixon Readi-Ride, Fairfield and Suisun Transit (FAST), Rio Vista Delta Breeze, Solano County Transit (SolTrans), and Vacaville City Coach. SolTrans and FAST have already taken steps to achieve their respective transitions. SolTrans is currently working with WSP on engineering and design services to bring both power and charging infrastructure to its facilities and two off-site locations – many of this project's elements are incorporated in this project. It should be noted that FAST and its associated service and facilities was not analyzed in this plan. FAST developed the Fairfield Transit Fleet Electrification Final Business Plan Report, an independent study to develop the framework for the electrification of FAST's fleet (conducted by Willdan Energy Solutions), which was already in development when the Transition Plan was initiated. Despite the separate studies, it is important to understand FAST's transition in the context of other Solano County agencies; therefore, the Transition Plan incorporates findings from FAST's report in some sections (vehicle procurement and costs). The FAST report is appended to this document for reference and further context (Appendix G).

1.2 Report Purpose and Approach

The purpose of this report is to provide the framework for each agencies' transition to ZEBs, pursuant to the CARB's ICT regulation. The Countywide Electrification Transition Plan outlines the existing conditions,

1 CARB ICT Regulation (https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-regulation)

methodologies and analyses, BEB technology and facility upgrade needs, proposed phasing schedule, cost and funding estimations, and staffing and training recommendations. By itemizing the existing conditions, assessment, and findings by agency, this document provides a robust and comprehensive study of how ZEBs could be implemented in STA's four transit agencies.

In the initial section, the report lays out the background information of the project and STA service area. Then, a brief overview of the market condition is discussed to give context about the current stage of BEB technology. The agency-specific sections will elaborate on the agencies' existing service and facility, electrification feasibility from service operation, facility, and utility aspects, and the complete ZEB transition plan that includes facility concept, phasing schedules, and cost analysis.

WSP assessed the viability of operating BEBs by modeling the respective agencies' transit operations with Lightning Bolt, a proprietary, formula-based tool that determines block completion. A power and energy analysis was subsequently completed to identify a shortfall in electricity and identify solutions to address it. The WSP design team then reviewed and documented each agency's existing site conditions and worked with key project representatives to develop and test a variety of alternative facility concept layouts based on various charging technologies. The preferred concepts serve as the foundation for the proposed phasing schedules and cost and funding estimations. It should be noted that due to WSP's current work with SolTrans, this report uses the preliminary concepts and designs found in the SolTrans Zero Emission Master Plan.

1.3 Report Structure

This report is organized into eight main sections:

1. **Introduction** – Overview of STA Countywide Electrification Transition Plan.
2. **Background** – Overview of STA transit agencies and service area.
3. **ZEB Technology and Market Conditions** – Overview of ZEB technology as well as existing manufacturers, products, and emerging technology.
4. **Methodology and Inputs** – Overview of the processes of service modeling, power and energy analysis, facility concept development, phasing schedule planning, and cost and funding estimation.
5. **Agency-Specific Sections** – Overview of each transit system's existing conditions, service modeling analysis results, energy and power analysis results, and complete ZEB transition plan, including facility concept, phasing schedules, and cost and funding estimations. Agency-Specific Sections include:
    a. Dixon Readi-Ride
    b. Rio Vista Delta Breeze
    c. Solano County Transit (SolTrans)
    d. Vacaville City Coach
6. **Funding Source** – Overview of the funding sources available at the federal, regional/state, and local levels.
7. **Staffing and Training** – Overview of the impacts of full-fleet electrification on staffing and training needs related to transit operations, bus yard management, vehicle maintenance, and charging infrastructure.
8. **Conclusion** – Summarizes the findings of the report.

2 BACKGROUND

The following section provides background on STA and its service area, including disadvantaged communities served by the agencies under STA.

2.1 Solano Transportation Authority (STA)

STA serves as the congestion management agency for Solano County. STA is responsible for countywide transportation planning, programming transportation funds, managing and providing transportation programs and services, delivering transportation projects, and setting transportation priorities. Five transit agencies are operating in Solano County, each with varying types of service and coverage (Table 2.1).

Table 2.1 Transit Agencies in Solano County

Agency	Transit Services
Dixon Readi-Ride	Demand Response Dial-a-Ride
FAST	Fixed Route Local Service ADA Paratransit (DART Service) Adult Recreation Center Taxi Program SolanoExpress Commuter Service
Rio Vista Delta Breeze	Demand Response Dial-a-Ride Fixed Route Local Service
SolTrans	Demand Response Paratransit Fixed Route Local Service SolanoExpress Commuter Service
Vacaville City Coach	Demand Response Paratransit Fixed Route Local Service

Source: Dixon Readi-Ride (2021), FAST (2021), Rio Vista Delta Breeze (2021), SolTrans (2021), Vacaville City Coach (2021)

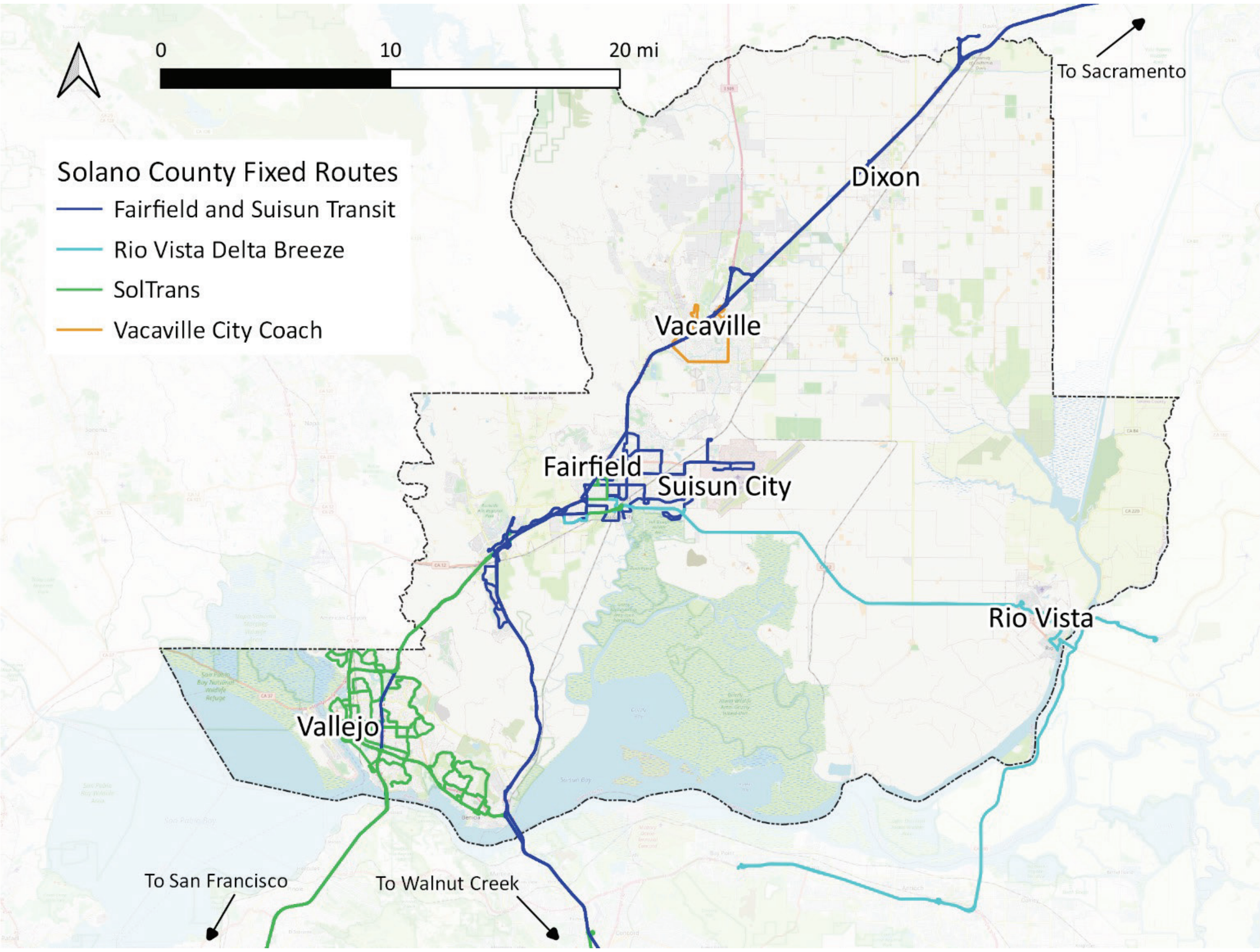
Note: "Demand Response Dial-a-Ride" includes paratransit service, while "Demand Response Paratransit" refers to service that is exclusively for ADA complementary service for disabled and senior riders.

2.2 Solano County Service Area

Solano County is approximately 822 square miles and contains the urbanized areas of Vallejo, Fairfield-Suisun City, Vacaville, Dixon, and Rio Vista. Approximately 448,000 people reside in the county, and roughly 3% of its workforce above the age of 16 use public transportation to commute to work.[2]

Agencies provide service throughout Solano County, with SolTrans and FAST also extending service into neighboring Alameda, Contra Costa, Yolo, and Sacramento Counties (Figure 2.1). All agencies provide fixed-route service (with the exception of Dixon Readi-Ride) and demand response and/or paratransit services.

Figure 2.1 STA Service Areas



Sources: State of California; OpenStreetMap Contributors

2 Solano County Census Reporter, ACS 2019

2.2.1 Weather and Topography

Solano County has a Mediterranean climate of warm, dry summers and mild, rainy winters. The average temperature can be as low as 39 degrees in the winter and as high as 89 degrees in the summer. [3] Due to its topography and landscape, Solano County experiences microclimates.[4]

Solano County has a minimum elevation of 72 feet[5] and a maximum of 2,818 feet.[6] This wide range in elevation affects the relative humidity and air circulation within the county. The average rainfall ranges between 13 inches near the coast and 22 inches inland.[7] The varied landscapes of waterfront cities to more rural and agricultural areas also relate to the creation of microclimates.

2.2.2 Utility Service

Pacific Gas & Electric (PG&E), one of the largest combined natural gas and electric energy companies in the United States, serves Solano County. As agencies in Solano County proceed with BEB transitions, they will need to coordinate with PG&E to assess infrastructure needs, explore electric vehicles (EV) incentives and programs, and install and connect power.

2.2.3 Disadvantaged Communities

Disadvantaged communities (DACs) refer to areas that suffer the most from a combination of economic, health, and environmental burdens. The California Environmental Protection Agency (CalEPA) defines a "disadvantaged" community as a community (census tract) that is located in the top 25th percentile of tracts identified by the California Communities Environmental Health Screening Tool (CalEnviroScreen). CalEnviroScreen uses environmental, health, and socioeconomic data to measure each census tract (community) in California. Each tract is assigned a score to gauge a community's pollution burden and socioeconomic vulnerability. A higher score indicates a more disadvantaged community, whereas a lower score indicates fewer disadvantages.

The replacement of conventional buses with BEBs will yield many benefits in the communities they serve, including reducing noise and harmful pollutants. Given that DACs are disproportionately exposed to these externalities, they should be considered and prioritized during the initial deployments of BEBs. Solano County's transit agencies will ensure that DACs are prioritized as buses are deployed.

Of the four analyzed agencies, two of them – Rio Vista Delta Breeze and SolTrans – operate in and serve DACs. Both agencies' bus yards are located in DACs, and 25% and 47% of fixed-route mileage are operated in DACs, respectively. The DAC-serving routes are summarized in Table 2.2 and illustrated in Figure 2.2.

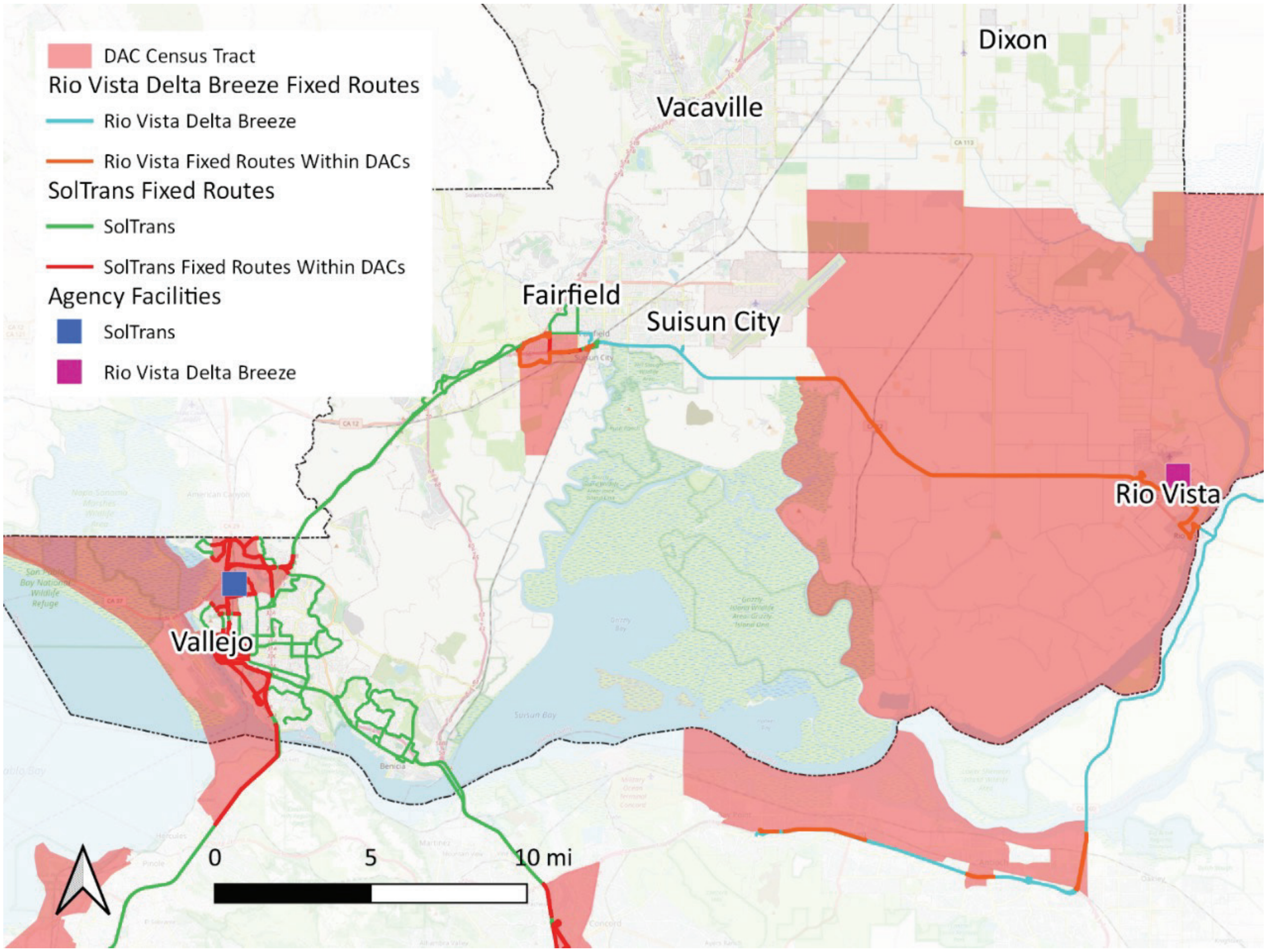
3 NOAA
4 Daily Republic
5 Any Place America
6 Peak Visor
7 BAAQMD

Table 2.2 Summary of DAC-Serving Routes

Agency	DAC-Serving Routes	% of DAC Serving Routes
Dixon Readi-Ride	None	None
Rio Vista Delta Breeze	50 and 52	25%
SolTrans	1, 2, 3, 4, 5, 6, 7A, 7B, 8, 12, 38, 82, Red Line, and Yellow Line	47%
Vacaville City Coach	None	None

Source: CalEnviroScreen 4.0 (2021)

Figure 2.2 Disadvantaged Communities Served by Solano County Transit Agencies



Source: WSP, CalEnviroScreen 4.0 (2021), OpenStreetMap Contributors

3 ZEB TECHNOLOGY AND MARKET CONDITIONS

The following section provides an overview of ZEB technologies and the current market conditions of BEB, and the charging infrastructure.

3.1 Battery-Electric Buses

Battery-electric buses (BEBs) use onboard batteries to store and distribute energy to power an electric motor and other onboard systems. Like many other battery-powered products, BEBs must be charged for a longer period of time to be operational.

BEBs can be charged at the yard (overnight or midday) or on-route (typically during layovers). A yard charging strategy typically consists of buses with high-capacity kWh (kilowatt-hour) battery packs that are charged overnight for four to eight hours with "slow" chargers (which have a charge rate of 150 kilowatts (kW) or less). An on-route charging strategy typically consists of buses with low-capacity battery packs that are charged with "fast" chargers – usually more than 150 kW – during bus layovers (typically five to 20 minutes).

BEBs are charged via several dispenser types (conductive and inductive) and orientations (overhead or ground-mounted). Figure 3.1 presents the methods to dispense electricity to a BEB (from left to right): plug-in, overhead inverted pantograph, and inductive.

Figure 3.1 BEB Charging Methods

Source: YorkMix, ABB (formerly ASEA Brown Boveri), and Long Beach Transit (left to right).

Under existing conditions, BEBs cannot meet the ranges of internal combustion engine buses (ICEBs). BEBs typically have a range of 125-150 miles, and this range is affected by a myriad of factors, including temperature and heating, ventilation, and air conditioning (HVAC) usage, driving behavior, and topography. For this reason, if an agency's service blocks cannot be completed with BEBs, other capital-intensive strategies must be considered to meet range requirements, including, but not limited to, additional BEBs, on-route charging infrastructure, service changes, and/or a mixed-fleet strategy with the incorporation of FCEBs.

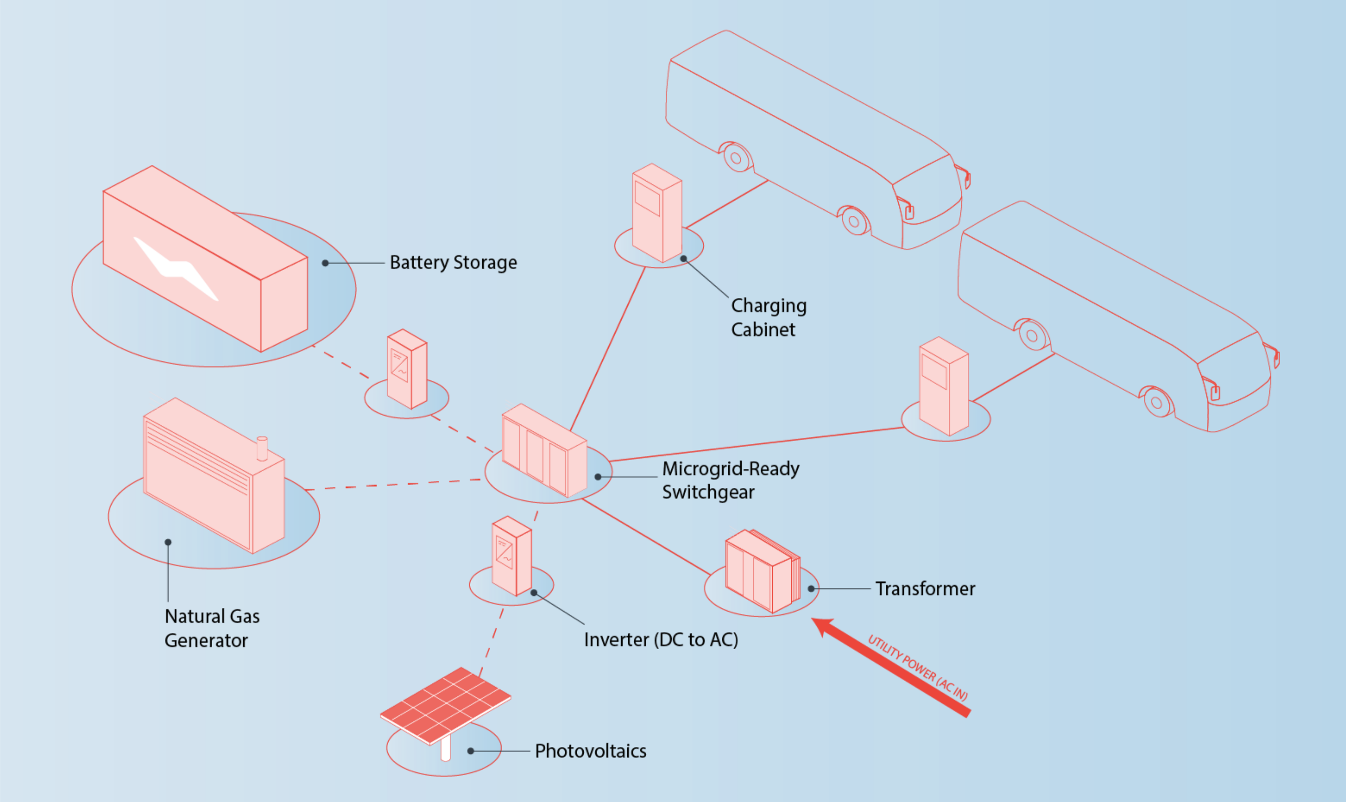
The cost of an individual BEB varies based on battery capacity, vehicle length, customizations (software/hardware, trimmings, etc.), bulk orders, and warranties. For that reason, it can be difficult to accurately estimate costs until entering a contract with an OEM. However, based on peer agencies' base BEB procurements, it is assumed that a cutaway can cost $450K, a 40-foot standard bus costs $850K, and a 40-foot motor coach costs $1.8M.

To sufficiently and safely charge BEBs, infrastructure and equipment must be in place, including:

- Charging cabinet(s) – dispense(s) power and, in most cases, converts power from alternating current (AC) to direct current (DC)
- Transformer(s) – steps down electricity to a safe and suitable limit
- Switchgear(s) – allows for the isolation of power

Other components can also be considered, such as battery storage, photovoltaics (solar panels), and backup generators. Figure 3.2 illustrates the various components of a BEB system.

Figure 3.2 Typical BEB Charging System



Source: WSP

This additional equipment can take up considerable space. Therefore, considerations to safety and reduction of impacts to existing operations must be carefully reviewed and assessed by both the agency and the utility. Due to the high electricity demand for charging a fleet of BEBs and the limited capacity available in existing grid infrastructure, expanded or new electrical service is usually required to transition fleets.

3.2 Market Conditions

3.2.1 Bus OEMS

Over the past 20 years, technological advances have made BEBs a viable and desirable alternative to ICEBs. There are a variety of bus OEMs that produce ZEBs in the United States, with many new OEMs joining the market. Table 3.1 summarizes the market-available standard, motor coach, and cutaway BEBs that best align – based on length and vehicle type – with Solano County's agencies' existing fleets (current double-decker and articulated offerings were not included).

Table 3.1 Available BEBs in the US Market (aligned with Solano County's fleets)

OEM	Vehicle Type	Length	Capacity (kWh)
ARBOC	Motor coach	30' – 35'	350 – 437
BYD	Standard	30' – 40'	215 – 352
	Motor coach	23' – 45'	141 – 446
GreenPower	Standard	30' – 40'	260 – 400
	Cutaway	25'	118
Gillig	Standard	35' – 40'	444
Lightning eMotors	Cutaways + Vans	Varies	<129
MCI	Motor coach	45'7" – 45'10"	389 – 544
New Flyer	Standard	35' – 40'	350 – 525
Nova	Standard	40'	564
Proterra	Standard	35' – 40'	450 – 675

Source: WSP

*Note: BYD is currently not in compliance with Buy America requirements

As of December 2021, approximately 3,500 ZEBs (95% of which were BEBs) are either in operation or procured in the United States – a 27% increase since 2020. Of these, approximately 1,300 ZEBs are in service. With state mandates such as CARB's ICT regulation, the demand for ZEBs is expected to increase and will certainly incentivize the launch of new OEMs and technology developments and help reduce the costs over time.

State Contracts

Bus procurements with individual OEMs can be very time-consuming and resource-intensive. The California Association for Coordinated Transportation (CalACT), a resource primarily for small, rural, and specialized transportation California-based transit providers, has several pre-approved and priced ZEBs that can be purchased to avoid lengthy bid and procurement processes. Table 3.2 presents the current ZEBs and prices that are offered via CalACT.

Table 3.2 California Bus Contract Price List

OEM	Model	Propulsion System	Length	Battery Capacity (kWh)	Cost
New Flyer	Xcelsior XE	Battery Electric	35'	311	$732,618
			40'	311	$741,768
	Xcelsior XHE	Fuel Cell	40'	100	$1,014,979
Proterra	Catalyst XR	Battery Electric	35'	220	$689,000
			40'	220	$699,000

Source: CalAct (2020)

3.2.2 Charger OEMS

Several charger OEMs have products on the market – most of which are based on Society of Automotive Engineers (SAE) standards – meaning most buses can charge with any conductive chargers that apply SAE standards. However, there are no standards for inductive charging, so adopters of one OEM (ex. WAVE) are not able to operate with other chargers (ex. Momentum). Table 3.3 summarizes the different charger OEMs and their current offerings. It should be noted that these represent DC chargers that are compatible with all bus OEMs.

Table 3.3 Available Chargers in the US Market

OEM	Charging Type	Dispenser Type	Power Output (kW)
ABB	Conductive	Plug-In and Pantograph	100-450
ChargePoint	Conductive	Plug-In and Pantograph	62.5-500
Ebus	Conductive	Pantograph	Custom
Hitachi	Conductive	Plug-In and Pantograph	Custom
Heliox	Conductive	Plug-In and Pantograph	180-450
Momentum Dynamics	Inductive		50-300
Power Electronics / Proterra	Conductive	Plug-In and Pantograph	60-600
Siemens	Conductive	Plug-In and Pantograph	150-600
Tritium	Conductive	Plug-In	50-350
WAVE	Inductive		250

Source: WSP

3.3 Emerging Technology

Several advancements and research in battery technology are aiming to improve battery energy densities and lifespans. Additional research is being conducted to reduce the cost and time required to manufacture these batteries as well as increase the cycle life.

The most significant advances are in energy density improvements resulting in reductions in battery weight. Anticipated breakthroughs within battery performance will address many of the limitations existing today in terms of range capability, weight, life expectancy, and degradation. As an example, for a bus with a 450 kWh battery, an increase of energy density from 150 Wh/kg to 300 Wh/kg could reduce bus battery weight by up to 3,000 pounds. This weight reduction would allow for additional kWh of battery capacity added or an overall reduction in bus weight.

Specific research includes:

- Lithium-air batteries are expected to exceed the conventional lithium-ion battery's charging capacity by ten times.
- Lithium-metal batteries have high specific energy and loading capabilities. They use a solid electrolyte instead of a liquid and are believed to have a higher energy density. They are also expected to have a faster charging rate, a higher voltage, and a longer cycle life.
- Semi-solid lithium batteries, rather than using a solid electrolyte, use a liquid electrolyte that prevents a gap from forming at the interface of the electrolyte and the anode-cathode separator. This ensures that access to the active material is not lost over the life of the battery.

Moreover, charger manufacturers and vehicle OEMs continue developing higher-powered charging systems, including higher powered pantographs capable of 600 kW charge rates and developing a new plug standard capable of 1 MW charging. Both of these technologies rely on changes in battery technology to develop batteries that can accept such high charging power.

4 METHODOLOGY AND ASSUMPTIONS

The following section provides an overview of the methodology and inputs used to determine the service requirements, energy and power needs, and facility concepts for each agency's ZEB transition. SolanoExpress service blocks are not included in the analysis. Two lines (Blue Line and Green Line) are part of the FAST Electrification Business Plan (refer to Appendix G). WSP replicated the methodology to analyze the rest of the service (Yellow Line and Red Line), that can be found in Appendix H.

4.1 Service Modeling Analysis

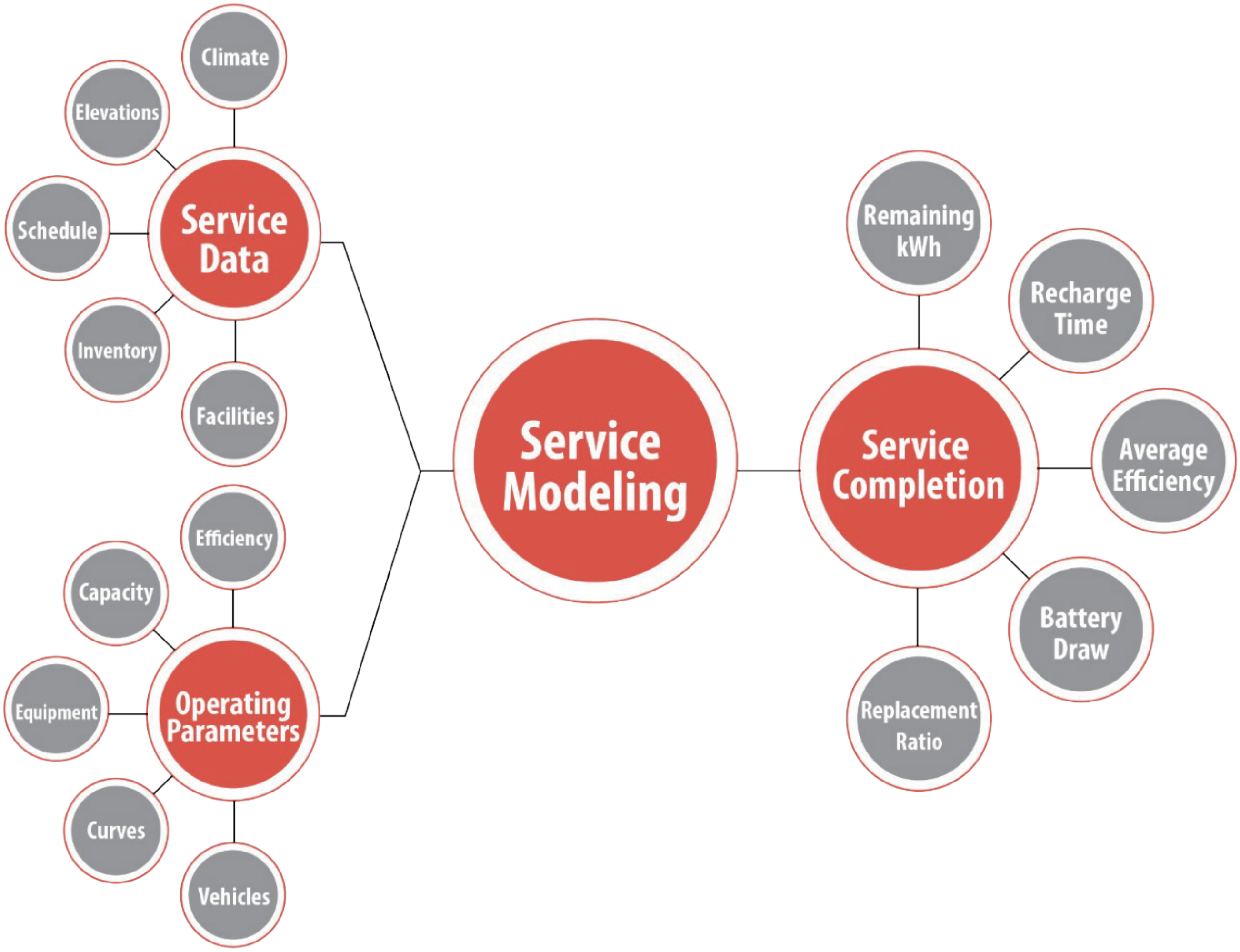
Lightning Bolt is a proprietary modeling tool developed by WSP to evaluate the feasibility of operating BEBs within a transit agency's existing bus schedule. The tool considers and analyzes several factors that may impact the performance of a BEB, including the specific operating conditions of an agency (topography, climate, and bus service schedule), charging and battery capacity parameters, and the extent to which all these factors would improve or reduce performance (Figure 4.1). Climbing hills and other landforms can negatively impact BEB performance and range – while going down a hill may help replenish the battery capacity to a lesser degree via regenerative braking. Meanwhile, ambient air temperature and the resulting HVAC usage are reported to have impacts on reducing BEB efficiency.

Lightning Bolt uses these inputs to determine the percent of service that can be completed under two scenarios: "typical" and "conservative." The two modeled scenarios – "typical" and "conservative" – demonstrate how the BEBs may perform under different conditions. The distinction between the scenarios is based on more conservative estimates for the metrics that have proven to be very impactful on energy consumption, such as ambient air temperature (using the highest or lowest average annual temperature) and elevation gain (assuming lower energy recaptured through regenerative braking).

The outputs are on a block-level scale which is a set of trips assigned to a single-vehicle during a service day. This level of analysis provides a clearer picture of the feasibility of electrifying an agency's vehicle fleet. If the modeled BEB "fails" to complete service, the output captures the degree of failure and the factors that contributed to that failure, from which WSP presents preliminary solutions (e.g., additional vehicle purchases, innovative charging solutions, and/or schedule changes). The results of modeling and this report will be used to inform both short- and long-term operating and procurement strategies as each agency transitions its fleet.

The *Service Modeling Technical Report* (Appendix B) provides a more in-depth review of the data inputs and methodology used to conduct the analysis.

Figure 4.1 Lightning Bolt Model Overview



Source: WSP

Since demand response travel times and distances are variable – and each agency tracks them differently – Lightning Bolt is not a suitable tool to assess the energy required. For these services, a separate analysis was done to determine the "max" or "average" distance traveled by each vehicle to establish a baseline for assessing the energy required and making BEB feasibility recommendations.

4.1.1 Data and Assumptions

The inputs used for the model fall into two categories: service data and operating parameters. Service data includes existing bus schedules, vehicle sizes assigned to each service block, non-revenue service distances, route slope, and climate; whereas operating parameters refer to specific BEB assumptions and adjustments, such as battery capacity, vehicle efficiency, and battery safety buffers.

For the purposes of the analysis, WSP assumed that 80% of the advertised battery capacity is the operating (or usable) capacity. This accounts for an assumed 10% capacity that is deemed unusable by the OEM, as well as an additional 10% safety buffer to reduce range anxiety for operators and mitigate impacts to service.

For the end of warranted life (EWL) battery conditions, WSP assumes 80% of the operating battery capacity (approximately 64% of the advertised capacity). In practice, batteries will degrade at different rates. Table 4.1 presents the BEBs used to model service for Solano County transit agencies.

Table 4.1 Modeled BEBs

Vehicle Type	Average Capacity (kWh)	Operating Capacity (kWh)	EWL Operating Capacity (kWh)
Cutaway	118	94	76
35'	377	301	241
40'	324	259	207

Source: WSP

4.2 Power and Energy Analysis

To successfully transition to ZEB technologies, it is essential to understand the power and energy need that is required to support the fleet. These factors directly impact the capital (required number of chargers, sizing, and placement of utility infrastructure) and operating expenditures (power and energy bills).

The inputs used for calculating the required energy and power needs for each site were based on the results of the Service Modeling Analysis. The results were used to inform the development of proposed charging schedules and the value of a charge management system for the current and future fleet.

The analysis uses two scenarios, unmanaged and managed charging. The unmanaged charging scenario serves as a baseline and calculates the requirements assuming no managed charging solutions are used. This scenario provides the most flexible system but at a higher cost and potentially longer construction schedule. The managed charging scenario takes advantage of a charging stations management system (CSMS) that will allow BEB charging events to be initiated in an intelligent way to reduce the total amount of electrical power required at any given time, thus, reducing electricity demand and operational costs.

The *Power and Energy Report* (Appendix C) provides a more in-depth review of the data inputs and methodology used to conduct the analysis, including detailed energy resiliency and mitigation analysis discussions.

4.2.1 Data and Assumptions

WSP conducted site visits, utility bills, and PG&E databases[8] to identify circuits that feed each site. These data provide a preliminary understanding of the gap between existing and required electrical capacity. Further analysis is then conducted to assess site-specific utility upgrade recommendations.

8 The Integration Capacity Analysis (ICA) and Photovoltaic and Renewable Auction Mechanism (PVRAM) maps are designed to help contractors and developers find information on potential project sites for distributed energy resources. The information on these maps is illustrative and is likely to change or be modified over time.

Charging Rate

For the power and energy analysis, 150 kW (output) DC chargers in a 1:2 (one charger to two dispensers/ buses) were modeled and analyzed for each agency. This is a common configuration, but other options are available and should be considered during the design stage.

The maximum power provided by each charging cabinet is slightly lower than the input nameplate power suggests due to cooling system loads and other inherent inefficiencies both on the charger and battery sides. Peak charger output power often occurs between 20% and 80% of a battery's state-of-charge (SOC), with substantially reduced output power from 80% to 100% SOC. WSP assumes a constant charge rate of 90% of the advertised power of the charger to account for the variations, which equals 67.5 kW in a 1:2 configuration (Table 4.2).

Table 4.2 Modeled Charger Outputs

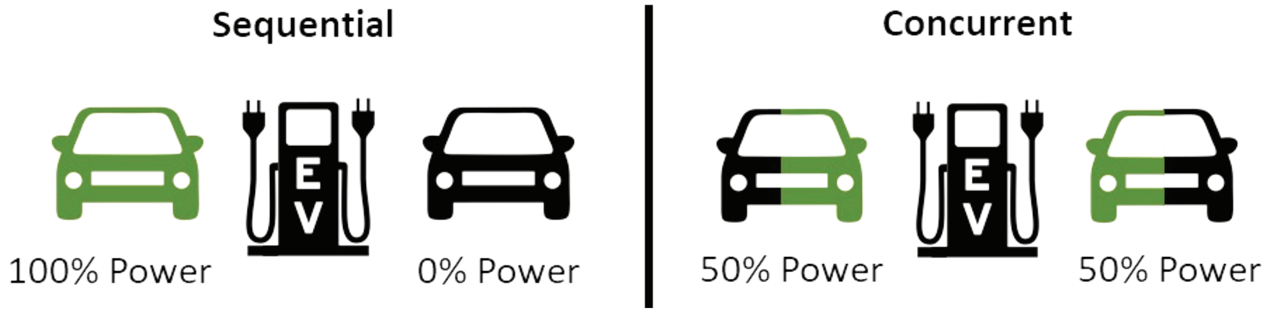
Avg Peak Output Power	Avg Modeled Charger Power	1:2 Charger to Dispensers Ratio
150 kW	135 kW	67.5 kW

Source: WSP

Charging Methods

When a charging cabinet provides power to more than a single vehicle, it can do so via two methods: sequential or concurrent charging (Figure 4.2). Sequential charging is when the charging cabinet selects which of its dispensers it provides power to, meaning it can only charge a single vehicle at a time with full power. Concurrent charging allows power to be equally split between two or more vehicles. This enables vehicles to charge at the same time, albeit at a lower rate. Depending on the amount of energy that needs to be replenished and the time spent charging, both concurrent and sequential charging configurations can be beneficial for an agency to adopt. For Dixon Readi-Ride and Vacaville City Coach, the BEBs are assumed to be charged sequentially, while at Rio Vista Delta Breeze, the BEBs are charged concurrently.

Figure 4.2 Sequential and Concurrent Charging



Source: WSP

4.3 Facility Analysis

WSP conducted site visits between June 23-24, 2021, to gather information on site conditions, circulation, vehicle inventories, electrical equipment, and other site-related items for facility operations analysis. Some agencies also provided existing facility drawings for additional context. In conjunction with the Service Modeling and Power and Energy Analyses findings, this information was used to develop conceptual drawings that provide the most viable method(s) to accommodate ZEB infrastructure on-site.

Each site's concept plan uses the existing fleet inventory and accommodates future fleet increases (as suggested by the agency). The concepts presented are not intended to reflect any fleet expansion as a method of resolving service shortcomings noted in the Service Modeling Analysis. Table 4.3 shows a breakdown of each agency's existing and future fleet inventory. Vans have been excluded from the list since they have a GVWR of less than 14,000 pounds and are therefore not required to be electrified according to the CARB ICT regulation.

A more detailed description of the assumptions used in this analysis can be found in the *BEB Facility Concepts Report* (Appendix D).

Table 4.3 Solano County Fleet Summary

Agency	Existing Fleet	Future Fleet
Dixon-Readi Ride	8*	10*
Rio Vista Delta Breeze	4*	8*
SolTrans	56	70
Vacaville City Coach	25	31

Source: Dixon, Rio Vista, and Vacaville Short Range Transit Plan Fiscal Year 2021 – Fiscal Year 2030, and General Transit Feed Specification Data. SolTrans Zero Emission Bus Master Plan

Note: *Excludes vans

4.4 Phasing Schedule Analysis

The following section contains an overview of the methodology used to build the construction and vehicle procurements timelines.

4.4.1 Facility Construction

Facility infrastructure upgrades are planned in one or two on-site segments, or "stages," that generally represent a natural break in bus parking at the facility. This approach to construction will lead to minimal impacts on operations and no impact on riders.

Buses parked in areas that fall within each stage will be relocated for approximately six months (based on construction assumptions) to allow for the installation of the BEB charging equipment. Upon completion of each construction stage, buses can return to their parking space.

WSP and STA agencies coordinated to develop high-level assumptions for construction stages and durations based on a design-bid-build delivery method. These durations were then used to develop conceptual schedules that provide some insight into when these facilities may be ready to support ZEBs. Some stages can overlap with each other, while others rely on the completion of a previous task. The scheduling assumptions for each agency's construction process are summarized in Table 4.4, with additional details below.

The developed schedules are conceptual and may not capture some of the nuances that have the potential to prolong project delivery, including lag times, environmental clearance (CEQA/NEPA[9]), multiple build stages, materials delays, stakeholder engagement and approvals, and review times.

Table 4.4 Scheduling Assumptions

Stage	Responsibility	Description	Duration (months)
Utility Enhancements	PG&E	Plan, design, and construct off-site utility enhancements to support the power needs of each facility.	16
Design Procurement	Agency	Develop, advertise, and award contract to develop detailed designs for each facility.	4 – 6
Detailed Design	Designer	Take conceptual designs to 100%.	9 – 11
Construction Procurement	Agency	Develop, advertise, and award contract to construct infrastructure at each facility.	5 – 6
Construction	Contractor	Construction at each facility, including the structure, charging/fueling infrastructure, and supporting connections.	7 – 11

Source: WSP

4.4.2 Vehicle Procurement

All agencies in Solano County are categorized as "small transit agencies" in the regulation and, as such, must ensure that 25% of new bus deliveries between 2026 and 2028, and 100% beyond 2029, are ZEBs. During the delivery phase of procurement, buses are delivered to agencies as they come off the line at a rate specified by contract, typically two to five vehicles per week. Depending on the size of the procurement and vehicle up-fit required on-site, the delivery period may take several weeks or months.

To develop a procurement schedule, each agency must consider several requirements and constraints, such as:

- ZEBs cannot be operated unless infrastructure is in place to charge/fuel them; therefore, the delivery of ZEBs must occur after the infrastructure is constructed.
- Each agency's current vehicles must satisfy the federally mandated "useful life."
- Each agency must also satisfy the purchase requirements of CARB's ICT regulation.

Assumptions used in developing the procurement schedule include:

- Standard buses are eligible to be retired 12 years (or 500,000 miles) after their acceptance date.
- Cutaway buses are eligible to be retired five years after their acceptance date.
- Vans are eligible to be retired four years (or 150,000 miles) after their acceptance date.
- The procurement assumes a 1:1 ICEB-to-BEB replacement ratio.

9 California Environmental Quality Act / National Environmental Policy Act

- The procurement plans assume that at the end of their useful life, standard buses are immediately retired and replaced by new BEBs if there are feasible charging positions
- When necessary, to ensure there are equal or fewer BEBs to charging positions, the retirement date of some vehicles is assumed to be extended until BEB replacement is feasible.
- This analysis considers all vehicles subject to CARB ICT regulations, thus excluding vans that have a GVWR below 14,000 pounds and are not required to be electrified.

4.5 Lifecycle Cost Analysis

WSP developed a tool to assess the lifecycle costs associated with fleet electrification that will subject Solano County's transit agencies to different pricing structures and exposure to energy price volatility. The analysis consists of capital, operations, and maintenance (O&M), disposal, and environmental costs.

Agency-specific data points are preferable to inform the cost assumptions. However, industry and peer agency data are leveraged if data is unavailable. The total costs of operating a full BEB fleet ("Build" scenario) is compared to a "No Build" baseline scenario which assumes no change in the current types of vehicles in the fleet.

The following sections will briefly describe the assumptions used in the analysis. The *Cost and Funding Report* (Appendix F) provides a more in-depth review of the assumptions, data inputs, and methodology used to conduct the analysis. The values presented throughout this document are subject to change and are based on the most current information available at the time of this analysis.

4.5.1 Data and Assumptions

The lifecycle cost model employs a nominal discount rate of 9.5%. All cost assumptions are in 2021 dollars, while each agency's results are in year of expenditure (YOE) dollars. The model also accounts for inflation using the historical Consumer Price Index for all Urban Consumers (CPI-U) and Producer Price Index (PPI) for Bus Chassis Manufacturing.

Capital Costs – Vehicle

Vehicle purchase costs include the base purchase price (Table 4.5), additional service preparation and inspection costs, special tools and diagnostic equipment costs, and allowances for contingency. For transit buses above 35-feet, an additional $120,000 was assumed as additional options and charges. For BEBs, an additional cost for battery extended warranty over the life of the vehicle is assumed. The vehicle capital expenditure is based on the fleet procurement plan and incurred one year prior to the operational start date to account for delivery lag and acceptance testing.

The vehicle capital expenditure is based on the fleet procurement plan[10] and incurred one year prior to the operational start date to account for delivery lag and acceptance testing.

10 Appendix E: *Phasing Strategy and Transition Report*

Table 4.5 Assumed Vehicle Base Purchase Price

Bus Type	Gasoline	Hybrid	CNG	BEB
Cutaway	$132,514	-	$249,306	$263,905
35' Standard Bus	-	-	$919,576	$1,048,081
40' Standard Bus	-	$1,107,117	$833,105	$1,065,530

Source: WSP, MTC Bus Pricing, and California State Contract

Notes: Base vehicle costs for BEB are sourced from the California State Buy board. ICEBs base costs are sourced from the Metropolitan Transportation Commission (MTC) Regional Bus/Van Pricelist FY2022-23 Sheet

Capital Costs – Infrastructure

Five types of costs make up the utility improvement costs: direct cost, general conditions, contractor fee, bonds and insurances, and contingency. Direct costs are physical infrastructure and equipment costs. General conditions are 20% of the direct cost. The contractor fee percentage is 15% of direct cost and general conditions. Bonds and insurances are 3% of the total costs. Lastly, an extra 30% is added on top of the total costs for contingency.

Infrastructure capital cost was developed by a WSP estimator who assessed the facility needs at Dixon Readi-Ride, Rio Vista Delta Breeze, and Vacaville. For SolTrans, a previous estimate by a separate contractor was used for the analysis. Detailed infrastructure cost estimates are provided in the *Cost and Funding Report* (Appendix F).

Operation and Maintenance Costs

Vehicle O&M costs include not only time of the individual to operate the vehicle but also general vehicle maintenance, tire service, fueling infrastructure annual maintenance, fuel or energy, and bus disposal and retirement costs. Vehicle O&M costs are specific to the vehicle types and the length of the vehicles. Overall O&M costs are influenced by each vehicle's operating costs per mile and annual mileage. Table 4.6 provides the assumed average vehicle mileage and useful life for each bus type, while Table 4 7 presents the vehicles O&M costs over years of operation. The fueling infrastructure O&M costs varies for each agency, depending on the existing condition of fueling infrastructure on-site.

Table 4.6 Assumed Average Vehicle Mileage and Useful Life

Bus Type	Service Type	Useful Life	Average Vehicle Mileage (miles)			
			Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans	Vacaville City Coach
Cutaway	Fixed Route	10 years (except. SolTrans: 7 years)	-	28,378	-	-
	Demand Response		22,956	35,595	14,031	39,273
35' Standard Bus	Fixed Route	12 years	-	-	-	27,777
40' Standard Bus	Fixed Route	12 years	-	-	36,068	-

Source: WSP

Notes: Average vehicle mileage is estimated based on the fleet age and mileage outlined in the STA 2020 Short Range Transportation Plan (SRTP)

Table 4.7 Vehicle O&M Costs by Year of Operation

Year of Operation	"No Build" Scenario			"Build" BEB Scenario		
	Cutaway	Hybrid 40'	CNG 35'/40'[11]	Cutaway[11]	35'[12]	40'[12]
Year 1 ($/mi)	0.81	0.40	0.20	0.80	1.17	1.17
Year 2 ($/mi)	0.88	0.57	0.20	0.87	1.26	1.26
Year 3 ($/mi)	0.96	0.66	0.25	0.95	1.45	1.45
Year 4 ($/mi)	1.03	0.90	0.30	1.02	1.42	1.42
Year 5 ($/mi)	1.11	1.05	0.51	1.10	1.81	1.81
Year 6 ($/mi)	1.14	1.11	0.45	1.13	1.92	2.31
Year 7 ($/mi)	1.19	1.27	0.50	1.18	2.19	2.31
Year 8 ($/mi)	1.22	1.26	0.56	1.21	2.15	2.52
Year 9 ($/mi)	1.25	1.58	0.52	1.24	2.71	2.79
Year 10 ($/mi)	1.29	1.35	0.57	1.28	2.31	2.53
Year 11 ($/mi)	N/A	1.04	0.62	N/A	1.79	2.35
Year 12($/mi)	N/A	1.03	0.65	N/A	1.76	2.25
Tires ($/mi)	0.068[13]	0.068	0.068	0.072[14]	0.072	0.072
Charger ($/year per Vehicle)	N/A	N/A	N/A	218[13]		

Source: WSP Peer Agencies

11 Based on a peer agency's experience in San Bernadino County, California
12 Based on a peer agency's experience in Washington
13 Based on a peer agency's experience in Washington
14 Based on a peer agency's experience in Washington. Assumed 10 percent higher than baseline existing vehicles to account for the heavier weight of BEBs

Fuel and energy costs for vehicles are based on MCE Clean Energy and US EIA's fuel price. Additionally, annual demand charge per electric vehicle was applied for BEB replacement scenarios using the MCE Clean Energy rates. Table 4 8 provides the summary of fuel/energy costs assumptions used in the analysis.

Table 4.8 Fuel and Energy Cost Assumptions

Category	Electricity			Diesel	Gasoline	CNG		
	25'	35'	40'	40'	25'	25'	35'	40'
Fuel/Energy Cost	$0.19/kWh[15]			$2.33/gal[16]	$2.72/gal[17]	$2.41/gal[18]		
Demand Charges ($/vehicle-year)	$3,766[19]			N/A	N/A	N/A		
Vehicle Fuel Efficiency (mpdge or kWh/mile for BEB)	0.79	1.88	2.08	6.1	8.1	5.59	3.9	3.0

Source: USEIA and MCE Tariffs for Large Businesses

Environmental Costs

Environmental costs consist of tailpipe emissions, lifecycle Greenhouse Gas (GHG) emissions, and noise. The analysis converts these non-monetized values to cash costs. The environmental costs are measured in dollars per mile, and the total cost calculations are driven by annual vehicle mileage. The vehicle tailpipe emissions in g/mi were provided by the AFLEET tool, Environmental Protection Agency (EPA) MOVES 2014b model, and PG&E carbon footprint calculator. Meanwhile, lifecycle GHG emissions were gathered from CARB's All Pathways List. Table 4.9 summarizes the emissions for different fuel types.

15 Based on MCE Clean Energy rates for primary rates in the E20-Large General Service category. Assuming a mix of 33% of summer rates and 67% of winter rates. Within the summer and winter rates, the analysis assumes peak, part-peak, and off-peak splits to be 20%, 40%, and 40%, respectively. This rate also includes PG&E's delivery rate, power charge indifference adjustment (PCIA) and franchise fee (FF).

16 2021 California average regular gasoline sales for resale average without tax from USEIA

17 2021 California average sales for resale No 2 Distillate without tax from USEIA

18 Five year average fuel price with tax from CNGNOW

19 Based on MCE Clean Energy rates for primary rates in the E20-Large General Service category. Assuming 11% of summer peak, 22% of summer part-peak and 67% of winter peak rates. Based on 2:1 bus to charger ratio for 150 kW chargers.

Table 4.9 Tailpipe Criteria Air Pollutant (CAP) and Lifecycle GHG Emissions (g/VMT)

Emission	BEB			Diesel Hybrid	Gasoline	CNG[20]		
	25'	35'	40'	40'	Cutaway[21]	24'	35'	40'
Vehicle Tailpipe CAP								
NOX	-	-	-	2.63	0.12	0.13	0.13	0.13
SOX	-	-	-	0.01	-		-	-
PM10	0.11	0.11	0.11	0.21	0.19	0.22	0.22	0.22
VOC	-	-	-	0.50	1.50	0.44	0.44	0.44
PM2.5	0.01	0.01	0.01	0.03	0.03	0.03	0.09	0.03
Lifecycle GHG								
CO2	358[22]	853[23]	943[24]	1,997	1,704	1,397	2,481	3,259

Source: AFLEET Analysis, EPA Moves 2014 Model, CARB, and PG&E

4.6 Funding Gap Analysis

The funding gap analysis aims to identify the additional amount of funding needed to be secured by each transit agency to fully electrify their fleet. The currently planned capital budget is identified from each agency's Short Range Transportation Plan (SRTP). Since these SRTP plans were adopted in 2020, there may be some overlap between the capital costs outlined in the SRTP Capital Costs and the electrification plan capital cost analyzed. Funding resources outlined in the SRTPs to support revenue vehicle replacements, electrical charging infrastructure, and facilities-related expenses for maintenance/yards are assumed to be available to support the *Solano Countywide Electrification Transition Plan*. Other existing agency revenues that could potentially be applied to this funding gap are also included.

The Cost and Funding Report (Appendix F) provides a more in-depth review of the assumptions, data inputs, and methodology used to conduct the analysis.

Staffing and Training

Staffing and training impacts related to fleet electrification were analyzed by using information from peer agencies with BEB experience and document reviews related to training. High-level recommendations are given in key areas essential to full fleet electrification. The actual staffing and training needs might vary based on the specific characteristics of Solano County's transit agencies' current staffing and service operations. See Section 10 for additional analysis and discussion.

20 GHG Emissions: CARB All Pathways. CNGF204 Carbon Intensity of 80.59.

21 Used the school bus option in the AFLEET tool.

22 0.524 lbs. CO2/kWh by PG&E Carbon Footprint Calculator

23 CARB All Pathways. ULS000L00072019, carbon intensity of 100.45

24 CARB All Pathways. 90 percent of CBO000L00072019, carbon intensity of 100.82 and 10 percent of ETHC244L, carbon intensity of 76.27

DIXON READI-RIDE

5 DIXON READI-RIDE

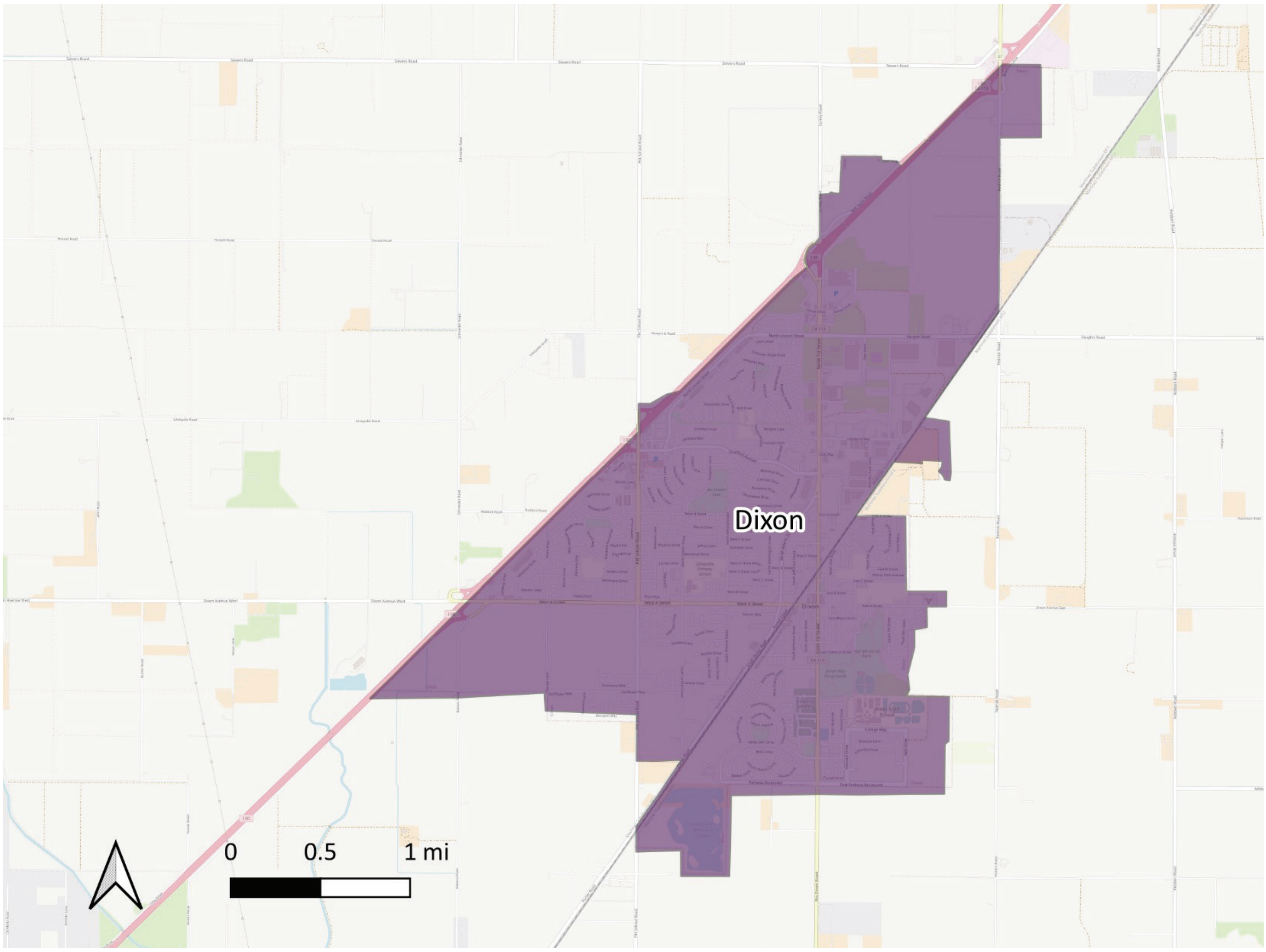
The following sections present Dixon Readi-Ride's existing conditions, service modeling results, power and energy analysis, facility concepts, phasing strategies, and cost and funding analysis to support the agency's ZEB transition.

5.1 Existing Conditions

5.1.1 Existing Service

Dixon Readi-Ride was established in 1983 as a public dial-a-ride transit system administered by the City of Dixon. It continues to provide curb-to-curb transit service within the city of Dixon (Figure 5.1). The hours of operation are Monday - Friday from 7:00 AM - 5:00 PM. The city has no fixed-route transit service.

Figure 5.1 City of Dixon



Source: Metropolitan Transportation Commission, OpenStreetMap Contributors

The service operates with two vans and eight cutaways, all powered by gasoline (Table 5.1). The vehicles were put in service between 2007 and 2019.

Table 5.1 Summary of Dixon Readi-Ride's Existing Fleet

Bus Type	Length	Fuel Type	In-Service Year	Quantity
Van	Unknown	Gasoline	2010	2
Cutaway	Unknown	Gasoline	2007-2019	8
			Total Vehicles	**10**

Source: Dixon Readi-Ride Short Range Transit Plan Fiscal Year 2021 – Fiscal Year 2030

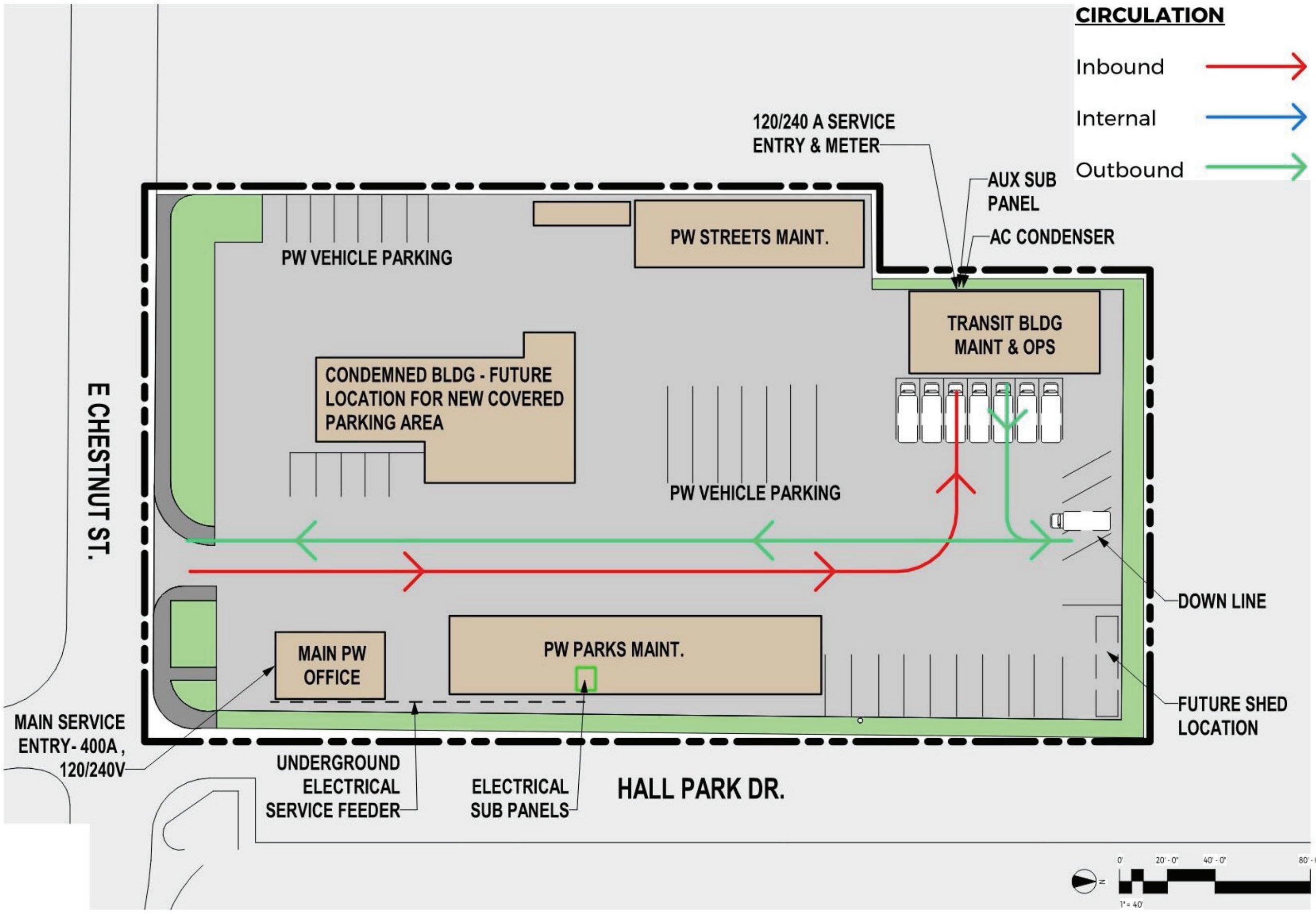
Note: A detailed list of Dixon Readi-Ride Existing Fleet is available in Appendix A: *Existing Conditions Report*

5.1.2 Existing Facility Conditions

The Dixon Readi-Ride facility is located at 285 East Chestnut Street (Figure 5.2). The transit operations share the site with the City of Dixon Public Works Department, and despite having a relatively small, dedicated portion of the overall site, transit operations still have adequate room to support the fleet. The transit operations consist of a parking area containing 13 parking spaces as well as a maintenance and operations building. There are also multiple single-phase electrical service entry points at the site.

There are two future site improvements planned at the facility. One is for a new storage shed that would be located in the northeast corner. The other is to demolish the condemned building in the center and replace it with a covered parking area for public works vehicles. Neither project is planned for the near future, and neither should affect the electrification implementation.

Figure 5.2 Dixon Readi-Ride Existing Facility and Site Circulation



Source: WSP

5.1.3 Existing Power and Energy Conditions

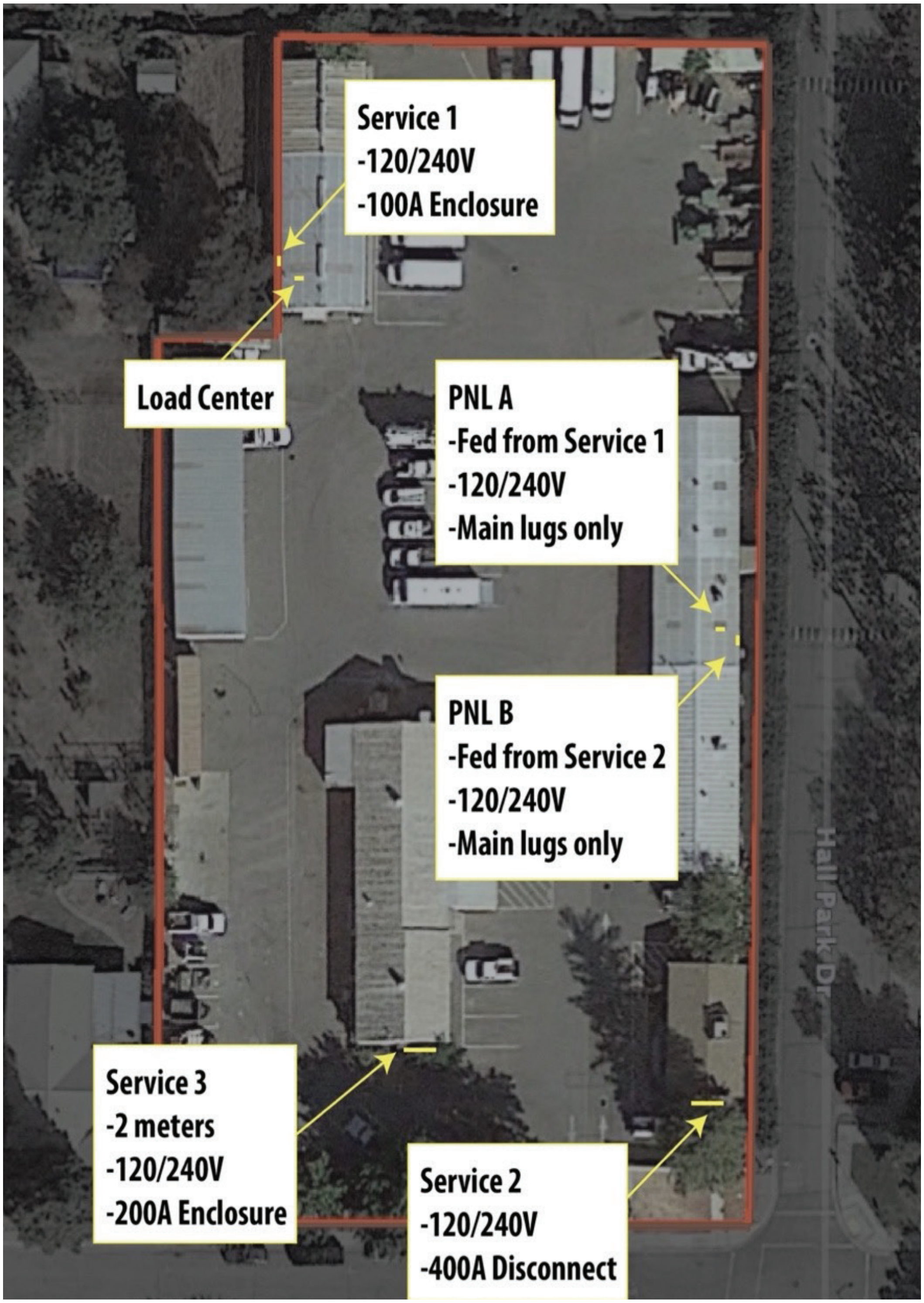
Dixon Readi-Ride's power is provided by the PG&E Dixon Substation (6206), which has a capacity of 39 megawatts (MW) on Bank 1 with a peak load of approximately 18.1 MW (based on publicly available data). The Dixon Substation feeds the Dixon 1103 feeder circuit that feeds the Dixon Readi-Ride yard. The Dixon 1103 Circuit is a 12-kilovolt (kV) circuit that has an existing capacity of 10.9 MW. PG&E estimates that the projected peak load of this circuit is 9.3 MW, leaving approximately 1.6 MW of available capacity.

If a new service is warranted from future transit upgrades, the new service could potentially be fed by the nearby Dixon 1102 Circuit if PG&E is unable to serve the required load from the existing 1103 circuit. The loads for the Dixon 1102 Circuit increase in the summer months and has peaks at 7:00 PM between June and August. BEBs on-site will most likely charge overnight, so this feeder profile should not affect Dixon Readi-Ride's electricity bill or peak demand charge.

Existing electrical service appears to be served by a 12 kV – 240/120V, single-phase, pole-mounted PG&E-owned transformer, likely shared with adjacent facilities and residential homes located approximately 0.5

miles from Dixon Substation. On-site electrical infrastructure includes two panelboards and three services (Figure 5.3). Appendix C: *Power and Energy Report* provides detailed information on the services.

Dixon Readi-Ride Plan View



Source: WSP

5.2 Service Modeling

Dixon Readi-Ride operates only demand response services. Since the vehicle miles traveled for demand response services are variable, the Lightning Bolt model could not be used. In lieu of this, WSP conducted a high-level analysis of range expectations using the daily and maximum mileage traveled by the fleet. The vans were not included in the following analysis because their GVWR is below 14,000 pounds, and thus they are not subject to the CARB ICT requirements.

Based on the average travel speeds (calculated from data provided in the SRTP and an assumed eight or 10-hour vehicle operator shift), the average daily vehicle distance for the service is between 83 and 103 miles. The GreenPower EV Star – a representative BEB replacement for Dixon Readi-Ride's existing vehicles – has an advertised range of 150 miles.

Based on the comparison between the advertised range of existing battery electric cutaways and the service's average daily vehicle distance, Dixon Readi-Ride should be able to operate its demand response service with no or minimal impact. Even with consideration to a 20% safety buffer, the advertised range of the BEB still exceeds the average distance traveled for its demand response service. However, under EWL battery conditions (64% advertised capacity), the expected vehicle range is at or below the calculated average daily vehicle distance.

However, it should be noted that this estimate does not consider HVAC usage, slope, and other service area-specific variables that can significantly impact the vehicle's efficiency and range. For this reason, it is recommended that more specific vehicle travel information be analyzed and/or a demonstration pilot be conducted to gauge real-world performance.

5.3 Power and Energy Analysis

Dixon Readi-Ride fleet currently consists of ten gas vehicles: eight cutaways and two vans. This analysis takes into consideration that in the future, the transit agency will have the capability to operate all BEB cutaways. This analysis calculated the electrical requirements for both the current and assumed future fleet.

The analysis evaluates the fleet under an unmanaged and managed charging scenario. In the unmanaged charging scenario, all vehicles will charge concurrently at the same time. Meanwhile, the managed charging scenario assumes that the vehicles will charge sequentially at a full charging rate before switching to the next vehicle. This scenario will reduce the peak demand power required but will result in a longer charging time. However, because BEBs are charging at the same rate during non-peak hours, the longer time should not affect the total energy (kWh) utility cost. The summary of the charging scenarios analysis is shown in Table 5.2.

Existing Fleet

To service the existing fleet, it is recommended that four 150 kW DC chargers be installed. The recommendation is for Dixon Readi-Ride to do managed charging. Managed charging will reduce the peak demand from 600 kW in the unmanaged scenario to 150 kW. It will reduce overall utility costs due to the lower peak demand and reduce capital costs because of the smaller equipment upgrades required. If necessary, one 150 kW DC fast charger can be used at full speed for flexible mid-day recharging.

Future Fleet

An additional 150 kW DC charger will be needed to anticipate the additional needs of two electric cutaways in the future fleet. The total peak demands are 750 kW and 300 kW for unmanaged and managed charging scenarios, respectively. Therefore, a charge management system is strongly recommended for Dixon Readi-Ride. Upgrading the electrical equipment to anticipate this load level will future-proof the site from fleet expansions.

Table 5.2 Summary of Dixon Readi-Ride Charging Scenarios

Fleet	Min. Required # of Chargers	Scenario	Charge Schedule	Charge Rate (per vehicle)	Peak Demand	Required Power Increase*
Current Fleet	Four 150 kW DC chargers	Unmanaged	All BEBs charge concurrently	67.5 kW	600 kW	660 kW
		Managed	Each BEB charges sequentially	135 kW	150 kW	165 kW
Future Fleet	Five 150 kW DC chargers	Unmanaged	All BEBs charging concurrently	67.5 kW	750 kW	825 kW
		Managed	8 BEB charge sequentially, the rest charge concurrently	135 kW	300 kW	330 kW

Source: WSP

*Note: Required power increase includes 10% buffer for ancillary loads and losses

Power and Energy Upgrades

Based on the analysis, the following facility electrical upgrades are required, assuming the worst-case scenario of unmanaged charging to accommodate the future fleet:

- 1000 kVA transformer fed by a new 12 kV underground electrical pole near Hall Park Drive
- 480V service entrance main switchboard with a minimum electrical rating of 1600 A and utility metering cabinet
- Underground electrical conductor in conduit from the new transformer to new 480V switchgear
- Vehicle charging stations with underground conduit connecting the charging stations to the new 480V switchgear

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Dixon Readi-Ride would be responsible for installing the on-site switchboard, utility metering cabinet, underground conduit, and charging stations. It is important to note that managed charging is strongly recommended, and electrical equipment properties should be determined during the design phase based on the level of electric service requested and discussions with PG&E.

Energy resiliency at the site is vital to ensure Dixon Readi-Ride has reliable service after transitioning to a full BEBs fleet. One or more of the strategies below provide a suitable level of backup power after considering the possible resiliency issues that the site might experience[25]:

- 400 kW standby permanent generator
- 400 kW trailer-mounted generator and associated connection equipment
- Solar PV system paired with 1 MWh BESS in 20' x 8' container

A generator with an output rating of at least 400 kW can power two 150 kW DC charging cabinets simultaneously and fully recharge all vehicles overnight. A solar PV system with battery storage could provide the site with supplemental power but will not be an effective standalone backup generation source.

5.4 ZEB Transition Plan

5.4.1 Facility Concept

The Dixon Readi-Ride facility concept supports ten charging positions. Positions are planned for the zero-emission vehicles (ZEVs) that will replace the existing eight cutaway vehicles while also leaving room for two additional vehicles in the future. Five DC charging cabinets and 10 DC plug-in dispensers are needed to support the fleet. The number of dispensers required can decrease through further evaluation of the buses' charging window and end-of-the-day SOC. Plug-in charging was determined to be the most suitable method of charging since the fleet solely consists of cutaway vehicles. Of the ten plug-in dispensers, four will be ground-mounted, while seven will be overhead-mounted and require cable retractors.

These vehicles are parked outdoors, either at the east of the maintenance building or at the north end of the facility along the fence line. Table 5.3 provides an overview of the proposed charging and utility infrastructure improvements. For additional details, refer to Appendix D: *BEB Facility Concepts report*. Figure 5.4 illustrates the proposed facility concept to support the electrification transition.

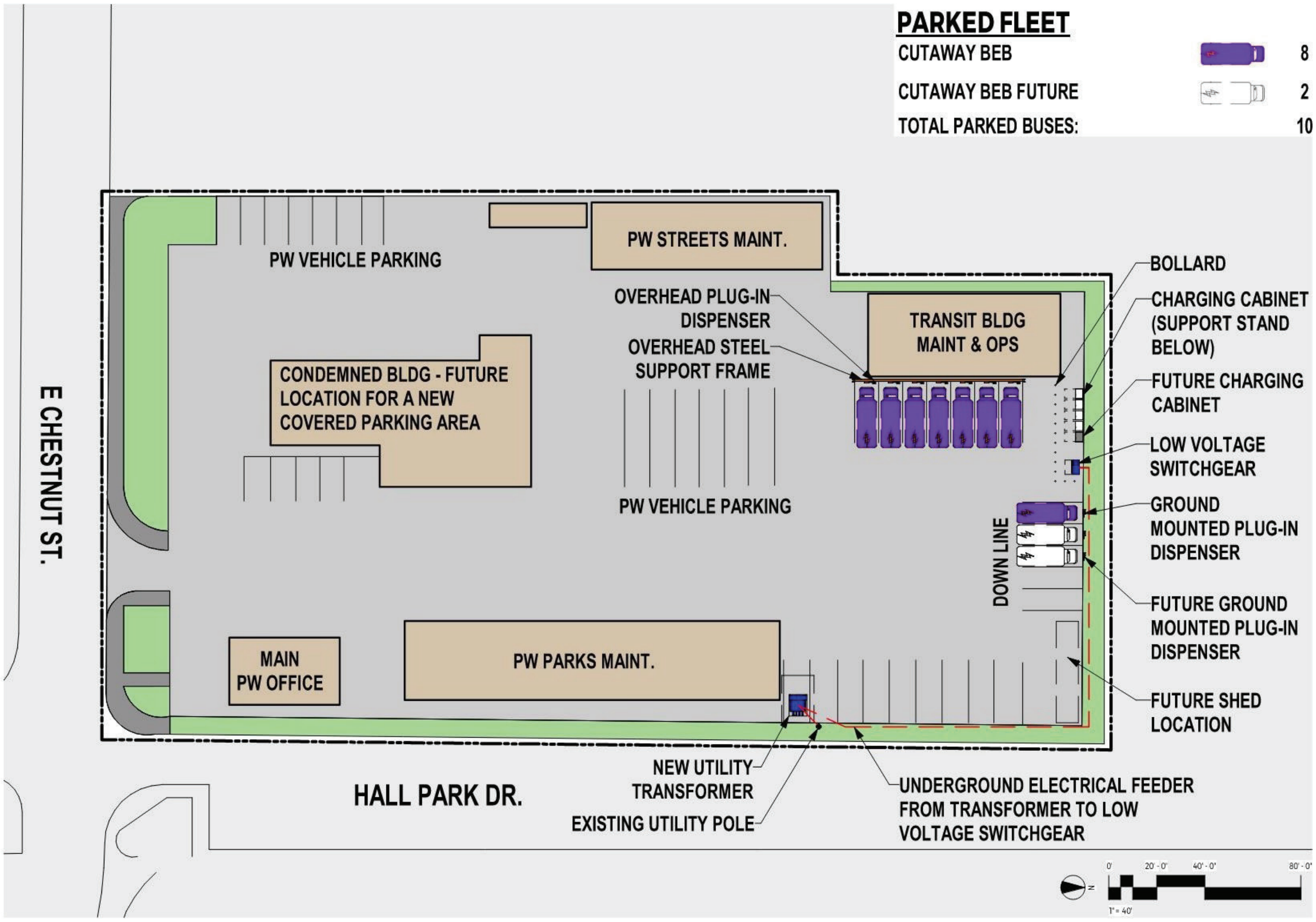
Table 5.3 Dixon Readi-Ride Recommended Infrastructure

Item	Quantity
150 kW DC Charging Cabinet	5
Plug-in DC Dispenser	10
Cable Retractor	7
Plug-in DC Dispenser in Maintenance Area	1
Transformer	1
Switchboard	1

Source: WSP

25 Appendix C: *Power and Energy Report* provides in-depth resiliency analysis for the site

Figure 5.3 Dixon Readi-Ride Preliminary Facility Concept



Source: WSP

5.4.2 Construction Schedule

Due to the relatively small fleet size and the proposed configuration of the improvements, it is recommended that all on-site improvements be constructed in a single stage. The charging cabinets and associated dispensers, however, could be procured and installed in stages to better align with a desired bus procurement schedule.

The vast majority of the planned charging infrastructure and utility distribution can be done with minimum impact on current operations. However, once construction begins, vehicles that park in front of the existing maintenance building will need to be relocated. Once the frame construction is completed, the buses can resume their current parking arrangement at night while overhead electrical cabling and equipment are installed. Careful coordination between the contractor and site managers will be needed to ensure that an adequate number of maintenance bays are still accessible during construction.

Based on the assumed duration, Dixon Readi-Ride's electrification transition will take 27 months, with an estimated completion date in September 2024 – assuming that the development of the design procurement begins in July 2022. Table 5.4 illustrates the proposed schedule.

Table 5.4 Dixon Readi-Ride Construction Schedule

	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Utilities							18 months																				
Design Procurement	6 months																										
Design							11 months																				
Construction Procurement															6 months												
Construction																					7 months						

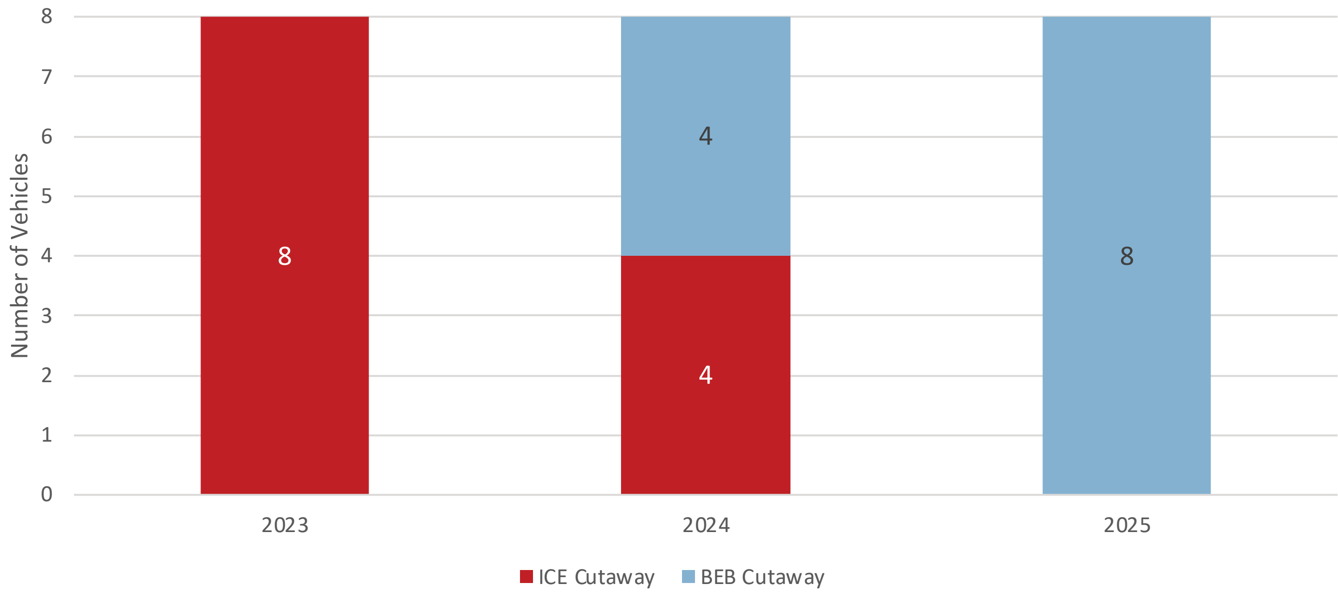
Source: WSP

5.4.3 Vehicle Procurement Schedule

It is essential that the delivery of new vehicles align with or after the completion of construction, given that the vehicles cannot be operated until chargers are installed. Therefore, the first delivery of battery-electric cutaways will not occur until October 2024. The fleet will be fully electric by 2025.

The developed procurement timeline assumes that vehicles will be purchased in two sets of four vehicles. This approach will help ease the transition so that Dixon Readi-Ride has the flexibility of continuing to operate ICE cutaways for a short period of time while the new ZEVs are delivered. This approach will also help ensure that any mid-life maintenance will not occur for the entire fleet at the same time. Figure 5.5 illustrates Dixon Readi-Ride's fleet mix over time (between ICE and ZEB vehicles).

Figure 5.4 Dixon Readi-Ride Fleet Mix



Source: WSP

5.4.4 Lifecycle Costs Analysis

Based on the lifecycle cost analysis, the total cash cost (including capital, O&M, disposal and excluding environmental costs) of operating a full BEB fleet is approximately $8M, 56% higher than if Dixon Readi-Ride continued to operate a full gasoline fleet. This is due to the significantly higher capital costs. The total vehicle capital costs (with modification) are $2.5M for BEB compared to $1.3M for ICE vehicles. Furthermore, the total charging/fueling infrastructure capital costs are $1.8M for BEB and $0 for ICEB fleet because Dixon Readi-Ride currently does not have any fueling infrastructure on-site.

However, the lifecycle environmental costs for gasoline fleet are approximately $0.38M higher than a full BEB fleet, which will bring the total cash and non-cash costs difference between the two fuel types down to 43%. The total lifecycle cash and non-cash costs are $2.70/mile and $3.86/mile for ICE and BEB fleets, respectively.

Table 5 5 provides the summary of the lifecycle cost analysis.

Table 5.5 Lifecycle Cost (2021-2037) Analysis Results for Dixon Readi-Ride (in millions of YOE$)

Cost Categories	"No Build" Scenario	"Build" BEB Scenario
Cash Costs		
Total Capital Costs	$1.25	$4.25
Total Operating Costs	$3.78	$3.57
Total Disposal Costs	-$0.06	-$0.06
Total Cash Cost	$4.97	$7.76
Non-Cash Costs		
Total Environmental Costs	$0.64	$0.26
Total Cash and Non-Cash Costs	$5.61	$8.02
Total Cash and Non-Cash Costs per Mile	**$2.70**	**$3.86**

Source: WSP

Note: The total costs may vary due to rounding. Refer to Appendix F: *Cost and Funding Report* for a detailed breakdown of each item.

5.5 Findings and Next Steps

5.5.1 Service Feasibility

Based on a high-level comparison between the advertised range of existing battery electric cutaways and the service's average daily vehicle distance, Dixon Readi-Ride should be able to operate its demand response service with no or minimal impact.

However, this analysis does not consider HVAC usage, slope, and other service area-specific variables that can significantly impact the vehicle's efficiency and range. For this reason, it is recommended that more specific vehicle travel information be analyzed and/or a demonstration pilot be conducted to gauge real-world performance.

5.5.2 Power and Energy Upgrades

Based on the analysis, it is recommended for Dixon Readi-Ride to install at least four 150 kW DC chargers for the current service with managed charging to keep the peak demand low. An additional charger will be needed to future-proof the site for fleet expansion. Managed charging will reduce overall utility costs due to the lower peak demand and also reduce capital costs because of the smaller equipment upgrades required.

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Dixon Readi-Ride would be responsible for installing the switchboard, utility metering cabinet, underground conduit, and charging stations.

The next immediate steps for Dixon-Readi Ride are:

1. Decide whether to invest in a charge management system.
2. Begin service application and coordination with PG&E to request new service for the calculated load
3. Determine outage mitigation methods. If a backup generator is selected, include the design and procurement in engineering and construction scope.
4. Procure long-lead items.
5. Begin construction.

5.5.3 ZEB Transition Plan

Facility Concept

The Dixon Readi-Ride facility concept supports ten charging positions. Five DC charging cabinets and 10 DC plug-in dispensers are needed to support the fleet. Plug-in charging was determined to be the most suitable method of charging since the fleet solely consists of cutaway vehicles.

Several considerations important for Dixon Readi-Ride facility improvements are:

- Due to cutaway vehicles typically being equipped with charging ports at the front of the vehicle, operators will have to pull forward into the parking spaces instead of backing into them. This will allow easier access between the dispenser and the vehicle charging port.
- The Public Works vehicles may also transition to battery-electric in the future. Therefore, the proposed infrastructure should be installed with consideration to future expansion.
- Although it is not anticipated to be an issue, the weight of the future vehicles should be specified in accordance with the existing vehicle lift capacity. If a heavier vehicle is specified, then the existing vehicle lifts will need to be upgraded.

Phasing Schedule

Due to the relatively small fleet size and the proposed configuration of the improvements, it is recommended that all on-site improvements be constructed in a single stage. The vehicle parking in front of the maintenance building will need to be relocated until the frame construction is completed.

Based on the assumed duration, Dixon Readi-Ride's electrification transition will take 27 months, with an estimated completion date in September 2024 – assuming that the development of the design procurement begins in July 2022.

To align the delivery of new vehicles with charger availability, the first round of vehicle procurement will be delivered in October 2024, after the completion of the facility's improvements. The developed procurement timeline assumes that vehicles will be purchased in two sets of four vehicles. The fleet will be fully ZE by 2025.

Cost And Funding

Based on the lifecycle cost analysis, the total cash cost of operating a full BEB fleet is approximately $8M, 56% higher than if Dixon Readi-Ride continued to operate a full gasoline fleet. This is due to the significantly higher capital costs. The costs difference goes down to 53% when considering the environmental costs of a full ICE fleet.

Overall, some of these fleet electrification investments can be funded through existing capital revenues outlined in the agency's FY 2021-2030 SRTP adopted in 2020 as outlined in Table 5.6. There are also additional funding sources through federal, state, regional, and other grant opportunities that can be explored to fill the estimated funding gap. This analysis only considers the capital costs needed based on the phasing schedule developed in sections 5.4.2 and 5.4.3 (for the BEB fleet) and the potential funding sources for capital projects. Strategies for addressing the identified gaps are discussed in sections 9 and 11.5.2.

Table 5.6 Dixon Readi-Ride Estimated Costs and Funding Shortfall by Year (in millions of YOE$)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Estimated Capital Costs	$0.00	$0.00	$2.38	$1.87	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$4.25**
Potential Funding Identified in SRTP	$0.00	$0.00	$0.19	$0.00	$0.00	$0.10	$0.00	$0.11	$0.00	$0.12	**$0.52**
Other Potential Existing Capital Revenues	$0.29	$0.29	$0.26	$0.23	$0.23	$0.21	$0.20	$0.17	$0.11	$0.12	**$2.09**
Surplus / Gap	$0.29	$0.29	-$1.94	-$1.64	$0.23	$0.31	$0.20	$0.28	$0.11	$0.24	**-$1.65**

Source: WSP

RIO VISTA

DELTA BREEZE

6 RIO VISTA DELTA BREEZE

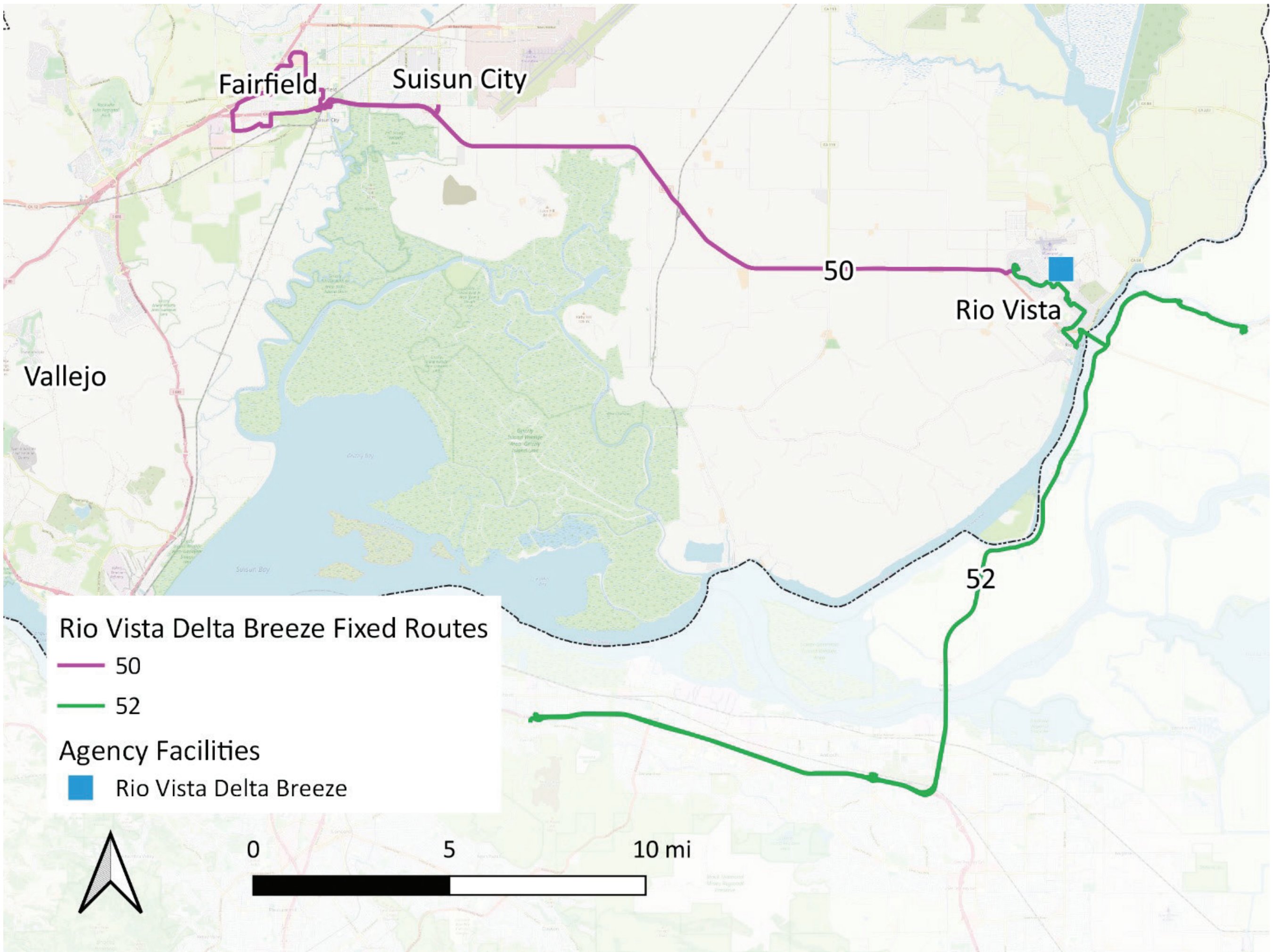
The following sections present Rio Vista Delta Breeze's existing conditions, service modeling results, power and energy analysis, facility concepts, phasing strategies, and cost and funding analysis to support the agency's ZEB transition.

6.1 Existing Conditions

6.1.1 Existing Service

Rio Vista Delta Breeze offers both demand response and deviated fixed-route services (in which actual stops on the route may vary from set designated stops) administered by the City of Rio Vista with service provided by STA in partnership with a contractor. The service area includes the City of Rio Vista and between Isleton, Rio Vista, Fairfield, Suisun City, Pittsburg/Bay Point Bay Area Rapid Transit (BART) station and Antioch with connections to Lodi (Figure 6.1). The hours of operation are generally Monday - Friday from 7:30 AM - 5:50 PM.

Figure 6.1 Rio Vista Delta Breeze Fixed Routes



Source: Metropolitan Transportation Commission, OpenStreetMap Contributors

The Rio Vista Delta Breeze fleet consists of one gasoline-powered van and four gasoline-powered cutaways (Table 6.1). The vehicles were put into service between 2011 and 2018.

Table 6.1 Summary of Rio Vista Delta Breeze's Existing Fleet

Bus Type	Length	Fuel Type	In Service Year	Quantity
Van	12'	Gasoline	2011	1
Cutaway	22'	Gasoline	2012	1
	25'	Gasoline	2013-2018	3
			Total Vehicles	**5**

Source: Rio Vista Short Range Transit Plan Fiscal Year 2021 – Fiscal Year 2030 Service Blocks

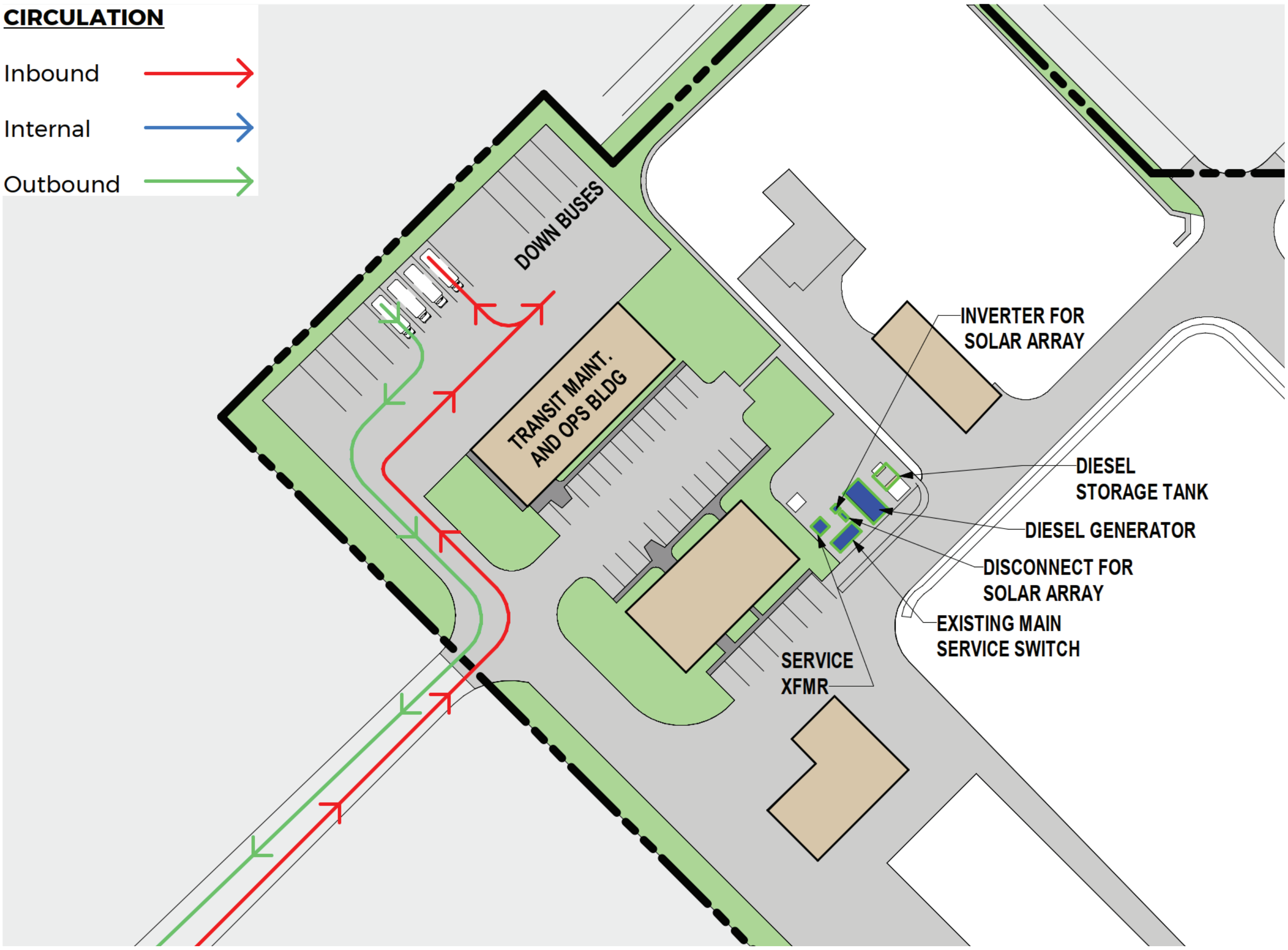
Note: A detailed list of Rio Vista Delta Breeze Existing Fleet is available in Appendix A: *Existing Conditions Report*

6.1.2 Existing Facility Conditions

The Rio Vista Delta Breeze facility is located at 3000 Airport Road (Figure 6.2). The transit operations share the site with the City of Rio Vista Northwest Wastewater Treatment Plant, and despite having a relatively small, dedicated portion of the overall site, transit operations still have adequate room to support the fleet. Maintenance and operations are all contained within the single building, with the maintenance bays accessed from the transit yard and the operations accessed from the employee parking on the east.

The operations could easily expand with minimal effort, and there is adequate room to accommodate electrification infrastructure. There are no planned modifications to the transit facilities at this time.

Figure 6.2 Rio Vista Delta Breeze Existing Facility and Site Circulation



Source: WSP

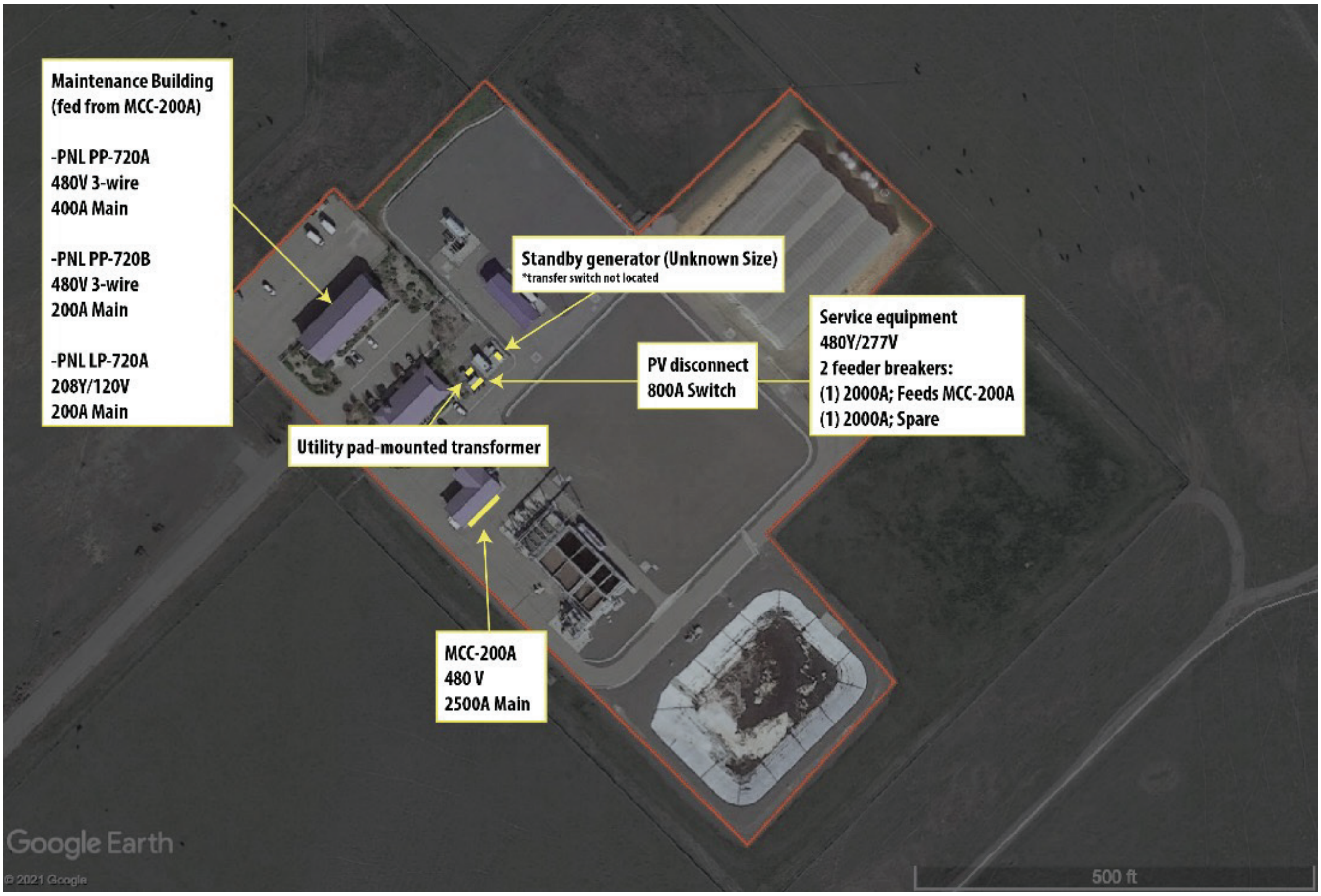
6.1.3 Existing Power and Energy Conditions

Rio Vista Delta Breeze's power is provided by the PG&E Grand Island Substation (6246), which has a capacity of 44.5 MW on Bank 3, with a peak load of approximately 14.6 MW (based on publicly available data). This substation feeds the Grand Island 2226 feeder circuit that feeds the Rio Vista Delta Breeze Yard. The Grand Island 2226 Circuit is a 21 kV circuit with an existing capacity of 18 MW. PG&E estimates that the projected peak load of this circuit is 10 MW, leaving approximately 8 MW of available capacity.

On-site electrical infrastructure includes a utility pad-mounted transformer, a small 75 kVA pad-mounted transformer, the main switchboard (labeled as MCC-200A), two feeder breakers, three panelboards, and one standby generator (Figure 6.3). Appendix C: *Power and Energy Report* provides detailed information on the equipment mentioned.

This site is shared with the wastewater treatment plant, whose electrical loads could be significant. Thus, future coordination with the water treatment plant on any equipment upgrades or changes will be needed.

Figure 6.3 Rio Vista Delta Breeze's Utility Plan View



Source: WSP

6.2 Service Modeling

6.2.1 Fixed-Route Service

Rio Vista Delta Breeze currently operates cutaway buses for their fixed-route services. Rio Vista Delta Breeze has two local service routes that are operated with four vehicle blocks ranging from 58 to 134 miles. The average vehicle block distance is 83 miles.

For the "typical" and "conservative" and "EWL" scenarios, three of the four blocks could be completed by a single-cutaway BEB. Table 6.2 presents a summary of the energy demands for the passing blocks. Even under worst-case scenarios reflected in the conservative scenario, the passing blocks only require 68 kWh on average (72% of the battery capacity) to complete the service.

It is assumed that each block is operated by a single vehicle. The "Efficiency Change" column shows how much the efficiency has declined from the baseline of 0.79 kWh/mile due to the additional consumption factors (e.g., HVAC and slope). The higher efficiency change in the conservative scenario reflects the higher energy used to operate HVAC in extreme weather and the less efficient regenerative braking system.

Table 6.2 Rio Vista Delta Breeze – Summary of Passing Blocks

Scenario	Passing Blocks	Avg. Distance (miles)	Avg. Required Battery Capacity (kWh)	Avg. State of Charge Remaining	Avg. Efficiency Change (kWh/mi)
Typical	3	66	56	41% (39 kWh)	0.05
Conservative	3	66	68	28% (26 kWh)	0.23

Source: WSP

Table 6.3 presents a summary of the energy demands for the failing blocks. Block 1 is the only failing block in both scenarios (and the EWL typical and conservative scenarios). At 134 miles, Block 1 is just within the stated range of the BEB; however, due to variables such as stops, slope, and weather, the battery efficiency is only sufficient to complete 81% and 61% of the block under the typical and conservative scenario, respectively.

Table 6.3 Rio Vista Delta Breeze – Summary of Failing Blocks

Scenario	Failing Blocks	Avg. Distance (miles)	Avg. Required Battery Capacity (kWh)	Avg. % of Block Completed	Avg. Efficiency Change (kWh/mi)
Typical	1	134	117	81%	0.08
Conservative	1	134	154	61%	0.36

Source: WSP

Based on the fleet estimated charging time, strategic vehicle-to-block assignments may mitigate the need to increase the vehicle replacement ratio for the failing block. For example, one of the other three vehicles can pull out to complete the failing block's service once sufficiently charged.

6.2.2 Demand Response Service

Since the vehicle miles traveled for demand response services are variable, the Lightning Bolt model could not be used to assess block performance. In lieu of this, WSP conducted a high-level analysis of range expectations using the daily and maximum mileage traveled by the fleet.

Based on the average travel speeds (calculated from data provided in the SRTP and an assumed eight or 10-hour vehicle operator shift), the average daily vehicle distance is between 90 and 113 miles. The GreenPower EV Star – a representative BEB replacement for Rio Vista Delta Breeze's existing vehicles - has an advertised range of 150 miles.

Based on the comparison between the advertised range of existing battery electric cutaways and the service's average daily vehicle distance, Rio Vista Delta Breeze should be able to operate its demand response service with no or minimal impact. Even with consideration to a 20% safety buffer, the advertised range of the BEB still exceeds the average distance traveled for its demand response service. However, under

EWL battery conditions (64% advertised capacity), the expected vehicle range is at or below the calculated average daily vehicle distance.

However, it should be noted that this estimate does not consider HVAC usage, slope, and other service area-specific variables that can significantly impact the vehicle's efficiency and range. For this reason, it is recommended that more specific vehicle travel information be analyzed and/or a demonstration pilot be conducted to gauge real-world performance.

6.3 Power and Energy Analysis

The Rio Vista Delta Breeze fleet currently consists of five gas vehicles: one van and four cutaways. The transit agency hopes to double its fleet with four additional 35-foot buses in the future. This analysis calculated the electrical requirements both with and without the addition of the four future buses.

The analysis evaluates the fleet under an unmanaged and managed charging scenario. In both scenarios, Rio Vista Delta Breeze fleet operators would begin charging all cutaways and buses at 9:00 PM. In the unmanaged charging scenario, all vehicles will charge concurrently at the same time, with half of the full charging power for each vehicle. Meanwhile, the managed charging scenario assumes that each vehicle will charge sequentially before switching to the next vehicle. This scenario will reduce the peak demand power required but will result in a longer charging time. However, because BEBs are charging at the same rate during non-peak hours, the longer time should not affect the total energy (kWh) utility cost.

Existing Fleet

To service four existing cutaways, it is recommended that two 150 kW DC chargers be installed. The recommendation is for Rio Vista Delta Breeze to do managed charging. Managed charging will reduce the peak demand from 300 kW in the unmanaged scenario to 75 kW. It will reduce overall utility costs due to the lower peak demand and reduce capital costs because of the smaller equipment upgrades required.

Future Fleet

In this scenario, the site is expected to have four 150 kW chargers to charge the four cutaways and four future 35-foot buses. The cutaways will all finish charging within 2.1 hours, and the 35-foot buses will finish charging within 7.4 hours. Managed charging will reduce the peak demand from 600 kW in the unmanaged scenario to 375 kW.

The summary of all charging scenarios for existing and future fleets is shown in Table 6.4.

Table 6.4 Summary of Rio Vista Delta Breeze Charging Scenarios

Fleet	Min. Required # of Chargers	Scenario	Charge Schedule	Charge Rate (per vehicle)	Peak Demand	Required Power Increase*
Current Fleet	Two 150 kW DC chargers	Unmanaged	All BEBs charging concurrently	67.5 kW	300 kW	330 kW
		Managed	Each BEB charges sequentially	67.5 kW	75 kW	165 kW[26]
Future Fleet	Four 150 kW DC chargers	Unmanaged	All BEBs charging concurrently	67.5 kW	600 kW	660 kW
		Managed	Each BEB charges sequentially	67.5 kW	375 kW	415 kW (suggested)

Source: WSP

*Note: Required power increase includes 10% buffer for ancillary loads and losses

Power and Energy Upgrades

Regardless of the existing or future fleet, the recommendation is to purchase a charge management system and use managed charging. The transit agency should request at least 415 kW of peak power which supports the future fleet needs, and the managed charging demand that accounts for a 10% buffer for ancillary loads and losses. If necessary, two 150 kW DC fast chargers can be used at full speed for flexible mid-day recharging. This would allow up to four cutaway vehicles and four 35-foot buses to fully recharge each night using managed charging.

Based on the analysis, the following facility electrical upgrades are required, assuming the worst-case scenario of unmanaged charging:

- 750 kVA transformer fed by new 12 kV underground conductor
- 480V service entrance main switchboard with a minimum electrical rating of 1200 A and utility metering cabinet
- Underground conduit from the location of the new transformer to the location of the new 480V switchgear
- Underground electrical conductor in conduit from the new transformer to new 480V switchgear
- Vehicle charging cabinets along with underground conduit connecting the charging stations to the new 480V switchgear

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Rio Vista Delta Breeze would be responsible for installing switchboard, utility metering cabinet, underground conduit, and charging stations. Managed charging is strongly recommended, and electrical equipment properties should be determined during the detailed engineering phase based on discussions with PG&E and the level of electric service requested.

26 Since each charger is capable of providing 150 kW, the minimum new electrical service must be capable of supplying at least this much power.

Energy resiliency at the site is key to ensuring Rio Vista Delta Breeze service delivery once transitioning to a full BEBs fleet. One or more of the strategies below provide a suitable level of backup power after considering the possible resiliency issues that the site might experience[27]:

- 400 kW permanent standby generator
- 300 - 600 kW Solar PV system paired with 1 - 2 MWh BESS in 10' – 40' intermodal container

A generator with an output rating of at least 400 kW can power two 150 kW DC charging cabinets simultaneously and fully recharge all vehicles overnight.

6.4 ZEB Transition Plan

6.4.1 Facility Concepts

The Rio Vista Delta Breeze facility concept supports eight charging positions. Positions are planned for the ZEVs that will replace the existing four cutaway vehicles while also leaving room for four additional vehicles in the future. Four DC charging cabinets and eight DC ground-mounted plug-in dispensers will be needed to support the fleet. The number of dispensers required can decrease through further evaluation of the buses' charging window and end-of-the-day SOC. Plug-in charging was determined to be the most suitable method of charging since the fleet solely consists of cutaway vehicles.

Table 6.5 provides an overview of the proposed charging and utility infrastructure. For additional details, refer to Appendix D: *BEB Facility Concepts Report*. Figure 6.4 illustrates the proposed facility concept to support the electrification transition.

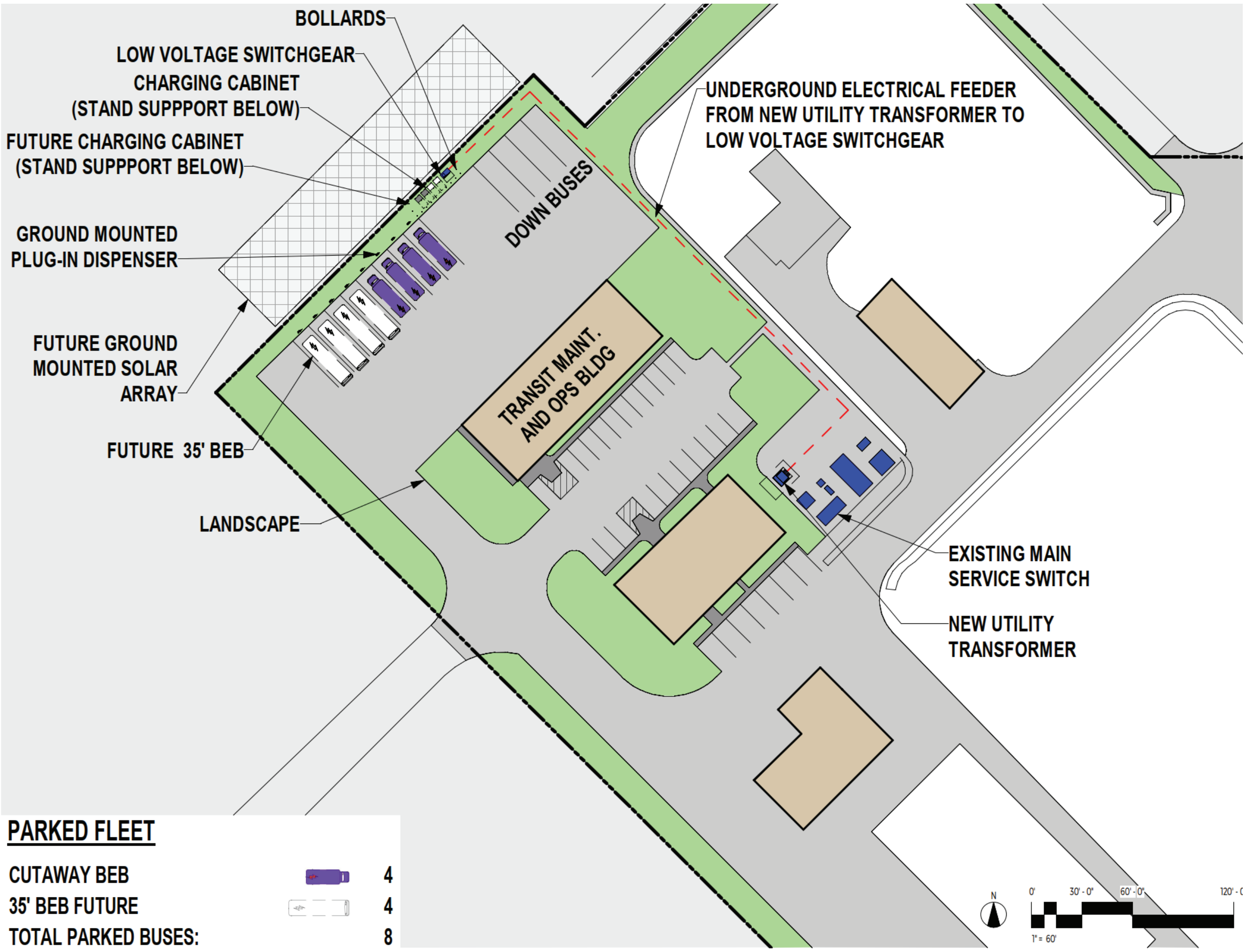
Table 6.5 Rio Vista Delta Breeze Recommended Infrastructure

Item	Quantity
150 kW DC Charging Cabinet	4
Plug-in DC Dispenser	8
Plug-in DC Dispenser in Maintenance Area	1
Transformer	1
Switchboard	1

Source: WSP

27 Appendix C: *Power and Energy Report* provides in-depth resiliency analysis for the site

Figure 6.4 Rio Vista Delta Breeze Preliminary Facility Concept



Source: WSP

6.4.2 Construction Schedule

Due to the relatively small fleet size and the proposed configuration of infrastructure installation, it is recommended that all on-site improvements be constructed in a single stage. However, the charging cabinets and associated dispensers could be procured and installed in stages to better align with a desired bus procurement schedule.

The planned infrastructure improvements can occur outside the current bus parking area, ensuring that all construction activities can occur without impacting existing operations.

Based on the assumptions, Rio Vista Delta Breeze's electrification transition will take 27 months, with an estimated completion date in September 2024 – assuming that the development of the design procurement begins in July 2022. Table 6.6 illustrates the proposed schedule.

Table 6.6 Rio Vista Delta Breeze Construction Schedule

	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Utilities							18 months																				
Design Procurement	6 months																										
Design							11 months																				
Construction Procurement															6 months												
Construction																					7 months						

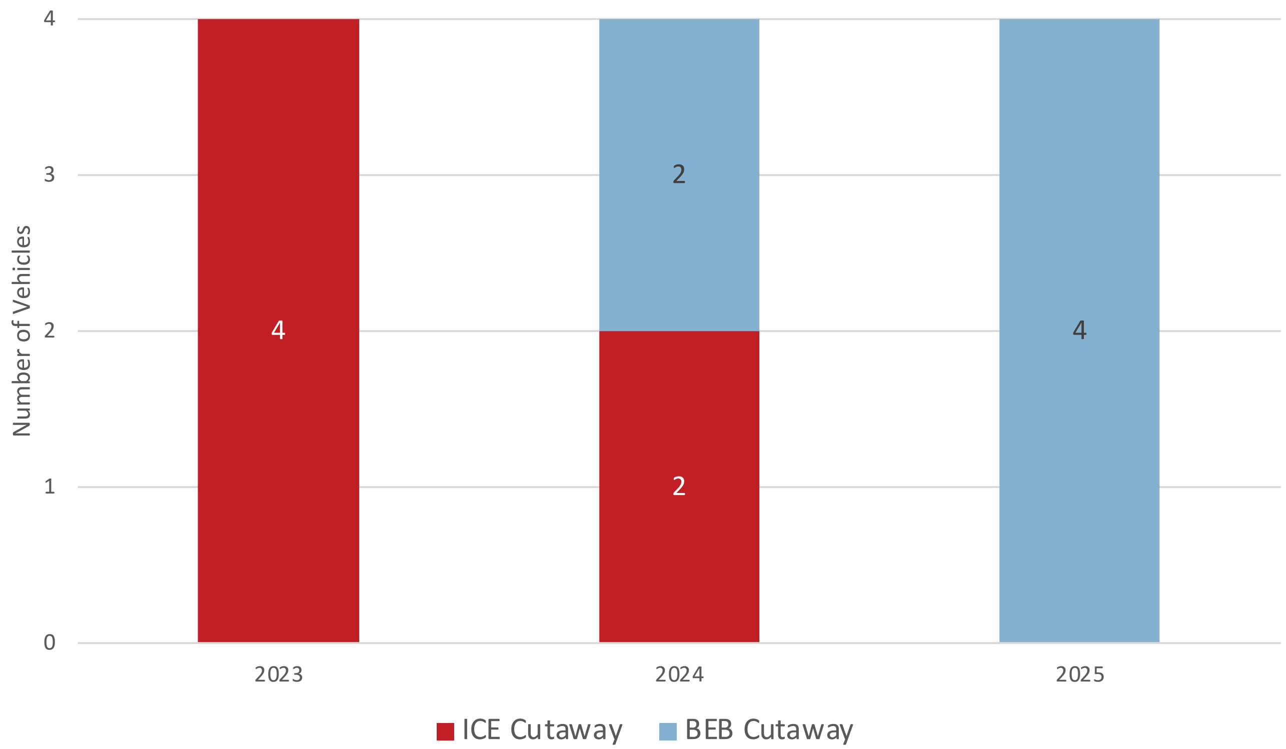
Source: WSP

6.4.3 Vehicle Procurement Schedule

It is essential that the delivery of new vehicles align with or after the completion of construction, given that the vehicles cannot be operated until chargers are installed. Therefore, the first delivery of battery-electric cutaways will not occur until October 2024. The fleet will be fully electric by 2025.

The developed procurement timeline assumes that vehicles will be purchased in two sets of two vehicles. This approach will help ease the transition so that Rio Vista Delta Breeze has the flexibility of continuing to operate ICE cutaways for a short period of time while the new ZE vehicles are delivered. This approach will also help ensure that any mid-life maintenance will not occur for the entire fleet at the same time. Figure 6.5 illustrates Rio Vista Delta Breeze's fleet mix over time (between ICE and ZEB vehicles).

Figure 6.5 Rio Vista Delta Breeze Fleet Mix



Source: WSP

6.4.4 Lifecycle Costs Analysis

Based on the lifecycle cost analysis, the total cash cost (including capital, O&M, disposal and excluding environmental costs) of operating a full BEB fleet is approximately $4.4M, 58% higher than if Rio Vista Delta Breeze continued to operate a full gasoline fleet. This is due to the significantly higher capital costs. The total vehicle capital costs (with modification) are $1.2M for BEB compared to $0.6M for ICEB. Furthermore, the total charging/fueling infrastructure capital costs are $1.2M for BEB and $0 for ICEB fleet because Rio Vista Delta Breeze currently does not have any fueling infrastructure on-site.

However, the lifecycle environmental costs for gasoline fleet are approximately $0.2M higher than a full BEB fleet, which will bring the total cash and non-cash costs difference between the two fuel types down to 45%. The total lifecycle cash and non-cash costs are $2.73/mile and $3.96/mile for ICE and BEB fleets, respectively.

Table 6.7 provides the summary of the lifecycle cost analysis.

Table 6.7 Lifecycle Cost (2021-2037) Analysis Results for Rio Vista Delta Breeze (in millions of YOE$)

Cost Categories	"No Build" Scenario	"Build" BEB Scenario
Cash Costs		
Total Capital Costs	$0.63	$2.46
Total Operating Costs	$2.18	$1.94
Total Disposal Costs	-$0.03	-$0.03
Total Cash Cost	$2.77	$4.37
Non-Cash Costs		
Total Environmental Costs	$0.33	$0.13
Total Cash and Non-Cash Costs	$3.10	$4.50
Total Cash and Non-Cash Costs per Mile	**$2.73**	**$3.96**

Source: WSP

Note: The total costs may vary due to rounding. Refer to Appendix F: *Cost and Funding Report* for a detailed breakdown of each item.

6.5 Findings and Next Steps

6.5.1 Service Feasibility

Only one of the four blocks failed for fixed-route service in both the typical and the conservative scenarios (Block 1). Based on the existing service schedule and assumed charging times, there is an opportunity for Rio Vista Delta Breeze to utilize one of the available service vehicles to complete Block 1 by scheduling an additional pull-out. While this will require additional analysis and cost considerations, this would allow Rio Vista Delta Breeze to maintain a 1:1 fleet replacement ratio.

If an additional pull-out to complete Block 1 is not viable, there are several other considerations to meet the service:

- Additional Service changes
- Wait for advancements in BEB technology
- Select a vehicle that has a higher battery capacity than the average used in the model
- Opportunity charging

For demand response, existing technology appears to be sufficient to meet the average daily range requirements of Rio Vista Delta Breeze; however, it is difficult to forecast specific consumption factors due to the variability of vehicle travel on a daily basis.

It should be noted that technology is rapidly evolving, and modeling may not reflect actual performance – especially when it is time to procure vehicles. Demonstration pilots and real-world applications are recommended in order to assess actual performance.

6.5.2 Power and Energy Upgrades

Based on the analysis, it is recommended that Rio Vista Delta Breeze purchase a charge management system and use managed charging to keep the required peak demand relatively low, depending on the future bus fleet. Managed charging will reduce overall utility costs due to the lower peak demand and also reduce capital costs because of the smaller equipment upgrades required.

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Rio Vista Delta Breeze would be responsible for installing switchboard, utility metering cabinet, underground conduit, and charging stations.

It is important to note that the Rio Vista Delta Breeze site is shared with an adjacent water treatment facility that may have spare capacity on the existing electrical service. However, the spare capacity may already be allocated to future upgrades to the water treatment facility, so this report considered the possibility of installing a new electrical service to power the vehicle fleet.

Rio Vista Delta Breeze needs to first evaluate their options and take the next immediate steps:

1. Decide whether to invest in a charge management system or not
2. Size the site for future fleet or existing fleet
3. Request the appropriate load from PG&E
4. Begin service application and coordination with PG&E
5. Determine outage mitigation methods. If a backup generator is selected, include the design and procurement in engineering firm RFP
6. Bid out to local engineering firm for detailed design
7. Procure long-lead items
8. Begin construction to point of contact with utility

6.5.3 ZEB Transition Plan

Facility Concept

The Rio Vista Delta Breeze facility concept supports eight charging positions. Four DC charging cabinets and eight DC ground-mounted plug-in dispensers will be needed to support the fleet. Plug-in charging was determined to be the most suitable method of charging since the fleet solely consists of cutaway vehicles.

Several considerations important for Rio Vista Delta Breeze facility improvements are:

- During the detailed design phase of the charging equipment implementation, the electrical utility service enhancements to support the bus charging infrastructure will need to be carefully coordinated between Rio Vista Delta Breeze, PG&E, and the City of Rio Vista Northwest Wastewater Treatment Plant.

- Although it is not anticipated to be an issue, the weight of the future vehicles should be specified in accordance with the existing vehicle lift capacity. If a heavier vehicle is specified, then the existing vehicle lifts will need to be upgraded.

Phasing Schedule

Due to the relatively small fleet size and the proposed configuration of the improvements, it is recommended that all on-site improvements be constructed in a single stage. Construction can occur without impact on existing operations.

Based on the assumed duration, Rio Vista Delta Breeze's electrification transition will take 27 months, with an estimated completion date in September 2024 – assuming that the development of the design procurement begins in July 2022.

To align the delivery of new vehicles with charger availability, the first round of vehicle procurement will be delivered in October 2024, after the completion of the facility's improvements. The developed procurement timeline assumes that vehicles will be purchased in two sets of two vehicles. The fleet will be fully ZE by 2025.

Cost and Funding

Based on the lifecycle cost analysis, the total cash cost of operating a full BEB fleet is approximately $4.4M, 58% higher than if Rio Vista Delta Breeze continued to operate a full gasoline fleet. This is due to the significantly higher capital costs. The costs difference goes down to 45% when considering the environmental costs of a full ICE fleet.

Overall, some of these fleet electrification investments can be funded through existing capital revenues outlined in the agency's FY 2021-2030 SRTP adopted in 2020 as outlined in Table 6.8. There are also additional funding sources through federal, state, regional, and other grant opportunities that can be explored to fill the estimated funding gap. This analysis only considers the capital costs needed based on the phasing schedule developed in sections 6.4.2 and 6.4.3 (for the BEB fleet) and the potential funding sources for capital projects. Strategies for addressing the identified gaps are discussed in sections 9 and 11.5.2.

Table 6.8 Rio Vista Delta Breeze Estimated Costs and Funding Shortfall by Year (in millions of YOE$)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Estimated Capital Costs	$0.00	$0.00	$1.41	$1.05	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$2.46**
Potential Funding Identified in SRTP	$0.00	$0.98	$0.00	$0.00	$0.00	$0.45	$0.00	$0.12	$0.00	$0.00	**$0.66**
Other Potential Existing Capital Revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
Surplus / Gap	$0.00	$0.98	-$1.41	-$1.05	$0.00	$0.45	$0.00	$0.12	$0.00	$0.00	**-$1.80**

Source: WSP

SolTrans

7 SOLANO COUNTY TRANSIT

The following sections present SolTrans' existing conditions, service modeling results, power and energy analysis, facility concepts, phasing strategies, and cost and funding analysis to support the agency's ZEB transition.

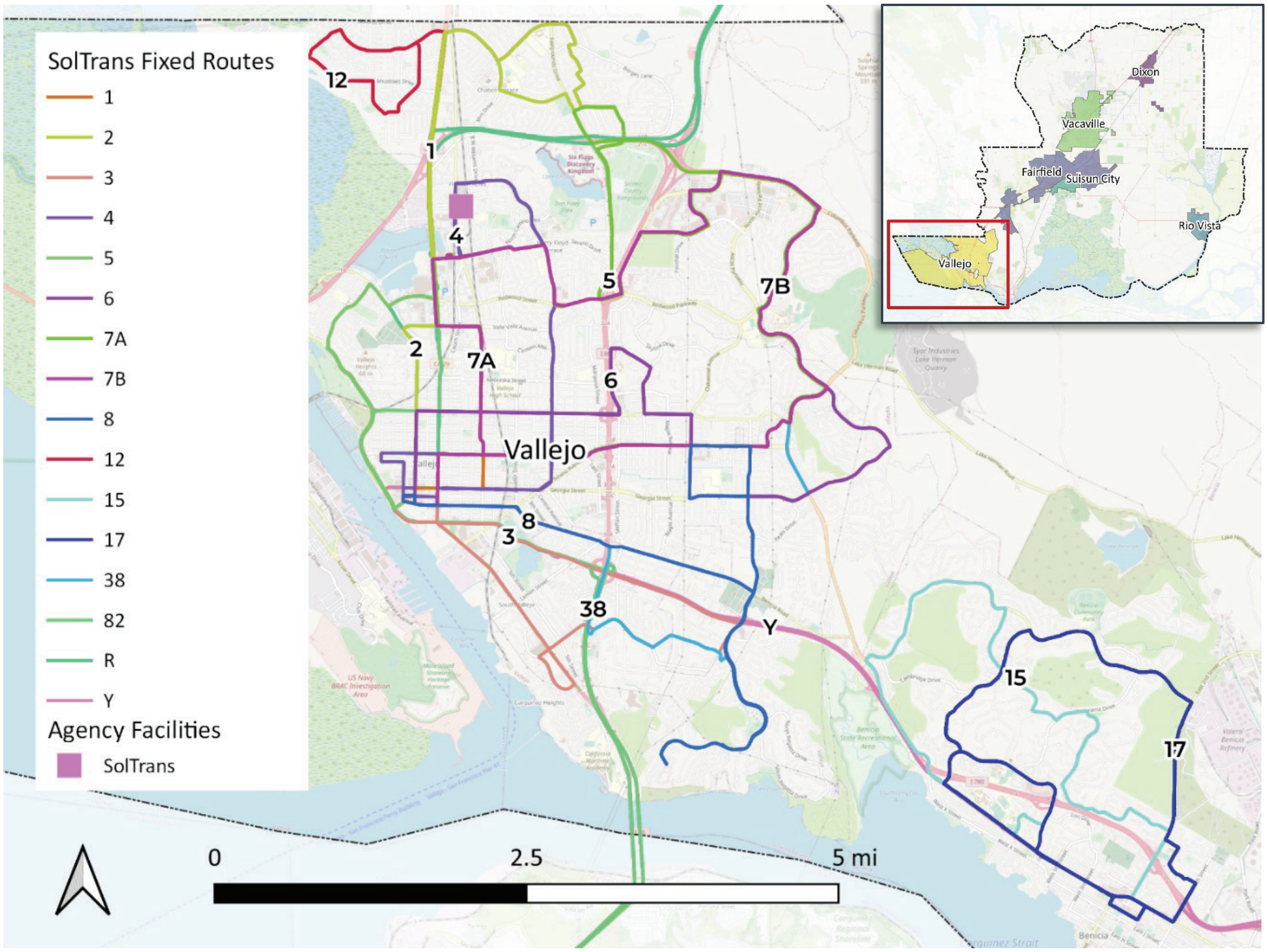
7.1 Existing Conditions

7.1.1 Existing Service

Solano County Transit (SolTrans) is a Joint Powers Authority (JPA) run by its own Board of Directors and consists of Benicia, Vallejo, and STA. It provides the highest volume of Solano County's intercity service that serves East Bay's BART stations, the San Francisco (SF) Bay ferry terminal in Vallejo, Napa Vine bus stops, and Contra Costa County transit systems (Figure 7.1). It also offers local transit to the cities of Benicia and Vallejo and connects with FAST at key locations. Local service is generally offered from 5:30 AM to 8:30 PM during the week, with limited routes and headways on weekends.

In addition to the local service, SolTrans offers two intercity services – SF Express and SolanoExpress, which FAST and SolTrans jointly manage. The SolanoExpress routes are not a part of this study as they are being evaluated under other related projects.

Figure 7.1 SolTrans Fixed Routes



Source: Metropolitan Transportation Commission, OpenStreetMap Contributors

The SolTrans fixed-route fleet consists of 59 buses and an additional coach bus that is loaned to FAST. There are 27 standard 40-foot buses, 14 cutaways, and 19 motorcoaches (Table 7.1). One of the buses runs on diesel, 21 are diesel hybrid, two are BEBs, 20 are compressed natural gas (CNG), and 15 are gasoline-powered cutaways. The vehicles were put in service from 2001 through 2019.

Table 7.1 Summary of SolTrans Existing Fleet

Bus Type	Length	Fuel Type	In Service Year	Quantity
Cutaway	24'	Gasoline	2016	3
	26'	Gasoline	2011	6
	Unknown	Gasoline	2018-2019	5
Standard Bus	40'	Diesel	2001	1
	40'	Diesel Hybrid	2011	21
	40'	Battery Electric	2016	4
	40'	CNG	2016	1
Coach	45'	CNG	2003-2019	19
			Total Vehicles	**60**

Source: 2020 Revenue Fleet Listing

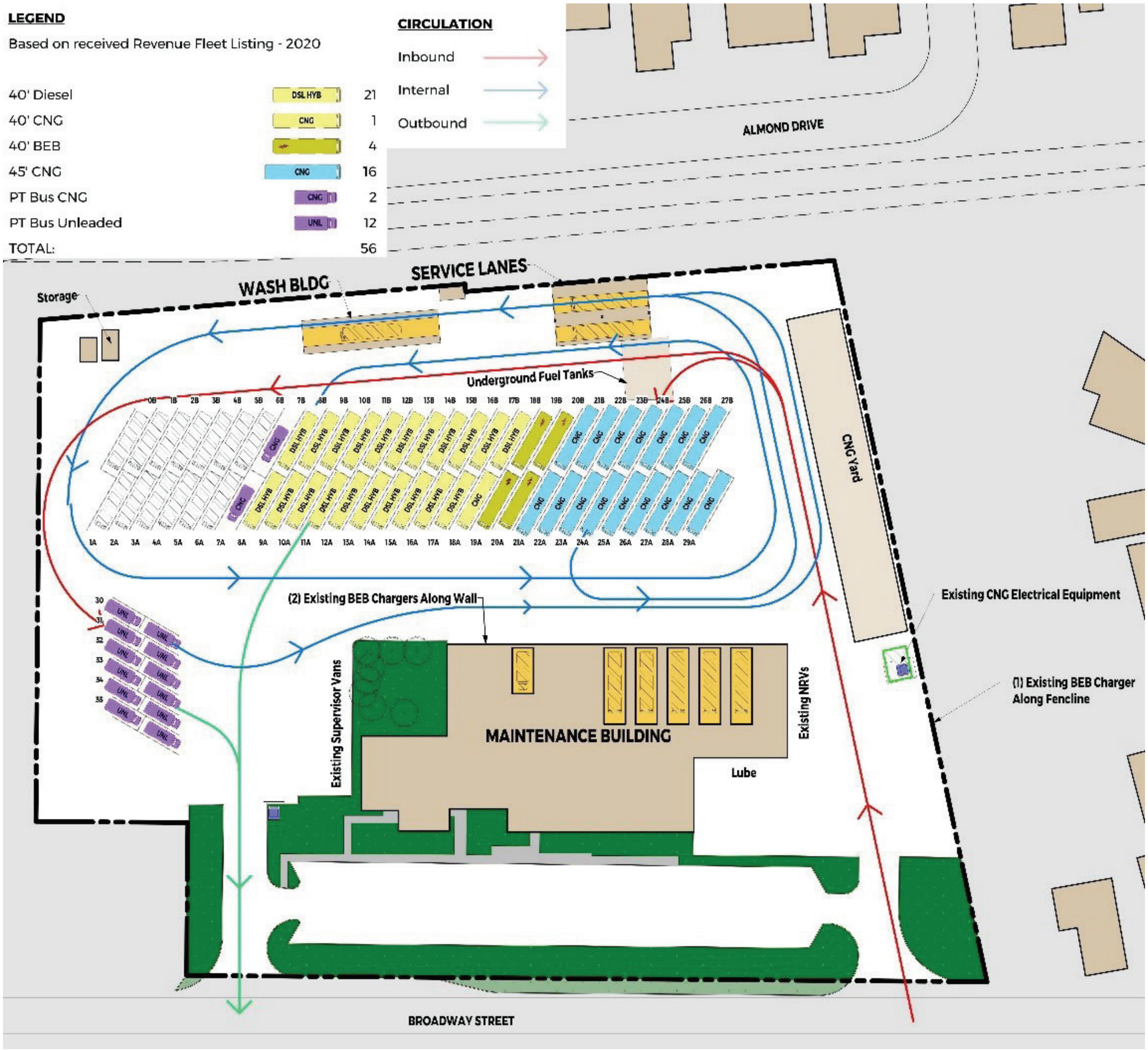
Note: A detailed list of SolTrans Existing Fleet is available in Appendix A: *Existing Conditions Report*

7.1.2 Existing Facility Conditions

The SolTrans facility is located at 1850 Broadway Street in Vallejo. The site consists of a joint maintenance and operations facility with five maintenance bays for buses and one for paratransit vehicles; a fuel island with two fuel lanes supplying diesel and CNG to buses and unleaded to non-revenue vehicles (NRVs) and paratransit buses; an associated CNG compression and storage yard; underground fuel tanks; a backup generator; BEB charging equipment area; employee parking; and bus parking (Figure 7.2). The site has four 80 kW AC BEB dispensers to charge SolTrans four existing BYD 40-foot BEBs.

SolTrans has developed a master plan for a full-BEB retrofit of the existing facility and is currently in the process of implementing Phase 1 of that plan.

Figure 7.2 SolTrans Existing Facility and Site Circulation



Source: WSP

7.1.3 Existing Power And Energy Conditions

SolTrans' power is provided by the PG&E Highway Substation (4265), which has a capacity of 44.6 MW on Bank 1, with a peak load of approximately 22.4 MW (based on publicly available data). This substation feeds the Highway 1106 feeder circuit that feeds the SolTrans yard. The Highway 1106 Circuit is a 12 kV circuit that has an existing capacity of 12.8 MW. PG&E estimates that the projected peak load of this circuit is 9.9 MW, leaving approximately 3 MW of available capacity.

Two electrical services serve the site. Appendix C: *Power and Energy Report* provides detailed information on the transformers, meters, switchboards, and generators associated with each service.

7.2 Service Modeling

7.2.1 Fixed-Route Service

SolTrans currently operates 40-foot buses for their fixed-route services. SolTrans' local service consists of 42 vehicle blocks ranging from eight to 201 miles. All but one block operates under 150 miles, the general range for existing BEBs. The average vehicle block miles traveled is 74 miles.

A single 40-foot BEB could complete 38 and 27 of the 42 blocks in the typical and conservative scenario, respectively. Table 7.2 summarizes the energy demands for the passing blocks. The "Efficiency Change" column shows how much the efficiency has declined from the baseline of 2.08 kWh/mile due to the additional consumption factors. The higher efficiency change in the conservative scenario reflects the higher energy used to operate HVAC in extreme weather and the less efficient regenerative braking system.

Table 7.2 SolTrans – Summary of Passing Blocks

Scenario	Passing Blocks	Avg. Distance (miles)	Avg. Required Battery Capacity (kWh)	Avg. State of Charge Remaining	Avg. Efficiency Change (kWh/mi)
Typical	38	67	165	36% (94 kWh)	0.38
Conservative	27	55	160	37% (97 kWh)	0.81

Source: WSP

Four blocks fail to complete the service block in the typical scenario. The failing blocks are some of the longest, both in distance and time. Meanwhile, 15 blocks fail in the conservative scenario. Table 7.3 presents a summary of the energy demands for the failing blocks. The average distances of the failing blocks in the typical and conservative scenarios are lower than the BEB's advertised range of 156 miles. However, due to variables such as stops, slope, and weather, the battery efficiency is insufficient to complete the whole block.

Table 7.3 SolTrans – Summary of Failing Blocks

Scenario	Failing Blocks	Avg. Distance (miles)	Average Block Duration (hours)	Avg. Required Battery Capacity (kWh)	Avg. % of Block Completed	Avg. Efficiency Change (kWh/mi)
Typical	4	137	11:50	341	81%	0.41
Conservative	15	107	9:48	317	85%	0.89

Source: WSP

Three blocks in the typical scenario and 12 blocks in the conservative scenarios fail after completing more than 80% of the blocks. These blocks can likely achieve completion with minor service changes or advancements in BEB technology. Moreover, based on the fleet charging analysis, strategic vehicle-to-block assignments may mitigate the need to increase the vehicle replacement ratio for the failing blocks, especially in the typical scenario.

When calculating the EWL scenario, more blocks cannot be completed with a 1:1 vehicle replacement using existing technology due to battery capacity degradation. Table 7.4 shows the number of completed and uncompleted blocks for typical and conservative EWL scenarios. There would be 11 fewer blocks that could be completed in the typical scenario, while nine fewer blocks would be completed in the conservative scenario. Thus, at the end of battery warranted life, the percentage of completed blocks compared to the total number of blocks are 64% and 43% for typical and conservative scenarios, respectively.

Table 7.4 SolTrans – Summary of EWL Scenarios

Scenario	Passing Blocks	Failing Blocks	Percent Passing
EWL Typical	27	15	64%
EWL Conservative	18	24	43%

Source: WSP

7.2.2 Demand Response Service

Since the vehicle miles traveled for demand response services are variable, the Lightning Bolt model could not be used. In lieu of this, WSP conducted a high-level analysis of range expectations using the daily and maximum mileage traveled by the fleet.

Based on the average travel speeds (calculated from data provided in the SRTP and an assumed eight or 10-hour vehicle operator shift), the average daily vehicle distance is between 75 and 90 miles. The GreenPower EV Star – a representative BEB replacement for SolTrans' existing vehicles – has an advertised range of 150 miles.

Based on the comparison between the advertised range of existing battery electric cutaways and the service's average daily vehicle distance, SolTrans should be able to operate its demand response service with no or minimal impact. Even with consideration to a 20% safety buffer, the advertised range of the BEB still exceeds the average distance traveled for its demand response service. However, under EWL battery conditions (64% advertised capacity), the expected vehicle range is just barely greater than the calculated average daily vehicle distance.

However, it should be noted that this estimate does not consider HVAC usage, slope, and other service area-specific variables that can significantly impact the vehicle's efficiency and range. For this reason, it is recommended that more specific vehicle travel information be analyzed and/or a demonstration pilot be conducted to gauge real-world performance.

7.3 Power and Energy Analysis

This site has been analyzed previously in a separate study of SolTrans' Phase 1 BEB transition and is currently in the design and bid phase. All information in this section is based on the previous report, with no additional analysis performed. Additionally, technical information presented in this section does not depict the SolTrans requirements as designed or as constructed. Requirements and specifications may have changed during the design & construction process and may not be reflected in this section.

7.3.1 Maintenance Facility Site Electrical Components

The SolTrans maintenance facility detailed design & engineering for phase 1 was completed in 2021. A summary of the electrical scope of work for phase 1 is elaborated below. Future phases will accommodate additional buses.

- Install new 480V electric service
- Install new main meter switchboard
- Construct approximately 50' of new underground electrical duct bank
- Construct approximately 300' of conduit
- Install four new 800A electric distribution panels
- Install one new 400A auxiliary electrical panel
- Install one new 100 kVA auxiliary transformer for lighting and control
- Install 21 new BEB charging cabinets with retractable plugs
- Add/Alternate: install a solar PV system
- Add/Alternate: install battery energy storage system

In terms of energy resiliency, SolTrans' needs to maintain the ability to operate from the maintenance facility site in the event of utility failure. The SolTrans conceptual design includes an add-alternate option to install up to two 2-megawatt hour batteries on the site, for a total of four megawatt-hours of battery storage. In addition to photovoltaic panels, the backup batteries will generate and store back up power for standard duration power failures (two hours).

7.3.2 Curtola Electrical Components

Phase 1 will include:

- New 12 kV service
- One new 500 kVA transformer
- One new site meter
- One new 750-amp switchboard
- One 300 kW ground-mounted induction charger pad and associated charging cabinet
- All required conduit and connections to distribute phase 1 power needs

7.3.3 Vallejo Transit Center Electrical Components

Phase 1 will include:

- New 12 kV service
- One new 1,500 kVA transformer to replace 750 kVA transformer (replacing the existing transformer)

- One new site meter
- One new 1,500-amp switchboard
- One new 45 kVA 480V/120V AUX transformer (one per switchgear)
- Two 300 kW ground-mounted induction charger pads and associated charging cabinets
- All required conduit and connections to distribute phase 1 power needs

The final phase will include the following in addition to the Phase 1 equipment:

- One 300 kW ground-mounted induction charger pad and associated charging cabinet
- One new 45 kVA 480V/120V AUX transformer (one per switchgear)
- All required conduit and connections to distribute ultimate phase power needs

7.4 ZEB Transition Plan

7.4.1 Facility Concept

The SolTrans facility concept supports 70 charging positions: 26 for 40-foot buses, 16 for coach buses, 14 for ZE cutaways, and 14 additional positions for future expansion. The number of dispensers required can decrease through further evaluation of the buses' charging window and end-of-the-day SOC. Overhead plug-in dispensers are shown in the masterplan drawing; however, this plan can also support the application of pantographs.

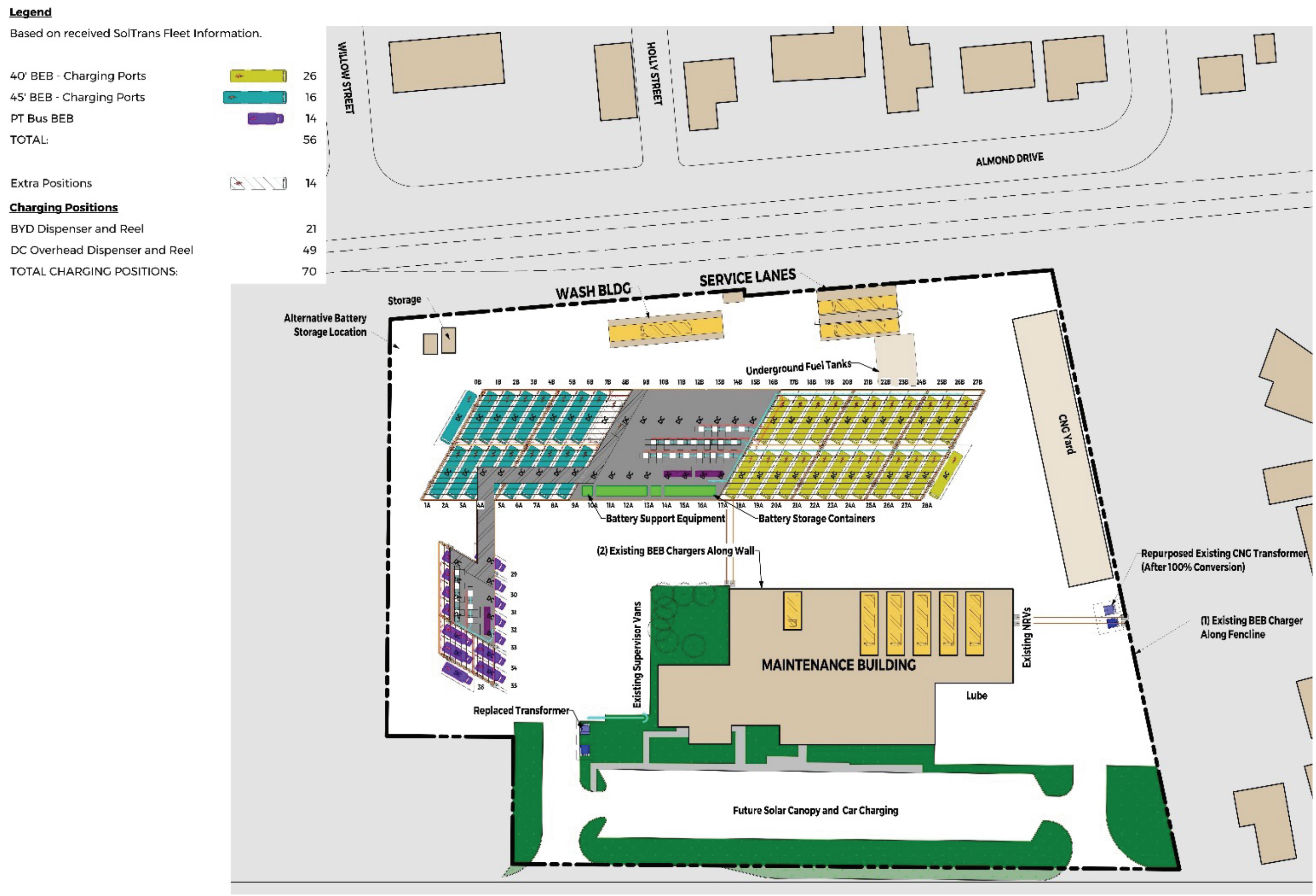
Table 7.5 provides an overview of the proposed charging and utility infrastructure. For additional details, refer to Appendix D: *BEB Facility Concepts Report*. Figure 7.3 illustrates the proposed facility concept to support the electrification transition.

Table 7.5 SolTrans Recommended Infrastructure

Item	Quantity
150 kW DC Charging Cabinet	25
80 kW AC Charging System	21
Plug-in DC Dispenser	49
Plug-in AC Dispenser	21
Cable Retractor	70
Transformer	4
Switchboard	3
2-Megawatt hour (MWh) Battery Backup	2

Source: WSP

Figure 7.3 SolTrans Preliminary Facility Concept



Source: WSP

7.4.2 Construction Schedule

The available funding is insufficient to support the installation of an entire overhead support structure, battery backup containers, and solar panels at the initial stage of implementation. As such, it was deemed most appropriate to develop the site in two separate stages.

Based on the assumed duration, SolTrans' electrification transition will take 39 months (over two stages), with an estimated completion date in May 2025. The first construction stage's design procurement and design steps have already been completed. Thus, the first step in this timeline is construction procurement. In order to sync up to the first construction stage, the utility upgrade request should be initiated in March 2022. Table 7.5 illustrates the proposed schedule. Appendix E: *Phasing Strategy and Transition Report* provide details for each construction stage.

Table 7.6 SolTrans Construction Schedule

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Source: WSP

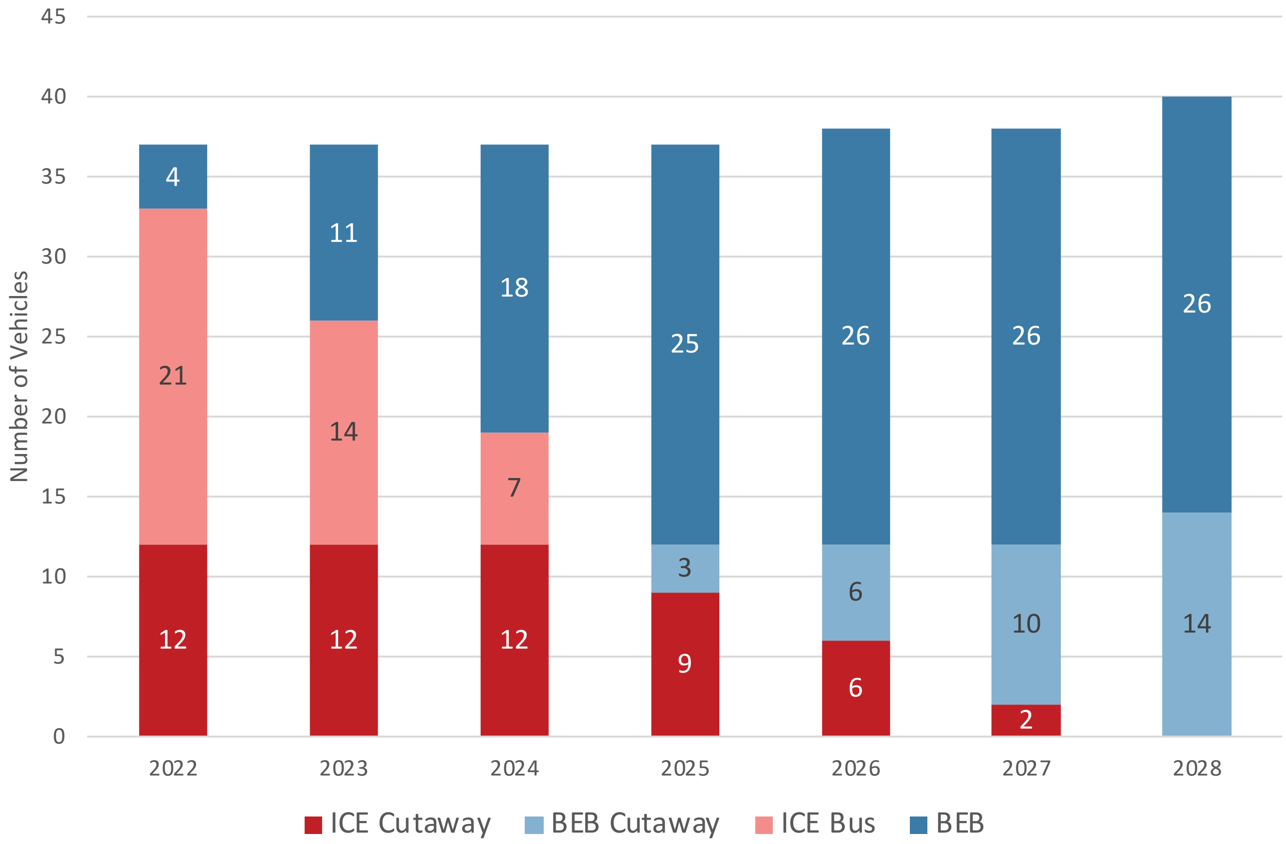
7.4.3 Vehicle Procurement Schedule

The delivery of new vehicles must align with or after the completion of construction, given that the vehicles cannot be operated until chargers are installed. The developed procurement timeline assumes that vehicles will be purchased in staggered sets of vehicles. This approach will help ease the transition so that SolTrans has the flexibility of continuing to operate ICE cutaways for a short period of time while the new ZE vehicles are delivered. This approach will also help ensure that any mid-life maintenance will not occur for the entire fleet at the same time.

The Stage 2 construction will add chargers for ZE cutaways (as well as coach buses). The ZE cutaways are shown in the procurement timeline to be purchased over the course of four years, with the transition completed by 2028.

Figure 7.4 illustrates SolTrans' fleet mix over time (between ICE and ZEB vehicles).

Figure 7.4 SolTrans Fleet Mix



Source: WSP

7.4.4 Lifecycle Costs Analysis

Based on the lifecycle cost analysis, the total cash cost (including capital, O&M, disposal, and excluding environmental costs) of operating a full BEB fleet is approximately $80M, 39% higher than if SolTrans continued to operate the current fleet. The total vehicle capital costs (with modification) are comparable between BEB and ICEB. Based on the cost estimates developed by M Lee Corporation, the total charging/fueling infrastructure capital costs are $19M for BEB and $7M for ICEB fleet. The fueling infrastructure costs for ICEB fleet assume that the CNG tank installed in 2016 will be replaced in 2036, the three diesel storage tanks of unknown age are assumed to be replaced in 2025, and the above ground storage tank installed in 2010 will be replaced in 2040.

However, the lifecycle environmental costs for the current ICEB fleet are approximately $2M higher than a full BEB fleet, which will bring the total cash and non-cash costs difference between the two fuel types down to 33%. The total lifecycle cash and non-cash costs are $6/mile and $7.96/mile for ICE and BEB fleets, respectively.

Table 7.7 provides the summary of the lifecycle cost analysis.

Table 7.7 Lifecycle Cost (2021-2037) Analysis Results for SolTrans (in millions of YOE$)

Cost Categories	"No Build" Scenario	"Build" BEB Scenario
Cash Costs		
Total Capital Costs	$37	$49
Total Operating Costs	$21	$31
Total Disposal Costs	-$0.2	-$0.2
Total Cash Cost	$58	$80
Non-Cash Costs		
Total Environmental Costs	$4	$2
Total Cash and Non-Cash Costs	$62	$82
Total Cash and Non-Cash Costs per Mile	**$6**	**$7.96**

Source: WSP and M Lee Corporation for Infrastructure Costs Estimate

Note: The total costs may vary due to rounding. Refer to Appendix F: *Cost and Funding Report* for a detailed breakdown of each item.

7.5 Findings and Next Steps

7.5.1 Service Feasibility

Only four blocks failed under the typical scenario for fixed-route service; while 15 blocks failed under the conservative scenario. Although additional analysis and cost considerations are required, it is possible that SolTrans can make service changes to have additional vehicles pull out by using one of the available service vehicles to help reduce the percentage of incomplete blocks.

There are various mitigation measures to consider for the failing blocks:

- Additional Service changes
- Wait for advancements in BEB technology
- Select a vehicle that has a higher battery capacity than the average used in the model
- On-route charging

For demand response, existing technology appears to be sufficient to meet the average daily range requirements of SolTrans; however, it is difficult to forecast specific consumption factors due to the variability of vehicle travel on a daily basis.

It should be noted that technology is rapidly evolving, and modeling may not reflect actual performance – especially when it is time to procure vehicles. Demonstration pilots and real-world applications are recommended in order to assess actual performance.

7.5.2 Power and Energy Upgrades

The SolTrans portion of the project includes three sites: the maintenance facility, the Curtola Park-and-Ride, and the Vallejo Park-and-Ride. Currently, all three sites have gone through detailed design and are currently undergoing the bidding process for engineering, procurement, and construction. Therefore, the next steps for SolTrans are outside the scope of this report.

7.5.3 ZEB Transition Plan

Facility Concept

The SolTrans facility concept supports 70 charging positions. Both overhead plug-in dispensers or pantographs can be implemented at the facility.

Several considerations important for SolTrans facility improvements are:

- This report is based on the plan developed by SolTrans and reflects a hybrid charging strategy. The proposed infrastructure allows SolTrans the flexibility to adopt different charging strategies as the fleet is transitioned.
- The existing CNG-supporting electrical service will ultimately be transitioned to support BEB charging infrastructure in the final configuration when CNG vehicles are phased out. Managing the phasing for this process will be crucial to ensure that CNG is available until all vehicles are able to be transitioned.

Phasing Schedule

It was deemed most appropriate to develop the site in two separate stages. Based on the assumed duration, SolTrans' electrification transition will take 39 months (over two stages), with an estimated completion date in May 2025. The first construction stage's design procurement and design steps have already been completed.

To align the delivery of new vehicles with chargers availability, the first round of vehicle procurement will be delivered in October 2024, after the completion of the facility's improvements. The developed procurement timeline assumes that vehicles will be purchased in staggered sets of vehicles, and the fleet will be fully ZE by 2028.

Cost And Funding

Based on the lifecycle cost analysis, the total cash cost of operating a full BEB fleet is approximately $80M, 39% higher than if SolTrans continued operating the current fleet. This is due to the significantly higher capital costs. The costs difference goes down to 33% when considering the environmental costs of a full ICE fleet.

Overall, some of these fleet electrification investments can be funded through existing capital revenues outlined in the agency's FY 2021-2030 SRTP adopted in 2020 as outlined in Table 7.7. There are also additional funding sources through federal, state, regional, and other grant opportunities that can be explored to fill the estimated funding gap. This analysis only considers the capital costs needed based on the phasing schedule developed in sections 7.4.2 and 7.4.3 (for the BEB fleet) and the potential funding sources for capital projects. Strategies for addressing the identified gaps are discussed in sections 9 and 11.5.2.

Table 7.8 SolTrans Estimated Costs and Funding Shortfall by Year (in millions of YOE$)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Estimated Capital Costs	$0.00	$18.66	$17.26	$10.05	$2.33	$0.68	$0.00	$0.00	$0.00	$0.00	**$48.98**
Potential Funding Identified in SRTP	$3.78	$1.46	$1.46	$3.96	$2.91	$2.91	$0.59	$0.61	$2.13	$0.47	**$20.28**
Other Potential Existing Capital Revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
Surplus / Gap	$3.78	**-$17.20**	**-$15.80**	**-$6.08**	$0.58	$2.23	$0.59	$0.61	$2.13	$0.47	**-$28.69**

Source: WSP

CITY COACH

8 VACAVILLE CITY COACH

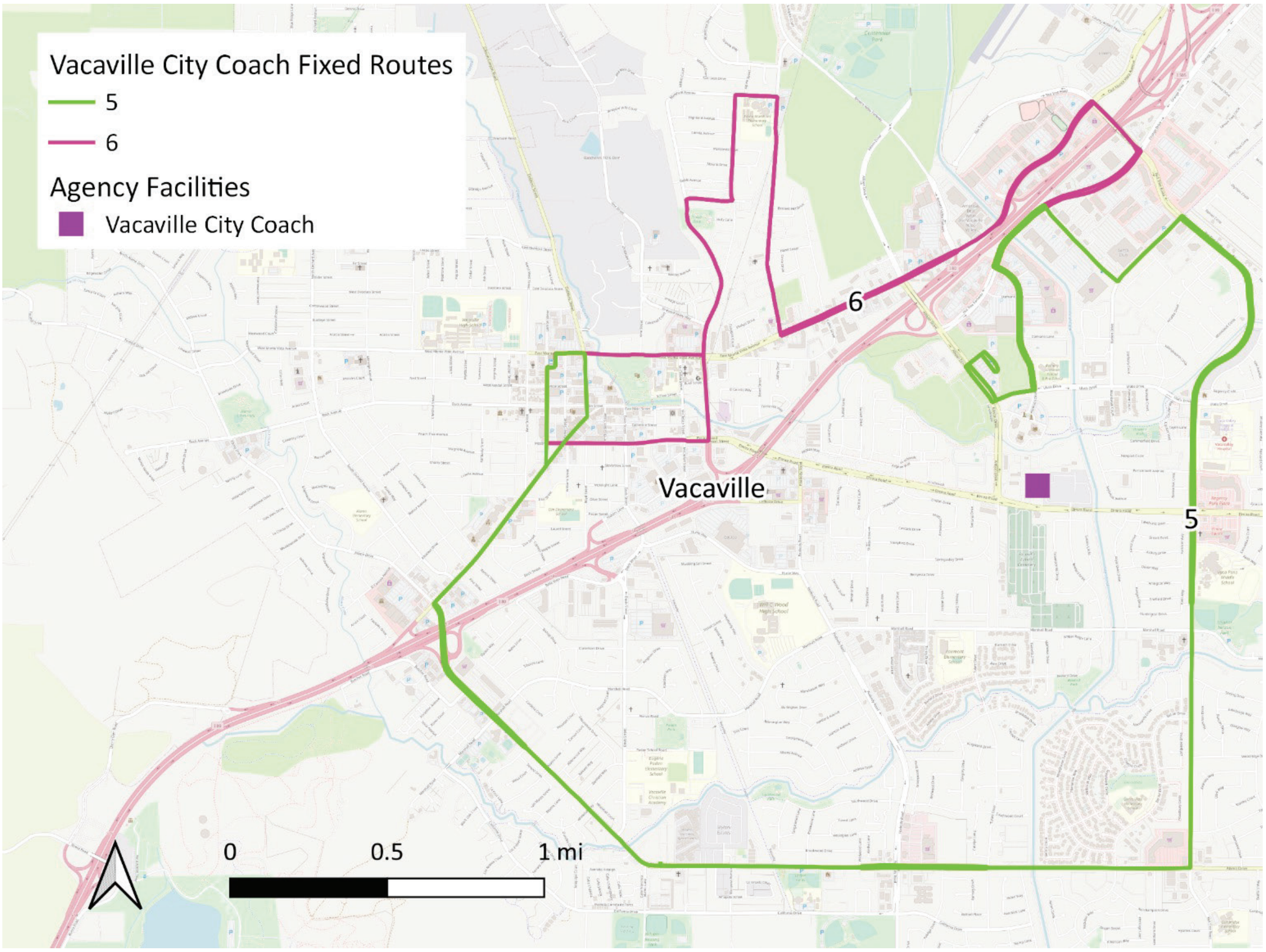
The following sections present Vacaville City Coach's existing conditions, service modeling results, power and energy analysis, facility concepts, phasing strategies, and cost and funding analysis to support the agency's ZEB transition.

8.1 Existing Conditions

8.1.1 Existing Service

Vacaville City Coach operates under the Public Works Department through its General Services Division. Previously, Vacaville City Coach operated six fixedroutes that provide coverage throughout the city but has since implemented COVID-19-related service cuts (Figure 8.1) and plans to operate a much more scaled-down version closer to the pandemic service. Weekday service runs from 6:00 AM to 6:30 PM on 30-minute headways throughout the day, Monday through Friday. Reduced service is provided from 8:00 AM to 6:15 PM on Saturday.

Figure 8.1 Vacaville City Coach Fixed Routes



Source: Metropolitan Transportation Commission, OpenStreetMap Contributors

The fixed-route fleet consists of 18 standard 35-foot buses, and the demand response fleet consists of seven cutaways (although there are additional cutaway vehicles that have been procured) (Table 8.1). The 35-foot buses all run on CNG, while the cutaways run on gasoline. The vehicles were first put in service between 2008 and 2015.

Table 8.1 Summary of Vacaville City Coach Existing Fleet

Bus Type	Length	Fuel Type	In Service Year	Quantity
Cutaway	24'	Gasoline	2008-2015	7
Standard Bus	35'	CNG	2009-2013	18
			Total Vehicles	**25**

Source: Vacaville City Coach Short Range Transit Plan Fiscal Year 2021 – Fiscal Year 2030

Note: A detailed list of Vacaville City Coach Existing Fleet is available in Appendix A: *Existing Conditions Report*

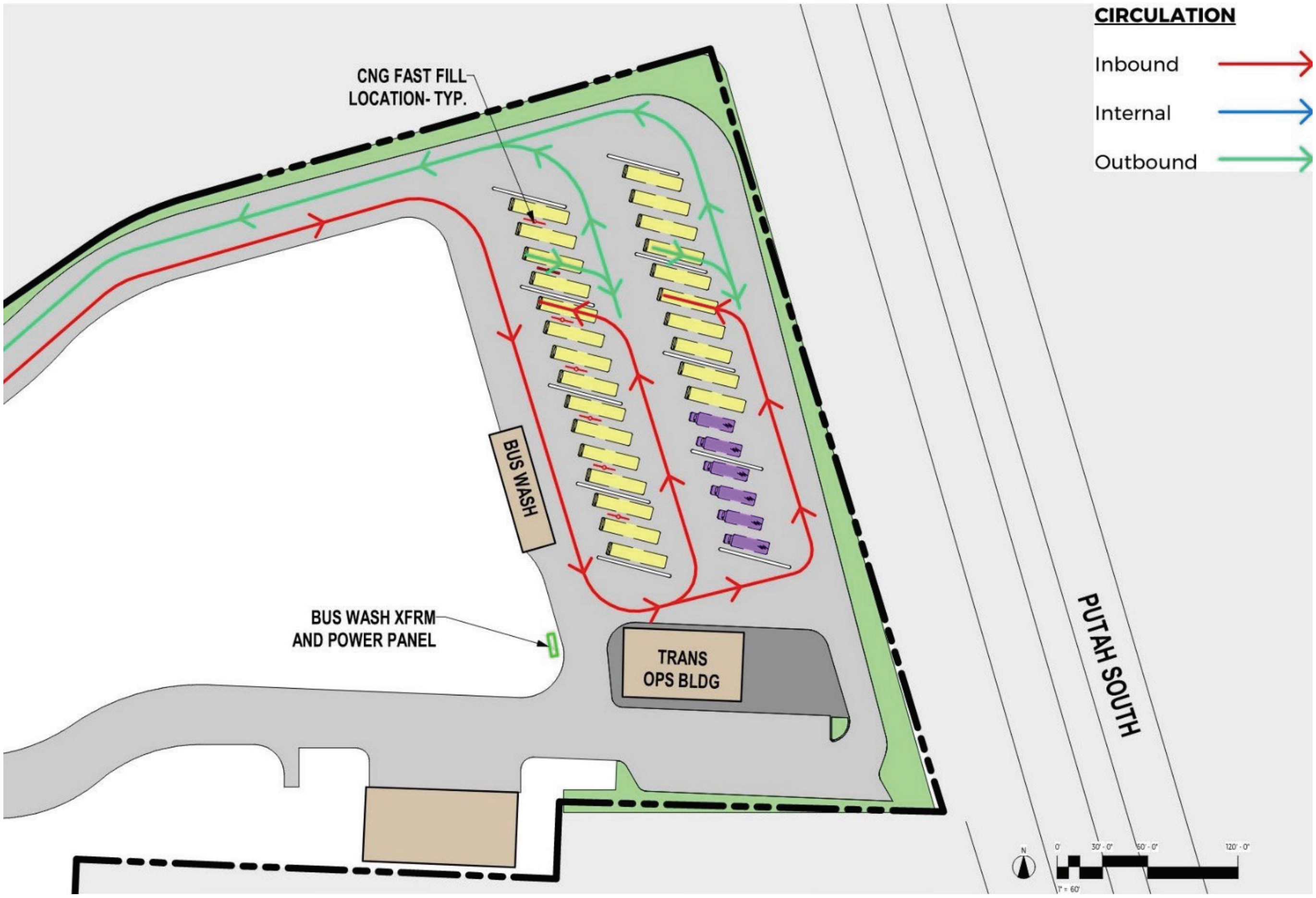
8.1.2 Existing Facility Conditions

The Vacaville City Coach facility is located at 1001 Allison Drive (Figure 8.2). The transit operations share the site with the City of Vacaville Public Works Department.

The maintenance building is located at the site's northwest corner and services both transit vehicles and public works vehicles. The bus parking area is outfitted with seven fast-fill CNG dispensers. There is also a fueling station near the facility's entrance that provides fast-fill CNG, diesel, and unleaded fuel and is used by both transit and public works vehicles. A bus wash is located adjacent to the bus parking area and services only transit vehicles.

The transit operations portion of this site has an additional transit bus parking capacity. There are currently no new planned projects that would affect the transit area operations or negatively affect the electrification efforts. When transitioning to ZEB, the existing fast-fill locations in the bus parking area will require special coordination to ensure that CNG fueling is not negatively impacted during transition phases.

Figure 8.2 Vacaville City Coach Existing Facility and Site Circulation



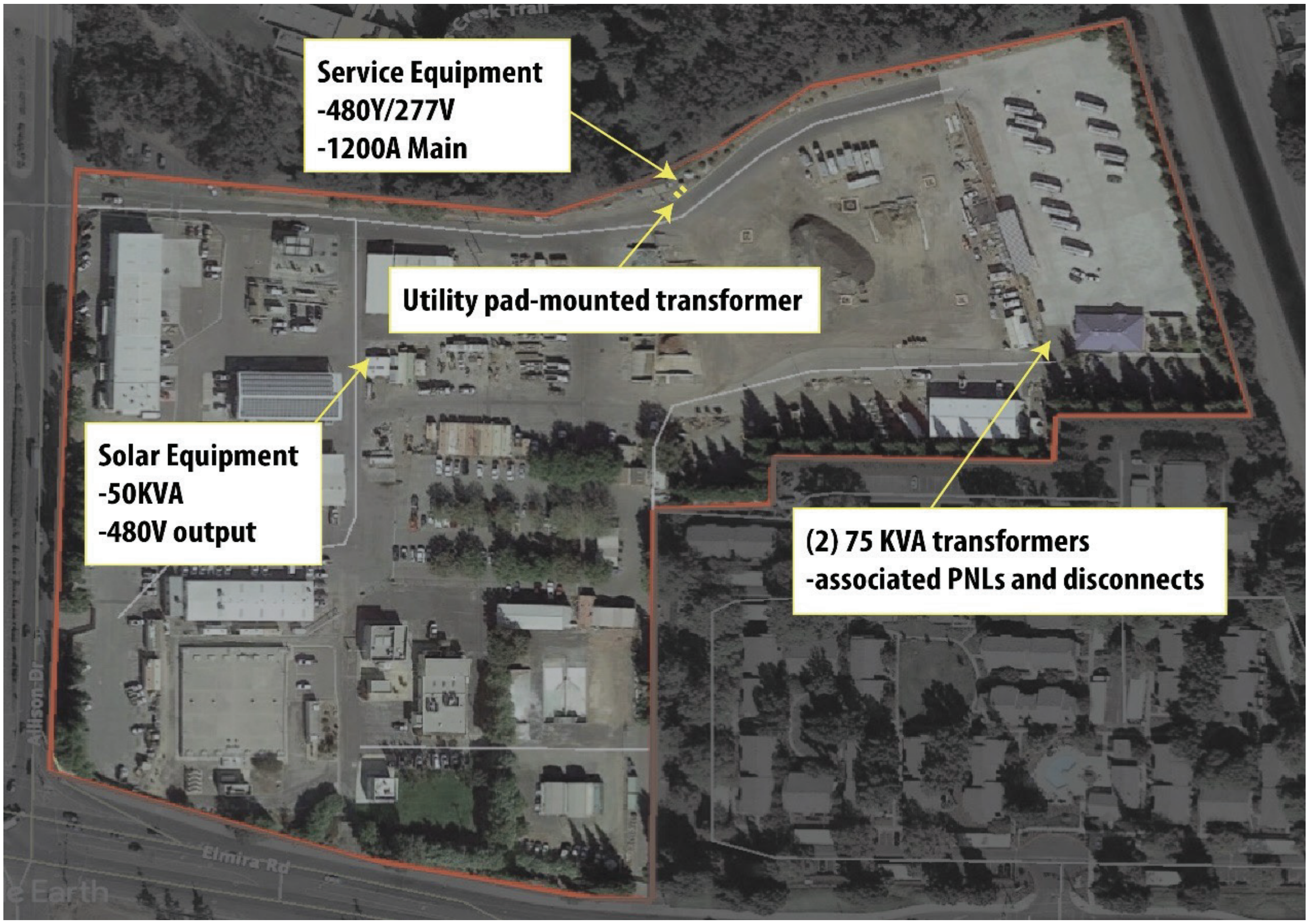
Source: WSP

8.1.3 Existing Power and Energy Conditions

Vacaville City Coach's power is provided by the PG&E Vacaville Substation (6360), which has a capacity of 44.6 MW on Bank 2, with a peak load of approximately 37.8 MW (based on publicly available data). This substation feeds the Vacaville 1105 circuit that feeds the Vacaville City Coach yard. The 12 kV Vacaville 1105 Circuit has an existing capacity of 10.9 MW. PG&E estimates the projected peak load of this circuit as 9.2 MW, leaving approximately 1.7 MW of available capacity.

The site has a utility pad-mounted transformer, two 75 kVA transformers and their associated panelboards and disconnects, one main switchboard with an estimate of three spare breakers, a solar panel, and a generator (Figure 8.3). If necessary, the existing electrical infrastructure can power a small number of bus chargers while awaiting new utility service upgrades or outage restoration from PG&E.

Figure 8.3 Vacaville City Coach Utility Plan View



Source: WSP

8.2 Service Modeling

8.2.1 Fixed-Route Service

Vacaville City Coach currently operates 35-foot buses for their fixed-route services. Vacaville City Coach's local service is operated with two-vehicle blocks. One service block is approximately 125 miles, while the other is 172 miles.

Based on the service modeling analysis, a single BEB cannot complete one of the blocks in the typical scenario. Furthermore, both blocks will fail in the conservative scenario. While both blocks are within the average stated range of the replacement BEBs, due to variables such as slope and weather, the battery efficiency is not sufficient to complete the block. Table 8.2 summarizes the energy demands for the passing block. The "Efficiency Change" column shows how much the efficiency has declined from the baseline of 1.88 kWh/mile due to the additional consumption factors. In the typical and conservative EWL scenarios, neither block can be completed by a single vehicle.

Table 8.2 Vacaville City Coach – Summary of Passing Blocks

Scenario	Passing Blocks	Avg. Distance (miles)	Avg. Required Battery Capacity (kWh)	Avg. State of Charge Remaining	Avg. Efficiency Change (kWh/mi)
Typical	1	125	293	3% (8 kWh)	0.46
Conservative	-	-	-	-	-

Source: WSP

Table 8.3 presents a summary of the energy demands for the failing blocks. On average, 75-76% of the blocks could be completed by a single 35-foot BEB in typical and conservative scenarios. The higher efficiency change in the conservative scenario reflects the higher energy used to operate HVAC in extreme weather and the less efficient regenerative braking system.

Table 8.3 Vacaville City Coach – Summary of Failing Blocks

Scenario	Failing Blocks	Avg. Distance (miles)	Avg. Required Battery Capacity (kWh)	Avg. % of Block Completed	Avg. Efficiency Change (kWh/mi)
Typical	1	172	399	75%	0.44
Conservative	2	149	404	76%	0.85

Source: WSP

8.2.2 Demand Response Service

Since the vehicle miles traveled for demand response services are variable, the Lightning Bolt model could not be used. In lieu of this, WSP conducted a high-level analysis of range expectations using the daily and maximum mileage traveled by the fleet.

Based on the average travel speeds (calculated from data provided in the SRTP and an assumed eight or 10-hour vehicle operator shift), the average daily vehicle distance is between 104 and 130 miles. The GreenPower EV Star – a representative BEB replacement for Vacaville City Coach's existing vehicles - has an advertised range of 150 miles.

Based on the comparison between the advertised range of existing battery electric cutaways and the service's average daily vehicle distance, Vacaville City Coach should be able to operate its demand response service with no or minimal impact. Even with consideration to a 20% safety buffer, the advertised range of the BEB still exceeds the average distance traveled for its demand response service. However, under EWL battery conditions (64% advertised capacity), the expected vehicle range is below the calculated average daily vehicle distance.

However, it should be noted that this estimate does not consider HVAC usage, slope, and other service area-specific variables that can significantly impact the vehicle's efficiency and range. For this reason, it is recommended that more specific vehicle travel information be analyzed and/or a demonstration pilot be conducted to gauge real-world performance.

8.3 Power and Energy Improvements

Vacaville City Coach fleet currently consists of seven gas cutaways and eighteen CNG 35-foot buses. This analysis considers that the transit agency can add up to five 35-foot buses and an electric cutaway at the site in the future. This analysis calculated the electrical requirements for both the current and assumed future fleet.

The analysis evaluates the fleet under an unmanaged and managed charging scenario. In the unmanaged charging scenario, all vehicles will charge concurrently at the same time. Meanwhile, the managed charging scenario assumes that the vehicles will charge sequentially at a full charging rate before switching to the next vehicle. This scenario will reduce the peak demand power required but will result in a longer charging time. However, because BEBs are charging at the same rate during non-peak hours, the longer time should not affect the total utility cost. It is important to note that the managed charging scenario showed in this analysis is only one example of many charging profile optimizations that can be performed to demonstrate the benefits of managed charging

Existing Fleet

To service the existing fleet, thirteen 150 kW DC chargers are recommended to be installed. The recommendation is for Vacaville City Coach to do managed charging. Managed charging will reduce the peak demand from 1875 kW in the unmanaged scenario to 900 kW. It will reduce overall utility costs due to the lower peak demand and reduce capital costs because of the smaller equipment upgrades required. If necessary, five 150 kW DC fast chargers can be used at full speed for flexible mid-day recharging.

Future Fleet

Three additional 150 kW DC chargers will be needed to anticipate the additional needs of the future fleet. The total peak demands are 1,875 kW and 1,050 kW for unmanaged and managed charging scenarios, respectively. Therefore, a charge management system is strongly recommended for Vacaville City Coach. Upgrading the electrical equipment to anticipate this load level will futureproof the site from fleet expansions.

The summary of the charging scenarios analysis is shown in Table 8.4.

Table 8.4 Summary of Vacaville City Coach Charging Scenarios

Fleet	Min. Required # of Chargers	Scenario	Charge Schedule	Charge Rate (per vehicle)	Peak Demand	Required Power Increase*
Current Fleet	Thirteen 150 kW DC chargers	Unmanaged	All BEBs charge concurrently	67.5 kW	1,875 kW	2,063 kW
		Managed	Each BEB charges sequentially	135 kW	900 kW	990 kW
Future Fleet	Sixteen 150 kW DC chargers	Unmanaged	All BEBs charge concurrently	67.5 kW	1,875 kW	2,063 kW
		Managed	Each BEB charges sequentially	135 kW	1,050 kW	1,155 kW

Source: WSP

*Note: Required power increase includes 10% buffer for ancillary loads and losses

Power and Energy Upgrades

It is highly advised for Vacaville City Coach to invest in a CSMS because the existing PG&E feeder, Vacaville 1105 Circuit, serving the site, only has a free peak capacity of 1.7 MW. The peak times for the feeder may or may not coincide with the projected peak times Vacaville City Coach wants to charge, nor can it support the potential 1.88 MW peak load Vacaville City Coach can potentially incur with unmanaged charging.

Based on the analysis, the following facility electrical upgrades are required, assuming the worst-case scenario of unmanaged charging:

- 3000 kVA transformer near the north end of site fed by new 12kV underground electrical service
- 480V service entrance main switchboard with a minimum electrical rating of 5000 A and utility metering cabinet
- Underground electrical conductor in conduit from the new transformer to new 480V switchboard
- Vehicle charging stations with underground conduit connecting the charging stations to the new 480V switchgear.

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Vacaville City Coach would be responsible for installing the switchboard, utility metering cabinet, underground conduit, and charging stations. Managed charging is strongly recommended, and electrical equipment properties should be determined during the design phase based on discussions with PG&E and the level of electric service requested.

Energy resiliency at the site is key to ensure Vacaville City Coach service delivery once transitioning to a full BEBs fleet. One or more of the strategies below provide a suitable level of backup power after considering the possible resiliency issues that the site might experience[28]:

- 500 kW permanent standby generator
- Solar PV system paired with 1 - 2 MWh BESS in 10' – 40' intermodal container

A generator with an output rating of at least 500 kW generator would be capable of recharging every vehicle in a 24-hour period but may require some vehicles to charge during the day if the outage duration is long

8.4 ZEB Transition Plan

8.4.1 Facility Concept

The Vacaville City Coach facility concept supports 31 charging positions. This will support the planned 10 ZEBs and 15 ZE cutaway vehicles/vans, while also leaving room for additional vehicles in the future. Sixteen DC charging cabinets and 31 dispensers are recommended to support the fleet. The number of dispensers required can decrease through further evaluation of the buses' charging window and end-of-the-day SOC.

To maximize the usage of the parking area and limit the amount of trenching required at the existing parking area, overhead charging was determined to be the preferred solution, with overhead plug-in being the preference over pantograph dispensers. It should be noted that while the 35-foot buses can be served by either overhead pantograph or overhead-mounted plug-in dispensers, the cutaway vehicles can only support plug-in charging.

Table 8.5 provides an overview of the proposed charging and utility infrastructure. For additional details, refer to Appendix D: *BEB Facility Concepts Report*. Figure 8.4 illustrates the proposed facility concept to support the electrification transition.

Table 8.5 Vacaville City Coach Recommended Infrastructure

Item	Quantity
150 kW DC Charging Cabinet	16
Plug-in DC Dispenser	31
Cable Retractor	31
Transformer	1
Switchboard	1

Source: WSP

28 Appendix C: *Power and Energy Report* provides in-depth resiliency analysis for the site

Figure 8.4 Vacaville City Coach Preliminary Facility Concept

Source: WSP

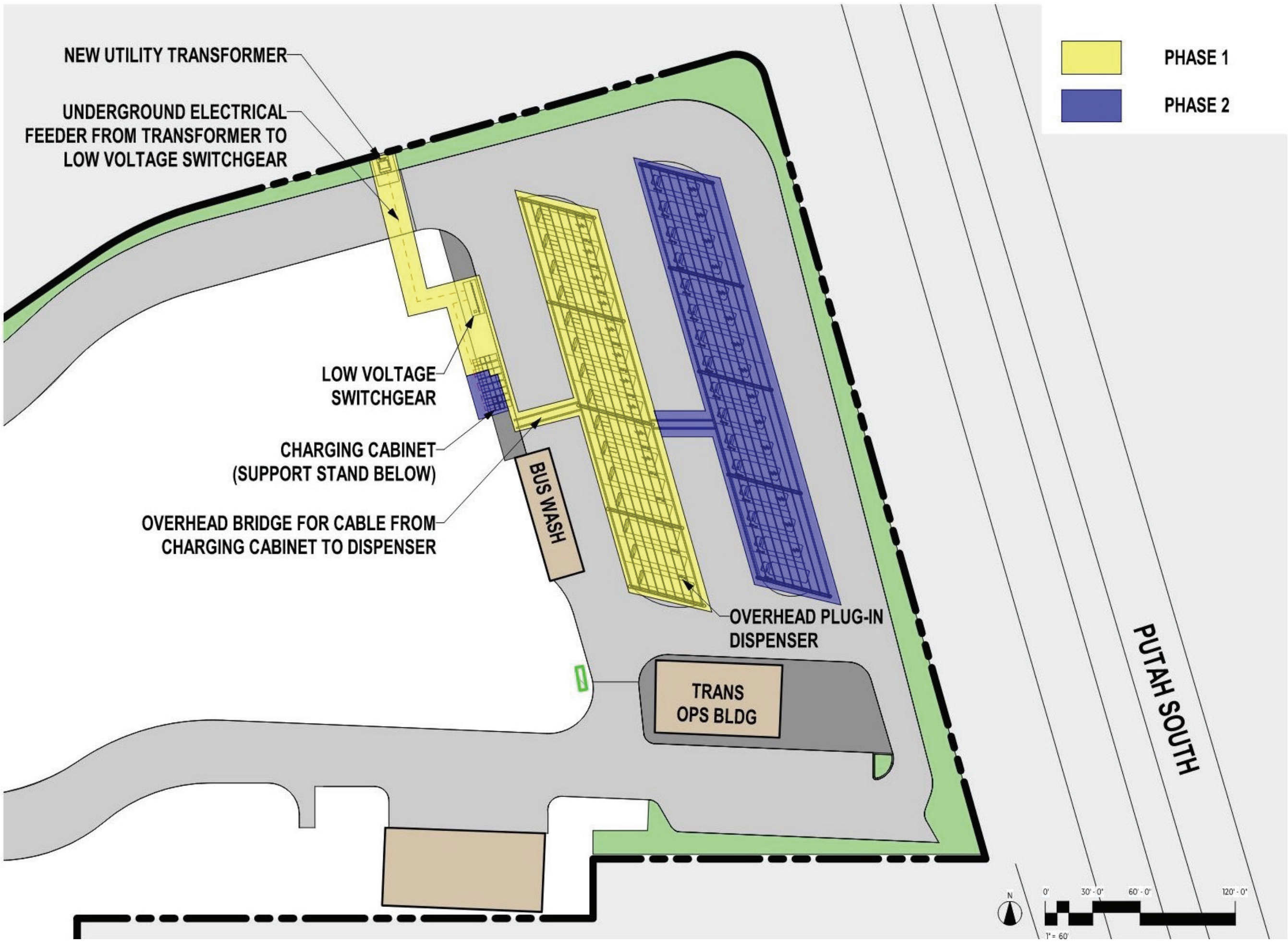
8.4.2 Construction Phasing

The Vacaville City Coach schedule is shortened due to Vacaville City Coach's goal to electrify ten vehicles by November 2023. In order to relieve some of the constraints, the transition has been split into two stages. The first stage is intended to install the needed support for the first procurement of 10 35-foot BEBs. The second stage is for the ZE cutaway fleet that does not need to meet the November 2023 goal (per the CARB ICT regulation, cutaways do not need to transition until 2026). Appendix E: *Phasing Strategy and Transition Report* details each construction stage.

During the first stage, the CNG fast-fill dispensers located at the bus parking positions will need to be decommissioned and removed from service. Existing CNG buses will need to be fueled through the fueling island.

Vacaville City Coach has procured a design firm to perform a 30% design. The 30% design work is scheduled to commence in March 2022. Meanwhile, the procurement for 100% design is planned to start in April 2022, with the actual design work starting in August 2022. The construction phases will be completed in February 2024. Figure 8.5 illustrates the construction phasing, and Table 8.6 illustrates the proposed schedule.

Figure 8.5 Vacaville City Coach Preliminary Staging Concept



Source: WSP

Table 8.6 Vacaville City Coach Construction Schedule

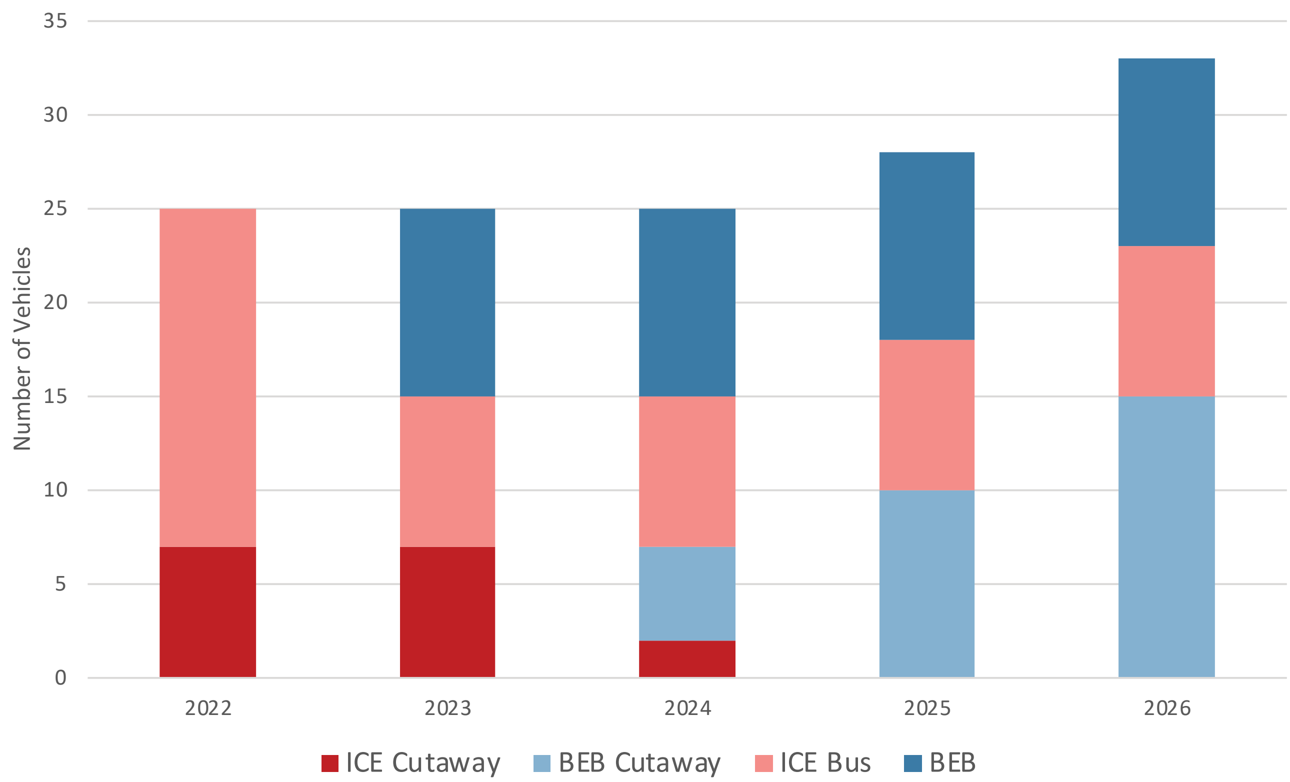
	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24
Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Utilities	18 Months																							
100% Design Procurement		4 Months																						
30% Design	5 Months																							
100% Design						5 Months																		
Construction Procurement									5 Months															
Stage 1 Construction														7 Months										
Stage 2 Construction																					4 Months			

Source: WSP

8.4.3 Vehicle Procurement Schedule

The delivery of new vehicles must align with or after the completion of construction, given that the vehicles cannot be operated until chargers are installed. Vacaville City Coach aims to procure ten 35-foot vehicles to align with the completion of Stage 1; subsequent procurements will align with Stage 2, with five ZE cutaways arriving in 2024. Additional cutaways will be procured in sets of five in 2025 and 2026. This approach will help ease the transition so that Vacaville City Coach has the flexibility of continuing to operate ICE cutaways for a short period of time while the new ZE vehicles are delivered. This approach will also help ensure that any mid-life maintenance will not occur for the entire fleet at the same time. Vacaville City Coach can choose to speed up the procurement of the cutaways, given that the dispensers will be available by April 2024. Figure 8.6 illustrates Vacaville City Coach's fleet mix over time (between ICE and ZEB vehicles).

Figure 8.6 Vacaville City Coach Fleet Mix



Source: WSP

8.4.4 Lifecycle Costs Analysis

Based on the lifecycle cost analysis, the total cash cost (including capital, O&M, disposal and excluding environmental costs) of operating a full BEB fleet is approximately $45M, 36% higher than if Vacaville City Coach continued to operate the current fleet. This is due to the significantly higher capital costs. The total vehicle capital costs (with modification) are $17M for BEB compared to $12M for ICEB. Furthermore, the total charging/fueling infrastructure capital costs are $9M for BEB and $5M for ICEB fleet. The fueling infrastructure costs for ICEB fleet assume that one CNG tank will be replaced in 2031 and another will be upgraded in 2039, while a diesel tank replacement was assumed to occur in 2022.

However, the lifecycle environmental costs for the current ICEB fleet are approximately $2M higher than a full BEB fleet, which will bring the total cash and non-cash costs difference between the two fuel types down to 28%. The total lifecycle cash and non-cash costs are $3.92/mile and $5.03/mile for ICE and BEB fleets, respectively.

Table 8.7 provides the summary of the lifecycle cost analysis.

Table 8.7 Lifecycle Cost (2021-2037) Analysis Results for Vacaville City Coach (in millions of YOE$)

Cost Categories	"No Build" Scenario	"Build" BEB Scenario
Cash Costs		
Total Capital Costs	$18	$26
Total Operating Costs	$15	$19
Total Disposal Costs	-$0.20	-$0.20
Total Cash Cost	$33.00	$45
Non-Cash Costs		
Total Environmental Costs	$3	$1
Total Cash and Non-Cash Costs	$36	$46
Total Cash and Non-Cash Costs per Mile	**$3.92**	**$5.03**

Source: WSP

Note: The total costs may vary due to rounding. Refer to Appendix F: *Cost and Funding Report* for a detailed breakdown of each item.

8.5 Findings and Next Steps

8.5.1 Service Feasibility

One service block in the typical scenario failed, and both failed in the conservative scenario. Under both scenarios, additional pull-outs from spares at the facility could support the service, while small advancements in battery technology could reduce the additional vehicles required to meet the service.

If additional pull-outs to complete service are not viable, there are several other considerations to meet the service:

- Additional Service changes
- Wait for advancements in BEB technology
- Select a vehicle that has a higher battery capacity than the average used in the model
- On-route charging

It should be noted that technology is rapidly evolving and modeling may not reflect actual performance – especially when it is time to procure vehicles. Demonstration pilots and real-world applications are recommended to assess actual performance.

For demand response, existing technology appears to be sufficient to meet the average daily range requirements of Vacaville City Coach; however, it is difficult to forecast specific consumption factors due to the variability of vehicle travel on a daily basis.

8.5.2 Power and Energy Upgrades

Based on the analysis, it is recommended for Vacaville City Coach to install at least thirteen 150 kW DC chargers with managed charging to keep the required power increase to 990 kW. Managed charging will reduce overall utility costs due to the lower peak demand and reduce capital costs because of the smaller equipment upgrades required.

PG&E would be responsible for installing the new transformer and underground electrical conductor, while Vacaville City Coach would be responsible for installing the switchboard, utility metering cabinet, underground conduit, and charging stations.

The next immediate steps for Vacaville City Coach are:

1. Decide whether to invest in a charge management system
2. Begin service application and coordination with PG&E for the appropriate load from PG&E
3. Determine outage mitigation methods. If a backup generator is selected, including the design and procurement in engineering firm RFP
4. Begin detailed engineering design
5. Procure long-lead items
6. Begin construction to point of contact with utility

8.5.3 ZEB Transition Plan

Facility Concept

The Vacaville City Couch facility concept supports 31 charging positions. Sixteen DC charging cabinets and 31 dispensers are recommended to support the fleet. Overhead charging was determined to be the preferred solution, with overhead plug-in being the preference over pantograph dispensers.

Several considerations important for Vacaville City Coach facility improvements are:

- Currently, vehicles can pull into some spaces in either direction. With charging equipment requiring a fixed location, the orientation of each parking space will not be flexible. However, with overhead-mounted equipment, it is much easier to reconfigure if parking direction preferences change in the future.
- As the charging infrastructure is phased in, the CNG fast-fill infrastructure in the parking area will need to be removed to facilitate the proposed charging strategy.

Phasing Schedule

The Vacaville City Coach schedule is shortened due to Vacaville City Coach's goal to electrify ten vehicles by November 2023. In order to relieve some constraints, the transition has been split into two stages. Vacaville

City Coach has procured a design firm to perform a 30% design. The 30% design work is scheduled to commence in March 2022. Meanwhile, the procurement for 100% design is planned to start in April 2022, with the actual design work starting in August 2022. The construction phases will be completed in February 2024.

The delivery of new vehicles must align with the completion of construction, given that the vehicles cannot be operated until chargers are installed. Ten 35-foot BEBs are going to be delivered in 2023 to align with the completion of Stage 1. Then, five ZE cutaways will be delivered each year from 2024 to 2026. The procurement of the cutaways can be sped up, given that the dispensers will be available by April 2024.

Cost And Funding

Based on the lifecycle cost analysis, the total cash cost of operating a full BEB fleet is approximately $45M, 36% higher than if Vacaville City Coach continued operating the current fleet. This is due to the significantly higher capital costs. The costs difference goes down to 28% when considering the environmental costs of a full ICE fleet.

Overall, some of these fleet electrification investments can be funded through existing capital revenues outlined in the agency's FY 2021-2030 SRTP adopted in 2020 as outlined in Table 8.8. There are also additional funding sources through federal, state, regional, and other grant opportunities that can be explored to fill the estimated funding gap. This analysis only considers the capital costs needed based on the phasing schedule developed in sections 8.4.2 and 8.4.3 (for the BEB fleet) and the potential funding sources for capital projects. Strategies for addressing the identified gaps are discussed in sections 9 and 11.5.2.

Table 8.8 Vacaville City Coach Estimated Costs and Funding Shortfall by Year (in millions of YOE$)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Estimated Capital Costs	$0.00	$11.91	$7.54	$4.77	$1.64	$0.00	$0.00	$0.00	$0.00	$0.00	**$25.87**
Potential Funding Identified in SRTP	$0.15	$0.15	$0.42	$0.33	$0.15	$10.00	$4.40	$0.15	$1.00	$3.15	**$19.90**
Other Potential Existing Capital Revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
Surplus/ Gap	$0.15	-$11.76	-$7.12	-$4.44	-$1.49	$10.00	$4.40	$0.15	$1.00	$3.15	**-$5.97**

Source: WSP

9 FUNDING SOURCES

This section identifies and evaluates the funding sources that may potentially be available to support STA and its member transit agencies to fund the transitions to all battery-electric bus (BEB) fleets. Options considered include federal, state, and regional/local/other funding sources. Refer to Appendix F: *Cost and Funding Report* for in-depth descriptions and comparison of the funding sources.

The sources listed in this section are based on what is available during the time this plan is being written. In the future, more funding sources might be available for electrification projects considering the increasing concerns to reduce the emissions from the transportation sector. Some of the grants and projects listed might also expire and are not continued. Therefore, STA and the related transit agencies must periodically update the list to ensure the accuracy of the list moving forward.

9.1 Federal Funding

The Infrastructure Investment and Jobs Act (IIJA), signed into law in November 2021 as the Bipartisan Infrastructure Law (BIL), provides for the lion's share of transportation-related formula and discretionary grant assistance that comes from the U.S. federal government. This legislation included a reauthorization of the programs included in the Fixing America's Surface Transportation (FAST) Act, along with the creation of new ones. Overall, the BIL authorizes more funding opportunities to accommodate the country's transition to a more climate-friendly transportation system. Existing and new formula funding and discretionary grant programs will receive a historic investment of federal funds that will be eligible for fleet electrification and associated infrastructure projects.

The BIL also amends other programs and funding sources that could potentially be used for BEB purchases or other projects stipulated in the *Solano Countywide Electrification Transition Plan*. These include:

- Federal Highway Administration (FHWA) Surface Transportation Block Grant (STBG) Funding eligible uses expanded to include installation of EV charging infrastructure.
- FHWA Congestion Mitigation and Air Quality (CMAQ) funding eligible use expanded to include the purchase of medium- or heavy-duty ZE vehicles and related charging equipment.

Note that CMAQ and STBG funding in the nine-county Bay Area Region is distributed via the regional Metropolitan Transportation Commission (MTC) One Bay Area Grant (OBAG) program.

Table 9.1 provides a high-level summary of each funding source's key characteristics and considerations evaluated in this section. Appendix F: *Cost and Funding Report*.

Table 9.1 Potential Federal Funding Sources Overview

Federal Funding Program	Administering Agency	Eligibility			Funding Potential
		Maintenance Facility	Charging Infrastructure	BEB Purchase	
RAISE	USDOT	✓	✓	✓	Moderate to Low
CIG Small Starts	Federal Transit Administration (FTA)		✓	✓	Low
Section 5307: Urbanized Area Formula Grants	FTA	✓	✓	✓	High to Moderate
Section 5311: Formula Grants for Rural Areas	FTA	✓	✓	✓	High
Section 5339: Bus and Bus Facilities Formula Funds Grant	FTA	✓	✓	✓	High
Section 5339 (c): Low or No Emission Vehicle Program	FTA	✓	✓	✓	Moderate
Carbon Reduction Program	FHWA		✓		Moderate
Charging and Fueling Infrastructure Grant Program[29]	FHWA		✓		Low
Alternative Fuel Tax Credit	USDOE		✓		Moderate to High
New Market Tax Credits	USDOT	✓	✓		Moderate
Opportunity Zones	USDOT	✓	✓		Low to Moderate

Source: WSP

9.2 State Funding

A variety of funding programs within the State of California supports transit fleet electrification efforts. Table 9.2 provides a high-level summary of each funding source's key characteristics and considerations evaluated in this section. Appendix F: *Cost and Funding Report* provides more elaborate discussions on each funding source.

Additionally, STA and its member agencies can benefit from tax exemptions in California to aid in the fleet electrification transition. BEB purchases are exempt from California sales and use taxes when purchased by a transit agency. Moreover, the electricity that local agencies or public transit operators use as a motor vehicle fuel to operate public transit services is exempt from applicable user taxes imposed by California counties.

29 Refer to The National Electric Vehicle Infrastructure (NEVI) Formula Program Guidance

Table 9.2 Potential State Funding Sources Overview

State Funding Program	Administering Agency	Eligibility			Funding Potential
		Maintenance Facility	Charging Infrastructure	BEB Purchase	
Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)	CARB		✓	✓	Moderate
State Volkswagen Settlement Mitigation	CARB		✓	✓	Moderate to Low
Transit and Intercity Rail Capital Program (TIRCP)	CalSTA		✓	✓	High
Solutions for Congested Corridor Programs	CTC			✓	Low to Moderate
Low Carbon Transit Operations Program (LCTOP)	CalTrans	✓	✓	✓	High
Transportation Development Act: Local Transportation Fund (LTF)	Caltrans/ State Board of Equalization	✓	✓	✓	High
Transportation Development Act: State Transit Assistance (STAF)	Caltrans/State Controllers' Office (SCO)	✓	✓	✓	High
SB 1 State of Good Repair Program (SGR)	Caltrans/SCO	✓	✓	✓	High
Clean Mobility Options (CMO)	CALSTART		✓	✓	Moderate
Clean Transportation Program	CEC	TBD	TBD	TBD	Moderate to High

Source: WSP

9.3 Regional & Local Funding

In addition to the regionally administered state funding discussed in the previous sections, a few regional entities also disperse funding that could potentially be used for fleet electrification projects.

Table 9.3 provides a high-level summary of each funding source's key characteristics and considerations evaluated in this section. Appendix F: *Cost and Funding Report* provides more elaborate discussions on each funding source.

Table 9.3 Potential Regional / Local Funding Sources Overview

Regional/Local Funding Program	Administering Agency	Eligibility			Funding Potential
		Maintenance Facility	Charging Infrastructure	BEB Purchase	
One Bay Area Grant (OBAG)	MTC	✓	✓		Moderate to High
Transportation Funds for Clean Air (TFCA)	Bay Area Air Quality Management District (BAAQMD) & STA		✓	✓	Moderate to High
Carl Moyer Program	BAAQMD		✓	✓	Moderate to High
Community Emission Reduction Grant Program	BAAQMD		✓	✓	Moderate
Regional Traffic Impact Fee (RTIF)	STA				Low
EV Charge Network	PG&E		✓		Low
EV Fleet Program	PG&E			✓	High

Source: WSP

10 STAFFING AND TRAINING

One of the essential factors for a smooth transition to a full BEB fleet includes ensuring that the whole workforce, especially operators and technicians, is comfortable handling the new technology, which can be achieved by workforce evaluation and training. Moreover, workforce evaluation is one of the key elements in the Zero Emission Fleet Transition Plan required for federal grants funding.

The following sections discuss the impacts of full-fleet electrification on staffing needs and training. Recommendations are summarized from peer agencies that have experience in operating BEBs.

10.1 Staffing

Based on the data gathered from peer transit agencies, the prevailing approach for those that have deployed BEBs is to see BEB as simply another type of fleet vehicle which agency operators and technicians need to be prepared to drive, maintain, and repair like any other, regardless of its different propulsion and fueling systems. Most peer transit agencies emphasize the need to train existing staff on the newer BEB technology without increasing staffing levels. Unions have generally reacted positively to the implementation of BEBs, particularly because it allows their members to learn and work with new technology. The key is ensuring the staff is trained with proper procedures and safety measures regardless of the propulsion system.

The following sections will outline the high-level lessons learned from peer transit agencies in key areas essential for the transition process to a full BEB fleet. The actual staffing needs might vary based on the specific characteristics of Solano County's transit agencies' current staffing and service operations. A workforce evaluation tool released by FTA can be used to help identify the impact of the transition to a zero-emission fleet on the current workforce[30].

10.1.1 Transit Operations

One of the biggest challenges unique to BEBs is ensuring that the bus state-of-charge will be sufficient to complete the daily bus block. Peer transit agencies had established efforts to ensure an accurate performance monitoring system, such as actively relaying real-time state-of-charge data to dispatchers or establishing a separate division to provide direct support to ZEV-related issues. In some cases, very long vehicle blocks may need to be divided into smaller segments due to BEB range limitations, affecting operators' hours.

- Service Schedulers or Planners have to have the flexibility to adjust the schedule to fit the decreased range of a BEB. Scheduling might need to occur in advance of BEB delivery to anticipate for the shorter range.
- There would not be a need to add operator staff positions assuming a 1:1 ICEB to BEB bus replacement ratio
- Additional operator hours might be needed if the service changed to adapt to BEB's shorter range. The additional hours account for the deadheads to swap BEBs to and from the bus divisions.
- BEBs may require operators and dispatchers to be more cognizant of the remaining vehicle range and should use existing protocols to report issues to the transportation management center (TMC).

30 Refer to FTA Workforce Evaluation Tool

- Operators must be trained on the operation and charging of the BEBs, and how functions, such as HVAC and regenerative braking, will have a significant impact on battery performance.
- For potential on-road BEB breakdowns, it is recommended for road call crews to have two staff members per bus to provide a buddy system for high-voltage safety. The agency should work with third-party towing companies to ensure they have the proper training on how to tow a BEB safely.
- BEBs would not impact staffing levels for staff in the TMC and dispatchers.

10.1.2 Bus Yard Management

- BEBs will require modifications to the roles of service workers, yard starters (yard dispatchers), and maintenance controllers.
  - When the service workers receive the bus from transit operators, the bus needs to be parked in the charging position (instead of fueling).
  - Service workers have to ensure that the buses are connected to the chargers and charging as scheduled.
- Facility Technicians will be trained on all (non-bus) equipment applicable to the mechanic's grade.
- In the event that long blocks are cut due to BEB range limitations, more transit cleaners will be needed to provide midday cleaning for buses that are returned after serving a morning block.
- Since they will be working in the proximity of high voltage, Cleaners also have to be trained and understand the the safety elements of the vehicles and chargers.
- If the overall fleet size increases due to BEBs, the number of service workers and transit cleaners should be increased proportionally because their workload is based on the number of buses they can process within a limited amount of time.

10.1.3 Vehicle Maintenance

- All mechanics should receive PPE and high-voltage training, training for maintenance and troubleshooting vehicles and charging infrastructure.
- The staffing level impacts for the Fleet Maintenance department are largely dependent on the replacement ratio. If more than one BEB is required to replace one conventional bus, the number of mechanics may need to increase incrementally.
- On the other hand, BEBs do not have diesel engines, so preventive maintenance should be simpler to perform. It is recommended that the transit agencies continually monitor and assess mechanic staffing needs throughout the BEB rollout to satisfy the need for running repair and preventive maintenance. Once a BEB has been safely de-energized, the repair functions are the same as current diesel or CNG equipment.
- Mechanics will also be needed on the Quality Assurance and Vehicle Acceptance teams. Quality Assurance staffing may increase incrementally with an increase in fleet size. Vehicle Acceptance staffing will need to accommodate the large fleet turnover due to BEBs.
- BEB mileage should be reported to maintenance controllers upon pull-in every day in order to help them schedule preventive maintenance. The number of maintenance controllers may not need to increase. Some agencies might be able to take advantage of automatic mileage reporting from vehicle telemetry if their current ITS architecture allows for it.

10.1.4 Charge Management and Infrastructure Maintenance

Ensuring that BEBs are properly charged with electricity will be a new responsibility for the staff of the transit agencies. Charge management is complex because of competing priorities, including energy cost, electricity supply and capacity at individual facilities, BEB charging capability, and charging infrastructure capability. Charge management software is critical for managing the charging of large fleets to properly balance on-site electricity loads, schedule, monitor, and control each bus's charging process, and identify and help diagnose problems.

It is important to note that the complexity of the charge management process increases as the fleet size increases. Therefore, smaller transit agencies might not require as many resources as agencies with a bigger fleet. In general, a centralized charge management platform capable of remote operation is recommended for all transit agencies. These assumptions are used as a basis for the following staffing recommendations:

- A new SOP will need to be developed around the oversight of charge management and emergency response procedures.
- Fleet Maintenance mechanic shift supervisors should be responsible for using the charge management system to control and monitor BEB charging at the facility, maintaining coverage 24 hours a day, seven days a week. Because Fleet Maintenance is ultimately responsible for ensuring buses are available for revenue service, which currently includes fueling, Fleet Maintenance should set the parameters for BEB charging. Staffing changes are not likely necessary solely for charge management.
- Fleet Maintenance supervisors and staff should also have first-line responsibility for diagnosing bus charging problems. They may need assistance from the team assigned to do charging maintenance to diagnose problems.
- Most peer transit agencies primarily rely on in-warranty servicing and service contracts with bus OEMs, charger OEMs, or third-party electricians for their charging infrastructure maintenance.

10.2 Training

This section presents findings on BEB training best practices gleaned from peer transit agencies with BEB experiences as well as published reports.

10.2.1 Curriculum/Training Models

- Some reports and training curricula focus on the BEB propulsion system and associated electrical safety, since this sets BEBs apart from buses with conventional fuel sources. The California Transit Training Consortium (formerly known as the Southern California Regional Transit Training Consortium) is set up to provide BEB and advanced electronics training to current transit technicians, mechanics, and supervisors.
- OEM-provided training packages for BEBs are comprehensive and address all bus subsystems and components, even if there is a substantial commonality with conventionally fueled buses. At the same time, they are also very specific to the bus model and the installed systems and components being purchased by the transit agency. Training needs to be provided at this detailed level for each bus make/model purchased.

- There is significantly less material on charging infrastructure and equipment training. However, some transit agencies indicated that training is provided by charging equipment OEMs and software providers much the same way as bus OEMs.
- Generally, BEB-specific training is made available to all relevant staff and not limited to a subgroup of people (e.g., a handful of fleet mechanics or supervisors). However, training is still primarily subject to operational needs.
- While not prevalent now, supervisors will need to learn how to operate charge management software and provide an initial diagnosis of charging issues. Supervisors also require training for general high-voltage electrical safety, scaffolding, and Personal Protective Equipment (PPE).
- Mechanics require in-depth training for all new buses to understand manufacturer-specific and model-specific maintenance procedures.
- Operators' specific training varies by the transit agency. All agencies provide basic familiarization training. However, one suburban transit agency has additionally focused on operator driving behavior and feedback to increase energy efficiency and improve BEB range by taking advantage of regenerative braking. Other agencies operating in more urban environments acknowledged some benefits of "eco-driving" but made it a higher priority to train operators in defensive driving/driving safely.

Table 10 1 provides an example of training modules and the estimated hours based off of a peer agency's estimated requirements.

Table 10.1 BEB Training Modules (Sample)

Module	Hours
General Vehicle Orientation	8
Multiplex System	32
Entrance and Exit Doors	8
Wheelchair Ramp	4
Brake Systems and Axles	16 (8 per axle)
Air System and ABS	8
Front and Rear Suspension, Steering, and Kneeling	8
Body and structure	4
Propulsion & ESS Fam/HV Safety	24
Charging Equipment	4
Electric HVAC, AC Maintenance (Vendor Specific)	24
Propulsion & ESS Troubleshooting	16
Operator Orientation	8
Towing and Recovery	4

Source: SFMTA, 2019

10.2.2 Training Providers

- Most transit agencies interviewed use OEM training packages as a starting point for training. Typically, the agency selects which modules it wants to be taught at a particular time and schedules an on-site visit by the OEM and/or relevant subsystem suppliers to provide the selected training modules to agency staff. The transit agency is responsible for assigning staff to each training module. Some agencies also use OEM trainers to supplement their own training programs.
- In one typical pattern, OEM and subsystem suppliers are used in a "train-the-trainer" role, wherein the agency's staff trainers attend OEM/supplier training modules along with the other agency staff being trained. The staff trainers also receive the supplier's training materials, then use the materials and knowledge to train additional agency staff. In this manner, fewer OEM/supplier training hours are expended, and staff trainers can train more staff in multiple courses over time. This pattern is particularly useful when equipment warranties expire, and operator staff must take over full responsibility for maintenance.
- Third-party providers, including professional training companies, may also be contracted to provide on-site training in areas such as general electrical system safety. Additionally, with the growing interest in ZEV across all vehicle types, agencies may be able to partner with local technical colleges for workforce recruitment and training.
- Given the regional approach, there may be opportunities to create shared workforce development training centers and resources based on interest.

10.2.3 Training Procurement

Transit agencies typically procure training by including it as a budget item within capital purchase contracts, such as for new buses, software systems, or charging equipment. This training budget is used to pay OEM and system suppliers to provide in-person training for selected training modules.

11 CONCLUSION

11.1 Existing Conditions

Table 11.1 summarizes the initial findings for each Solano County transit agency as they pertain to: 1) service requirements; 2) facility operations and layout; and 3) energy usage and availability. Appendix A: *Existing Conditions Report* provides in-depth discussions on the agencies' existing services and facilities.

Table 11.1 Summary of Existing Conditions

Agency	Service	Facility	Utilities
Dixon Readi-Ride	• Operates 10 cutaways and vans for demand response service (only) • Daily range of 83-103 miles	• Shares facility with City of Dixon Public Works Dept.	• Existing circuit (Dixon 1103) is estimated to have 1.3 MW of available capacity • Dixon 1102 (circuit) may also be utilized.
Rio Vista Delta Breeze	• Operates 5 cutaways and vans • Fixed route daily average range of 83 miles • Demand response range daily range of 90-113 miles	• Shares facility with City of Rio Vista Northwest Wastewater Treatment Plant	• Existing circuit (Grand Island 2226) is estimated to have 8 MW of available capacity
SolTrans	• Operates 59 standard buses, cutaways, and coaches • All but 1 fixed-route service block are under 150 miles (average of 74 miles) • Demand response range daily range of 75-93 miles	• SolTrans has developed a Master Plan for a full-BEB retrofit of its existing facility and is currently in the process of implementing Phase 1 of that plan.	
Vacaville City Coach	• Operates 25 standard buses and cutaways • Fixed route daily range is 129 and 173 miles • Demand response range daily range between 104 and 130 miles	• Shares facility with City of Vacaville Public Works Department • Special coordination is required to ensure that CNG fueling is not negatively impacted during transition phases	• Existing circuit (1105) is estimated to have 1.7 MW of available capacity

Source: WSP

11.1.1 Fairfield Transit Fleet Electrification Final Business Plan Report

Based on the Fairfield Transit Fleet Electrification Final Business Plan Report, it is expected that electrifying FAST's fleet will be more expensive than continuing to operate its diesel fleet, primarily due to the initial capital costs – however, operating costs are expected to decrease overall.

Aside from costs, several other changes were proposed to successfully operate an electric transit fleet such as retrofitting the maintenance facility, splitting up the Blue Line into two routes (this service is now operated by SolTrans), and incorporating maintenance and repair work within gaps in bus charging schedules. Fairfield may need to train or hire specialized mechanics that service electric buses, and drivers will need to be trained on how to drive the buses most efficiently and how to properly use the chargers.

11.2 Service Modeling Results

The Service Modeling Analysis is based on existing vehicle specifications, and with technology rapidly evolving, the results are subject to change.

The analysis calculated the average baseline battery efficiencies for each agency's vehicle types and then modeled those vehicles on the blocks while accounting for additional consumption factors. The results were provided as "typical" and "conservative" scenarios; however, the typical scenario may be considered rather conservative and should be supplemented and confirmed with actual pilot projects. While operating battery capacity was factored into these analyses, the battery conditions should be considered "new." To simulate vehicle ranges under a degraded battery, block completion rates with 64% of operating battery capacity (EWL conditions) were also presented.

The demand response analysis was much simpler, based on average daily mileage ranges. More precise data is required for a more nuanced model.

Table 11.1 summarizes the initial findings for each agency. For all of the failing blocks in the fixed-route services, the following mitigation measures can be considered:

- Service changes (splitting blocks; additional pull-outs)
- Additional vehicles
- Wait for advancements in BEB technology
- Selecting a bus that has higher capacity than the average in the model
- Opportunity charging

The *Service Modeling Technical Report* (Appendix B) provides a more in-depth review of the data inputs and methodology used to conduct the analysis.

Table 11.2 Summary of Modeling Results

Agency	Fixed Route		Demand Response*
	Typical Scenario	Conservative Scenario	
Dixon Readi-Ride	• No fixed-route service	• No fixed-route service	• Assumed BEB replacement is expected to meet the existing range of 83 to 103 miles
Rio Vista Delta Breeze	• 1 of 4 blocks failed • EWL: 1 block failed	• 1 of 4 blocks failed • EWL: 1 block failed	• Assumed BEB replacement is expected to meet the existing range of 93 to 113 miles

Agency	Fixed Route		Demand Response*
	Typical Scenario	Conservative Scenario	
SolTrans	• 4 out of 42 blocks failed • EWL: 15 blocks failed	• 15 failing blocks • EWL: 24 blocks failed	• Assumed BEB replacement is expected to meet the existing range of 75 to 93 miles
Vacaville City Coach	• 1 out of 2 blocks failed • EWL: All blocks failed	• •All blocks failed • EWL: All blocks failed	• Assumed BEB replacement is expected to meet the existing range of 104 to 130 miles

Source: WSP

*Note: Assuming battery-electric cutaway replacement with 150 miles range

11.3 Facility, Power, and Energy Improvements

Electric bus charging systems require a significant amount of electrical power. Most facilities require moderate to significant upgrades to their existing electrical infrastructure, and PG&E must also upgrade equipment to supply the necessary power to the site. The final load demand and equipment upgrades depend on the fleet size, detailed site design, number of chargers, and the electrical contractor's analysis.

The facility analysis finds that each facility can accommodate the charging infrastructure needed to support a fully electric bus fleet. The facility upgrade recommendations will be refined and further evaluated in subsequent stages of design implementation.

Moreover, to ensure service delivery and energy resiliency during emergency outages, all sites can benefit by installing a permanent battery storage generator. Solar PV might be considered for Rio Vista Delta Breeze and Vacaville City Coach.

Appendix C: *Power and Energy Report* provides in-depth energy and resiliency analysis for each site, while Appendix D: *BEB Facility Concepts Report* provides the detailed facility concept for each site.

Table 11.3 summarizes the facility upgrades needed for Solano County's transit agencies to accommodate the maximum number of vehicles expected in the future fleet.

Table 11.3 Summary of Site Upgrades Required (Assuming Future Fleet Capacity)

	Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans	Vacaville City Coach
New Electrical Service	Yes	Yes	Yes	Yes
Utility System Upgrades	No	No	Yes	Maybe
Charging Equipment*	• Five 150 kW DC charging cabinets • Seven cable retractors	• Four 150 kW DC charging cabinets	• Twenty-one 80 kW AC charging system • Twenty-five 150 kW DC charging cabinets • Seventy cable retractors	• Sixteen 150 kW DC charging cabinets • Thirty-one cable retractors
Charging Strategy	• Three ground-mounted plug-ins • Seven overhead-mounted plug-ins • One plug-in dispenser in maintenance area	• Eight ground-mounted plug-ins • One plug-in dispenser in maintenance area	• Forty-nine overhead-mounted plug-ins w/ option for future overhead pantograph • Twenty-one plug-in AC dispensers**	• Thirty-one overhead-mounted plug-ins • Two plug-In dispensers in maintenance area
New Electrical Equipment Required	• Utility transformer • Main switchboard and meter • Underground conduit to chargers	• Utility transformer • Main switchboard and meter • Underground conduit to chargers	• Utility transformer • Main switchboard • Underground conduit to chargers	• Utility transformer • Main switchboard and meter • Electrical subpanels Large underground duct bank and conduit to chargers • Likely upgrades to utility-owned distribution equipment.

Source: WSP

*Note: Assuming 1:2 charger to dispensers ratio

**Note: Phase 1 will utilize 21 AC chargers and subsequent phases are programmed to accept either DC or AC systems depending on SolTrans' vehicle procurement decisions

11.4 Phasing Schedule

11.4.1 Construction Schedules

Each agency's construction schedule varies based on the size of the facility, its upgrade requirements, and the particular goals of the agency. All agencies are anticipated to have all required infrastructure installed and constructed in advance of the CARB ICT regulation's first purchase requirements in 2026 (25% of new purchases are required to be ZEB).

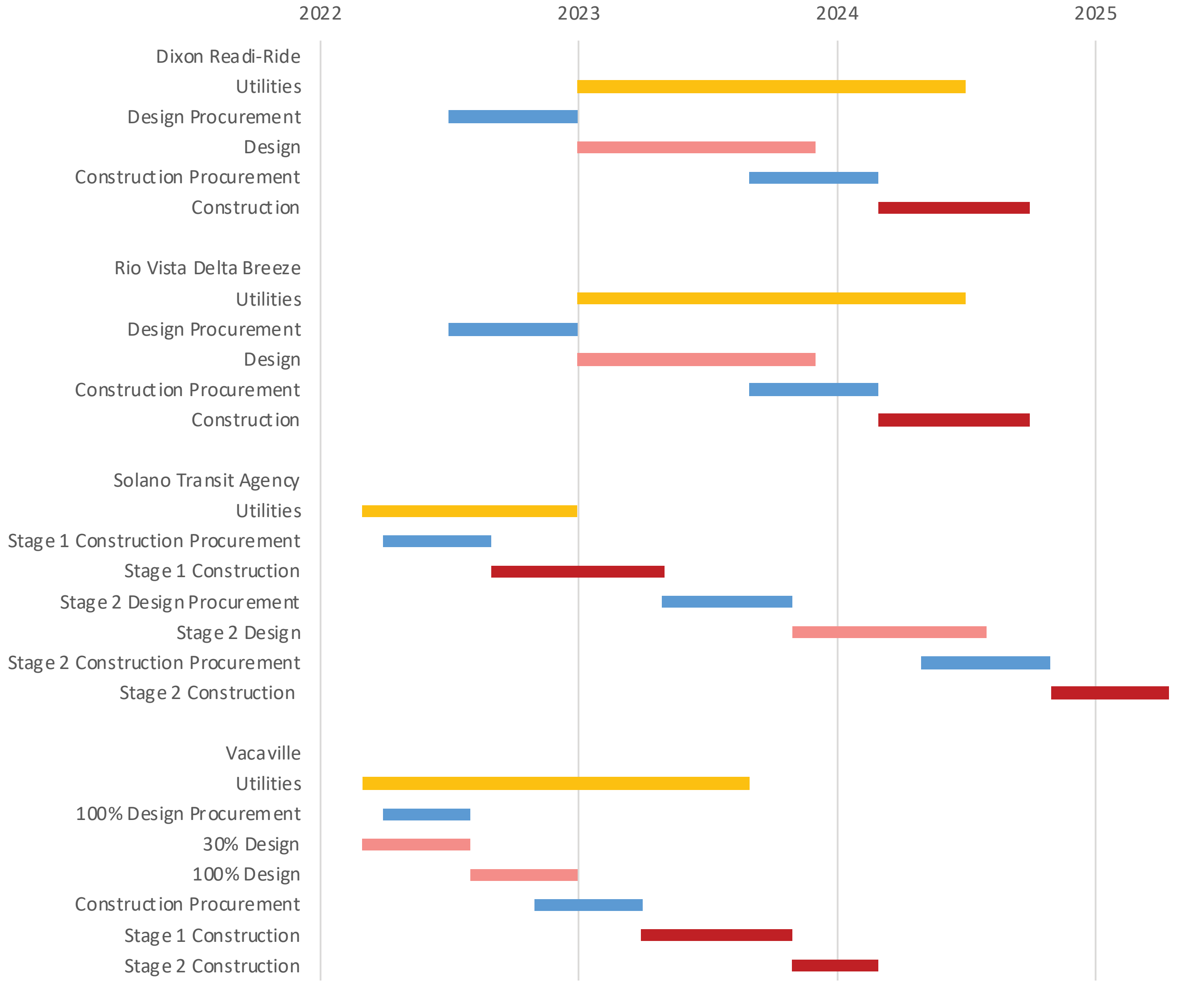
Table 11.4 provides an overview of each agency's construction schedule along with the number of proposed construction stages. Figure 11.1 presents the schedules for each agency's facility, broken up into the major steps of the transition. Detailed construction schedules are provided in Appendix E: *Phasing Strategy and Transition Report*.

Table 11.4 Construction Summary – All Agencies

Agency	No. of Stages	Timeline
Dixon Readi-Ride	1	July 2022 – Sept 2024
Rio Vista Delta Breeze	1	July 2022 – Sept 2024
Solano County Transit	2	March 2022 – May 2025
Vacaville City Coach	2	March 2022 – Feb 2024

Source: WSP

Figure 11.1 Construction Schedule – All Agencies



Source: WSP

11.4.2 Vehicle Procurement Schedules

The developed procurement schedules are based on future fleet projections. The assumed delivery dates of vehicles were developed with special consideration to vehicles' useful life, construction completion dates, and reducing impacts to maintenance staff. Table 11.5 shows the procurement schedule for each agency by year, by vehicle type. Detailed construction schedules are provided in Appendix E: *Phasing Strategy and Transition Report*. The table also includes FAST's proposed vehicle procurement schedule. Please refer to Appendix G: Fairfield Transit Fleet Electrification Final Business Plan Report for more detail.

Table 11.5 Vehicle Procurement Schedule – All Agencies

Year	Dixon Readi-Ride	Rio Vista Delta Breeze	SolTrans		Vacaville City Coach		FAST		Total
	Cutaway	Cutaway	Cutaway	Bus	Cutaway	Bus	Cutaway	Bus	
2021	-	-	-	-	-	-	5	1	6
2022	-	-	-	-	-	-	-	-	-
2023	-	-	-	7	10	-	1	9	27
2024	4	2	-	7	-	5	3	5	26
2025	4	2	3	7	-	5	3	5	27
2026	-	-	3	1	-	5	-	-	9
2027	-	-	4	-	-	-	-	8	12
2028	-	-	4	-	-	-	-	-	4
2029	-	-	-	-	-	-	-	4	4
2030	-	-	-	-	-	-	-	-	-
2031	-	-	-	-	-	-	-	3	3
2032	-	-	-	-	-	-	-	-	-
2033	-	-	-	-	-	-	-	15	15
Total	8	4	14	22	10	15	12	48	133

Source: WSP

11.4.3 Transition Considerations

In determining the path forward towards its transition goals, agencies must consider, address, and mitigate a variety of factors and risks, such as:

- **Service Completion:** Solano County agencies will have to align their procured vehicles with any needed service changes to accommodate the failing blocks identified in the Service Modeling Analysis. The gradual transitions as outlined in this plan will help ease the process by giving the agencies time to analyze performance data and fall back on ICE vehicles while they are still in the fleet.
- **Fleet Replacement Ratio:** The number of BEBs needed to complete service should be regularly re-assessed based on actual performance gathered during the incremental rollout of BEBs outlined in the phasing analysis.
- **Capital Improvement Plans:** The schedules in this report do not account for delays that might occur from capital improvement plans that are not directly related to fleet electrification (if any).
- **Service Growth:** The expanded fleets for Dixon Readi-Ride and Rio Vista Delta Breeze are not included in the procurement analyses due to the lack of information regarding future timelines.
- **RFPs and Utility Applications:** In most cases, the RFPs for design/construction packages should commence soon (as of this report). Additionally, utility applications must be submitted to PG&E up to 16 months in advance of each facility.

- **Charge Management:** Charge management is a necessary component for operating a BEB fleet. A charge management software system can track each bus's SOC while they are at the facility and in service and intelligently charge and dispatch buses based on the estimated energy needs of the upcoming service blocks. Therefore, it can reduce the number of BEBs and chargers needed.
- **Workforce Training and Impacts:** Training for the operation, maintenance, and handling of BEBs will be conducted after bus procurement and in advance of delivery. It is expected that all relevant personnel will be sufficiently trained before buses arrive. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that staff will be trained well in advance of the commissioning of these additions.

11.5 Cost and Funding

11.5.1 Lifecycle Cost

Overall, the cost-benefit analysis shows that the full lifecycle cash cost of a transition to battery-electric buses is higher than the continued reliance on ICE vehicles for all transit agencies (Table 11.6). While the initial capital and operating costs are higher for BEBs, there are opportunities for some savings in fuel costs. Additionally, operating cost benefits depend on continually evolving factors as BEBs deploy in transit services.

The analysis also shows that keeping the current fleet would result in a large emission generation over the ICEB operations' lifecycle compared to a full BEB fleet. The large vehicle emission difference between the two replacement scenarios was expected, as the technology in the BEBs is aimed to reduce GHG emissions, particularly for carbon emissions.

Detailed lifecycle cost analysis is provided in Appendix F: *Cost and Funding Report*.

The table below does not include the costs for FAST's transition. Since FAST's cost analysis was conducted under a different project, the specific output is not identical to those developed in the Transition Plan. The FAST report analyzed the costs for maintaining an ICE fleet as well as transitioning to a BEB fleet through 2040. Meanwhile, the rest of STA's agencies were analyzed through 2030. The net expenditures for all STA agencies (including FAST) are $254M for an ICE fleet and $330M for a BEB fleet, yielding an additional $76M in costs to transition all agencies. Please refer to Appendix G for more detail regarding FAST's costs and methodology.

Table 11.6 Summary of Lifecycle Costs Analysis (in million of YOE$)

Cost Categories	Dixon Readi-Ride		Rio Vista Delta Breeze		SolTrans		Vacaville City Coach		STA Countywide Costs	
	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet
Cash Costs										
Total Capital Costs	$1	$4	$0.60	$2	$37	$49	$18	$26	$57	$82
Total Operating Costs	$4	$4	$2	$2	$21	$31	$15	$19	$42	$56

Cost Categories	Dixon Readi-Ride		Rio Vista Delta Breeze		SolTrans		Vacaville City Coach		STA Countywide Costs	
	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet	Current Fleet	BEB Fleet
Total Disposal Costs	-$0.10	-$0.10	-$0.00	-$0.00	-$0.20	-$0.20	-$0.20	-$0.20	-$0.5	-$0.5
Total Cash Cost	$5	$8	$3	$4	$58	$80	$33	$45	$99	$137
Non-Cash Costs										
Total Environmental Costs	$0.60	$0.30	$0.30	$0.10	$4	$2	$3	$1	$8	$3
Total Cash and Non-Cash Costs	$6	$8	$3	$5	$62	$82	$36	$46	$107	$141
Total Cash and Non-Cash Costs per Mile*	**$2**	**$4**	**$3**	**$4**	**$6**	**$8**	**$4**	**$5**	**N/A**	**N/A**

Source: WSP & Willan

Notes: *Does not include FAST's cost analysis. FAST's lifecycle costs are $147M for an ICE fleet and $190M for a BEB fleet. FAST's lifecycle costs are through 2040 and do not include environmental and capital, O&M, or Disposal costs. The net expenditures for all STA agencies are $254M for existing ICE fleets and $330M for a BEB fleet, yielding an additional $76M in costs to transition all agencies
Rounded to the nearest hundred thousand when costs were less than one million dollars. Otherwise, it was rounded to the nearest million

11.5.2 Funding Gap

A funding gap analysis was conducted by comparing the annual capital costs analyzed in the lifecycle costs analysis with the identified potential funding in SRTP and other existing capital revenues. This analysis only considers the capital costs needed based on the BEB phasing schedule developed in this plan (refer to section 11.4) and the potential funding sources for capital projects.

Overall, some of these fleet electrification investments can be funded through existing capital revenues outlined in each agency's FY 2021-2030 SRTP adopted in 2020. However, STA and member agencies will also need to pursue additional funding through federal, state, regional, and other grant opportunities to fill the estimated funding gap to carry out the full scope of the *Solano Countywide Electrification Transition Plan*.

Table 11.7 summarizes the estimated capital costs and the funding surplus/gap per year by agency. Detailed funding gap analysis is provided in Appendix F: *Cost and Funding Report*.

It should be noted that the table below does not include FAST's funding surplus/gap since FAST's cost analysis was conducted under a different project and used a different methodology from this report. As noted in the FAST report, the cost to electrify FAST's fleet including incentives is $163.68M. The net funding gap for all STA agencies (including FAST) is -$201.79M. Please refer to Appendix G for more information regarding FAST's cost/funding analysis.

Table 11.7 Estimated Capital Costs and Funding Gap by Agency by Year (in million of YOE$)

Agency		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Dixon Readi-Ride	Estimated Capital Cost	$0.00	$0.00	$2.38	$1.87	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$4.25**
	Funding Surplus / Gap	$0.29	$0.29	-$1.94	-$1.64	$0.23	$0.31	$0.20	$0.28	$0.11	$0.24	**-$1.65**
Rio Vista	Estimated Capital Cost	$0.00	$0.00	$1.41	$1.05	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$2.46**
	Funding Surplus / Gap	$0.00	$0.98	-$1.41	-$1.05	$0.00	$0.45	$0.00	$0.12	$0.00	$0.00	**-$1.80**
SolTrans	Estimated Capital Cost	$0.00	$18.66	$17.26	$10.05	$2.33	$0.68	$0.00	$0.00	$0.00	$0.00	**$48.98**
	Funding Surplus / Gap	$3.78	-$17.20	-$15.80	-$6.08	$0.58	$2.23	$0.59	$0.61	$2.13	$0.47	**-$28.69**
Vacaville City Coach	Estimated Capital Cost	$0.00	$11.91	$7.54	$4.77	$1.64	$0.00	$0.00	$0.00	$0.00	$0.00	**$25.87**
	Funding Surplus / Gap	$0.15	-$11.76	-$7.12	-$4.44	-$1.49	$10.00	$4.40	$0.15	$1.00	$3.15	**-$5.97**
STA Countywide	Estimated Capital Cost	$0.00	$30.57	$28.59	$17.74	$3.97	$0.68	$0.00	$0.00	$0.00	$0.00	**$81.56**
	Funding Surplus / Gap	$4.22	-$27.69	-$26.27	-$13.21	-$0.68	$12.99	$5.19	$1.16	$3.24	$3.86	**-$38.11**

Source: WSP & Willdan

Notes: *Does not include FAST's cost analysis. The cost to electrify FAST's fleet, including incentives, is $163.68M. FAST's analysis is through 2040 and does not use the same methodology as STA's other agencies. The net funding gap for all STA agencies is -$201.79M. Rounded to the nearest ten thousand

11.5.3 Funding Recommendations

For federal funding programs, the BIL has significantly increased funding for formula programs like FTA Section 5307, 5311, and 5339. These sources of formula funding are fairly flexible and can be leveraged at an 80% federal / 20% local match to fund capital projects, including procurement of ZEBs, and construction of charging/fueling infrastructure and/or associated maintenance facilities. STA and transit agencies in Solano County could consider allocating a portion of these additional formula funds above those amounts needed for operations to fund capital projects like ZEB purchases and charging infrastructure. In addition to these formula funding programs, the FTA Section 5339(c) Low or No Emissions competitive grant program also received a big boost through the BIL – increasing in size from $182 M/year in FY 2021 to $1.1 B/year in awards starting in FY 2022 through FY 2026.

For state and regional funding programs, transit agencies in Solano County show a projected surplus of Caltrans TDA LTF funding in their SRTPs that could be used for electrification investments. Similarly, STA controls the allocation of TDA STAF funding, a portion of BAAQMD TFCA funds and controls the prioritization of local projects that may receive MTC OBAG funding, all of which could be leveraged. In addition, STA and member agencies should pursue the following opportunities as fleet electrification projects are well aligned with program objectives (and have previous success in obtaining funds to support ZEB infrastructure investments in some cases):

- CalSTA's TIRCP
- Caltrans' LCTOP
- Caltrans/State Controller's Office SB1 SGR Program
- Bay Area Air Quality Management District Carl Moyer and Community Emission Reduction Grant Programs

Other newer state transportation opportunities that STA and member agencies should monitor for funding and forthcoming procedural/eligibility requirements include the CALSTART CMO program as well as the CEC Clean Transportation Program.

Finally, with respect to other funding opportunities, STA and member agencies can apply for the PG&E EV fleet program, which can be used to support the purchase of ZEBs and charging infrastructure for PG&E customers.

Detailed funding analysis is provided in Appendix F: *Cost and Funding Report*.

11.6 Staffing And Training

One of the essential factors for a smooth transition to a full BEB fleet includes ensuring that the whole workforce, especially operators and technicians, is comfortable handling the new technology that can be achieved by workforce evaluation and training. Moreover, workforce evaluation is currently one of the key elements in the Zero Emission Fleet Transition Plan required for federal grants funding. A workforce evaluation tool released by FTA can be used to help identify the impact of transition to a zero-emission fleet on the current workforce[31].

31 Refer to FTA Workforce Evaluation Tool

Based on peer transit agencies' experiences, BEB transition will not greatly disrupt current staffing and training requirements or yard management. In large, BEB maintenance follows a "bus is a bus" philosophy, indicating that many bus repairs will be standard regardless of the powertrain. However, to ensure fleet maintainers are supported throughout the life of the BEBs, it is recommended that a substantial share of the OEM training budget be reserved for the tail end of subsystem warranties to ensure maintenance staff is prepared to service components as needed.

Staff training required to support a BEB fleet will require the development of new training materials, which should be supported by BEB OEMs. Additionally, while the OEM provides training modules for both maintenance technicians and operators, some training may need to be developed for other staff. Everyone should have a high-level understanding of high voltage safety, even if that message for other job classifications is simply to be able to recognize it and stay away from it.

Just as the broader ZEB industry is in a state of constant change, so is BEB training. Educators are in the process of developing additional training curricula and resources for transit agencies. Bus manufacturers are working to improve and update their training modules, manuals, and training materials to keep up with the fast pace of product development. The lessons learned discussed in this section should be treated as "snapshots in time" of the state of the industry. It is recommended for Solano County's transit agencies to review training guidance and resources as they are developed continually.