Zero Emission Bus Rollout Plan

Adopted August 2025

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EXECUTIVE SUMMARY

Transitioning to a zero emission fleet involves more than simply buying vehicles and a fueling system; the transition introduces new technology and processes into day-to-day operations. Successful fleet transition plans take a holistic approach to consider operational requirements, market conditions, available power, infrastructure demands, and costs. This Zero Emission Fleet Transition Plan encompasses all these elements and is intended to be a roadmap for Monterey-Salinas Transit District (MST) to convert their transit bus fleet to zero emissions by 2040.

MST has already started on the path towards a fully zero-emission fleet. Thirteen zero-emission buses are currently on order to comply with the ICT Rule, two 40-foot Gillig battery electric buses (BEBs), two 30-foot BYD BEBs, and one electric trolley is in operation and charged enroute through a wave inductive charger in Monterey. The Gillig BEBs are currently operating on Line 41, serving a disadvantaged community (DAC), and Line 49, which operates within a half mile of a DAC. Build Your Dreams (BYD) BEBs serve Lines 42 and 48, both operating within a one-mile radius of DACs. MST has an order of 13 ZEBs for Line 20, which serves low-income census tracts within a half-mile buffer of a DAC. Additionally, 100% of MST's heavy-duty buses are run on renewable biodiesel or renewable electricity.

Earlier planning efforts undertaken by MST had anticipated its last purchase of a biofuel vehicle would be in 2022, with a full shift to ZEBs starting in 2023. However, this strategy had assumed that technology advances would allow for a feasible transition of MST's routes served by cutaway vehicles. MST has also historically had difficulty in securing funding for zero emission vehicles, which has further delayed the agency's ability to transition the fleet.

This Study performed an updated energy modelling of BEBs and hydrogen fuel cell electric buses (FCEBs) using current route data to confirm operational feasibility and develop fleet charging strategies and recommendations for vehicle and charging infrastructure types. The in-depth analysis provides MST with data to guide important decisions involving capital programs and operations necessary to build key partnerships and support transition actions and phases. This Transition Plan outlines a phased implementation approach that aligns with MST's updated 2025 Innovative Clean Transit (ICT) Plan, existing fleet replacement schedule, and concurrent facilities modification design projects.

MST plans to first prioritize deploying BEBs to replace 35' and 40' biofuel buses on routes that can be operated without the need for enroute charging, bus swaps, or modifications to current revenue or non-revenue operations. Following this initial deployment, MST will deploy BEBs to replace 35' and 40' biofuel buses on routes which will require the use of enroute charging, but without the need for bus swaps or modifications to current revenue or non-revenue operations. In this phase, existing trolleys will also be replaced at a one-to-one ratio with electric trolleys. Finally, routes which cannot be served by battery electric technology coupled with enroute charging will be replaced with FCEBs. FCEB operations and maintenance may be centralized in the Thomas D. Albert (TDA) Facility; however, a recent LCTOP grant received by MST is enabling MST to prepare the South County Operations & Maintenance (SCO) Facility for FCEB operations and maintenance

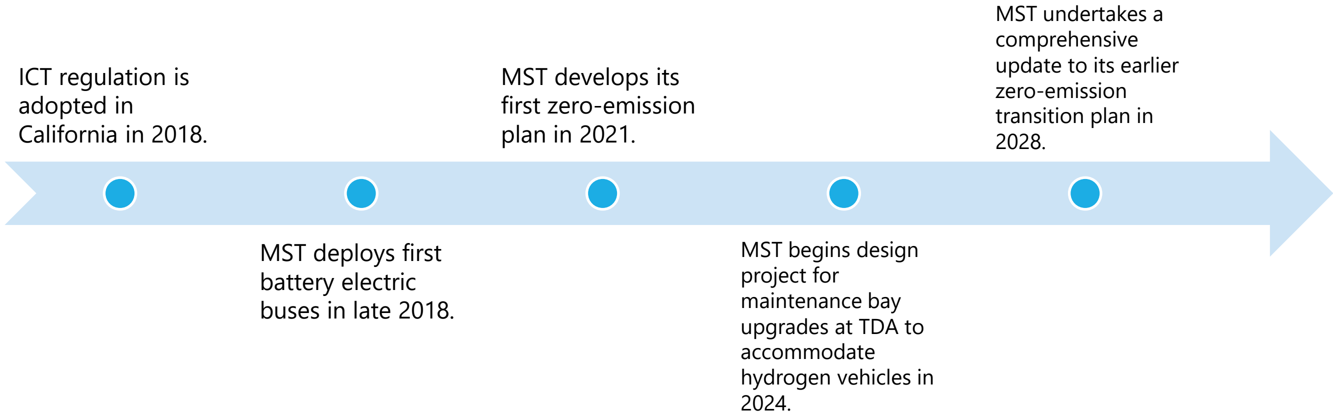
Updated modeling results revealed that transitioning to cutaways with existing battery electric technology would require nearly tripling non-revenue hours and miles and increasing the fleet size by 71 percent. Due to the range limitations of today's electrified cutaways, MST plans to defer the transition of this specific vehicle type to allow more time for vehicle technology to advance.

The total cost to transition MST's fleet to ZEBs is anticipated to be large. Capital costs for vehicles (excluding cutaways) and infrastructure are expected to exceed $130 million in current year dollars. Additional expenses for facility modifications, including but not limited to site, civil, and electrical work can also be anticipated.

1 INTRODUCTION

As one of the most geographically diverse transit agencies in California, serving communities from coastal flatlands to inland valleys, MST has developed a comprehensive plan to convert its entire transit bus fleet to zero emission vehicles by 2040. This transition represents a significant shift in operational practices, infrastructure development, and environmental stewardship across MST's expansive service area, which spans from the scenic Monterey Peninsula to the agricultural heart of the Salinas Valley. The Zero Emission Fleet Transition Plan (Transition Plan) outlined in this report serves as a strategic roadmap to guide MST through this complex transition.

The drive toward this transition stems from several factors, including regulatory requirements, environmental considerations, and advancements in zero-emission vehicle technology. California's Innovative Clean Transit (ICT) regulation, adopted by the California Air Resources Board in December 2018, requires all public transit agencies in the state to transition to 100% zero-emission bus (ZEB) fleets by 2040. This aligns with broader state and federal initiatives aimed at reducing greenhouse gas emissions and improving air quality across the state.



This Transition Plan builds from earlier efforts undertaken by MST to transition to a fully zero-emission fleet. MST's first zero-emission transition plan was developed in 2021 following ICT regulation. In the four years since that plan was published, there have been many changes both in the zero-emission technology market and within MST's operation, including service changes and expansions. Due to these changes, an update to MST's earlier transition strategy was required to ensure that the strategy laid out was still the best path forward.

Through this Transition Plan, MST has conducted a comprehensive analysis of its current operations, fleet composition, and infrastructure capabilities. This Transition Plan assesses energy modeling for BEBs and FCEBs, providing data-driven insights to inform decisions on vehicle technology selection, infrastructure requirements, and operational strategies that will serve MST's diverse communities. This Transition Plan results from collaboration with key stakeholders, including local and regional partners, utility providers, and industry experts. It considers MST's unique operational landscape, which spans diverse terrains from coastal flatlands to inland valleys, serving communities across Monterey County and beyond.

The Transition Plan serves as both a guiding document and a demonstration of MST's commitment to environmental sustainability, operational excellence, and community service. It offers a comprehensive blueprint for MST's transition to a zero-emission future, supporting the agency's continued efforts for efficient, reliable, and environmentally responsible transit service for generations to come.

2 POLICY & LEGISLATION IMPACTS

2.1 FEDERAL POLICY

As the transition to electric transportation accelerates, the U.S. federal government has taken a proactive role in shaping policies that support this shift. These initiatives aim to reduce greenhouse gas (GHG) emissions, decrease reliance on fossil fuels, and stimulate economic growth through innovation and job creation in the clean energy sector. By aligning local strategies with national objectives, transit authorities can effectively leverage federal resources and incentives to enhance their infrastructure and integrate ZEBs into their fleet.

Over the last several years, the federal government has supported ZEB initiatives through programs like the Federal Transit Administration's (FTA) Low or No Emission Vehicle Program, which provides funding for transit agencies to procure ZEBs and develop the necessary infrastructure. FTA's Bus and Bus Facilities Grant Program also provides fiscal support to transit agencies, allocating $1.5 billion dollars to buy American-made buses. 80% of the funding from this program will go towards zero and low-emission technology, as well as improving bus facilities to support these technologies. It should be noted, however, that both grant opportunities are highly competitive. While MST has consistently submitted grant applications over the past several years and received high scores, it has yet to be awarded funding.

2.1.1 INFRASTRUCTURE INVESTMENTS

The Bipartisan Infrastructure Law (BIL) supports infrastructure investment for ZEBs by allocating substantial funding for cleaner transit options.[1] The BIL authorized a combined total of approximately $52.5 billion for fiscal year 2022, with incremental increases in subsequent years, including dedicated funding for public transportation infrastructure projects. This funding is crucial for transit agencies like MST as they seek to develop the necessary charging infrastructure and maintenance facilities essential for ZEB operations.[2] The BIL emphasizes collaboration between federal and local entities to facilitate a streamlined process for grant applications and funding allocations.[3] It should be noted that with the new Presidential Administration in 2025, future availability of these funds may possibly be compromised, but it is too soon to tell what impact, if any, may be experienced as a result.

Under the BIL, specific programs such as the Carbon Reduction Program provide targeted financial resources that can be utilized for ZEB infrastructure investments, among other carbon-reducing initiatives. These programs can support the acquisition of ZEBs and fund the construction of charging stations, ensuring that transit agencies can meet operational demands while adhering to California's stringent air quality regulations. Funding from these programs can be used to support various carbon-reducing efforts, which means that state and local entities must balance limited funding allocations towards zero-emission transportation projects versus other efforts.

2.1.2 TAX CREDITS

The Inflation Reduction Act (IRA) extends significant benefits for ZEBs through various incentives aimed at promoting clean energy and reducing emissions. One of the key components of the IRA is the expansion of tax credits for charging infrastructure, which includes funding for ZEB charging stations. Additionally, the IRA includes provisions that incentivize the manufacturing of clean energy technologies in the U.S., which can lower the costs of ZEB production. By supporting domestic manufacturing, the act aims to create jobs while ensuring transit entities

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[1] U.S. Department of Transportation (2024): https://www.transportation.gov/mission/budget/bil-funding-status-report
[2] Bipartisan Infrastructure Law: https://www.transit.dot.gov/BIL
[3] California Transit Association: https://caltransit.org/Advocacy/How-We-Advocate/Key-Issues/ZEB

have access to affordable high-quality buses. The legislation also offers rebates and tax credits for public entities, including transit agencies, allowing them to receive direct payments for investments in clean energy projects.[4]

2.1.3 RESEARCH AND DEVELOPMENT GRANTS

The U.S. Department of Energy (DOE) provides grants for EV charging and clean transportation-focused research projects. Charging deployments highlighting innovative mobility solutions and increased charging accessibility are given priority.[5] These federal policies provide a framework that transit entities like MST can build upon so that future ZEB initiatives and fleet planning efforts are comprehensive and aligned with national goals.

2.2 STATE POLICY

At the state level, the ICT regulation mandates that all California public transit agencies transition to a 100% ZEB fleet by 2040, which aligns with federal goals for reducing GHG emissions. Together, these complementary policies encourage local agencies to innovate and reduce GHG emissions.

California's ambitious electrification efforts are supported by various programs that provide funds for zero emission vehicle (ZEV) infrastructure efforts. The state has dedicated significant funding to support clean transportation goals and is anticipated to receive more than $380 million from President Biden's Infrastructure Investment and Jobs Act (IIJA) for building out chargers.

In 2024, the California Energy Commission (CEC) approved more than $1 billion in funding for EV charging and hydrogen refueling projects for cars, trucks, and buses. Additional funding at the state level includes the Low Carbon Transit Operations Program (LCTOP), which provides flexible funding for transit agencies to reduce greenhouse gas emissions and improve mobility, especially in disadvantaged communities. The LCTOP has consistently provided annual funding for MST's operational uses since the program began, with recent allocations supporting ZEBs and charging infrastructure.

Under Senate Bill 375 (SB 375), California governing entities are expected to demonstrate land use and transportation measures that will be used to meet the region's GHG emission reduction targets as established by the California Air Resources Board (CARB) – a three percent reduction per capita change by 2020 and six percent per capita reduction by 2035 from passenger vehicles.[6] Meeting these targets will require progressive transportation planning, including ZEB fleet electrification, to achieve GHG reduction goals and work toward overall sustainability. SB 375 also offers California's Environmental Quality Act incentives to encourage projects that are consistent with the initiatives of the bill.[7]

Additionally, California signed a memorandum of understanding (MOU) to support the deployment of medium and heavy-duty (MHD) ZEVs through involvement in a Multi-State ZEV Task Force.[8] In July 2022, the Task Force published an Action Plan to support electrification of MHD vehicles. The plan includes strategies and recommendations to accomplish the goals of the MOU, including limiting all new MHD vehicle sales in the signatory states to ZEVs by 2050, accelerating the deployment of MHD ZEVs, and ensuring MHD ZEV deployments also benefit disadvantaged communities.[9]

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[4] Internal Revenue Service: https://www.irs.gov/clean-vehicle-tax-credits
[5] Alternative Fuels Data Center: https://afdc.energy.gov/laws
[6] Association of Monterey Bay Area Governments 2045 MTP (2022): https://ambag.org/sites/MTP
[7] Institute for Local Government | SB 375: https://www.ca-ilg.org/post/basics-sb-375
[8] Multi-State Medium- and Heavy-Duty ZEV MOU: https://ww2.arb.ca.gov//Multistate-Truck-ZEV-Governors
[9] Alternative Fuels Data Center: MHD and ZEV Deployment Support: https://afdc.energy.gov/laws/12471

Table 1 provides a snapshot of some of California's current laws, incentives, regulations, funding opportunities and other initiatives related to alternative fuel buses.[10]

Table 1. California State Incentives and Regulations

State Incentives	
Alternative Fuel and Vehicle Incentives	The CEC administers the Clean Transportation Program to provide financial incentives for businesses, vehicle and fleet owners, and consumers to advance the deployment of advanced transportation technologies.
Emissions Reductions Grants	Provides incentives to cover the incremental cost of purchasing engines and equipment. Eligible projects include heavy-duty fleet modernization and other significant near-term emission reduction projects.
Low Emission Truck and Bus Purchase Vouchers	CARB provides vouchers to eligible fleets to reduce the incremental cost of qualified electric, hybrid, or natural gas trucks and buses at the time of purchase.
Laws & Regulations	
Medium- and Heavy-Duty ZEV Requirement	CARB's Advanced Clean Truck Program requires all new medium- and heavy-duty vehicles sold in California to be a ZEV by 2045.

2.2.1 CALIFORNIA AIR RESOURCES BOARD

The CARB plays a pivotal role in shaping transportation policy aimed at reducing emissions and improving air quality across the state. As part of its broader mandate, CARB has implemented various programs targeting heavy-duty vehicles, including the ICT Regulation. CARB's initiatives are driven by the need to address significant public health risks associated with air pollution, including the reduction of harmful criteria pollutants like nitrogen oxides (NOx) and particulate matter. The board's regulatory framework not only focuses on emissions reductions but also emphasizes the importance of adopting clean technologies that align with California's climate goals.[11]

CARB collaborates with various stakeholders, including transit agencies like MST, to facilitate the transition to zero emission technologies. This partnership is essential for developing comprehensive strategies that include financial incentives, technical assistance, and infrastructure investment. Additionally, CARB's commitment to equity ensures that disadvantaged communities disproportionately affected by pollution benefit from cleaner transit options. By advancing policies that promote zero emission vehicles and supporting innovative solutions in public transportation, CARB aims to create a sustainable future while enhancing mobility options for all Californians.

CARB initially predicted the overall cost burden for transitioning to ZEBs would decrease over time as agencies across California purchased and implemented ZEBs and the required infrastructure. This has not come to fruition. A BEB purchased before 2021 was approximately 45% cheaper and a hydrogen FCEB was almost 100% cheaper. The cost for implementing hydrogen fueling infrastructure has ballooned and the price for hydrogen (as a fuel), for many

[10] Alternative Fuels Data Center: California Laws and Incentives (energy.gov)
[11] California Air Resources Board: https://ww2.arb.ca.gov/about

California transit agencies has consistently increased and remains above $10 per kg today. The theory of supply and demand has not resulted in cheaper ZEB technology costs as CARB had initially theorized. This is further complicated by the battery technology challenges that BEBs face and the transit OEM's inability to manufacture zero emission medium duty vehicles on a large scale.

To date, the District of Columbia and the seventeen (17) states shown in **Figure 1** below have adopted all or part of California's low-emission and zero-emission vehicle regulations, as allowed under Section 177 of the Clean Air Act. This additional support for the clean vehicle market means that more than 35% of new light-duty vehicle sales nationally meet California automotive emissions standards.[12]

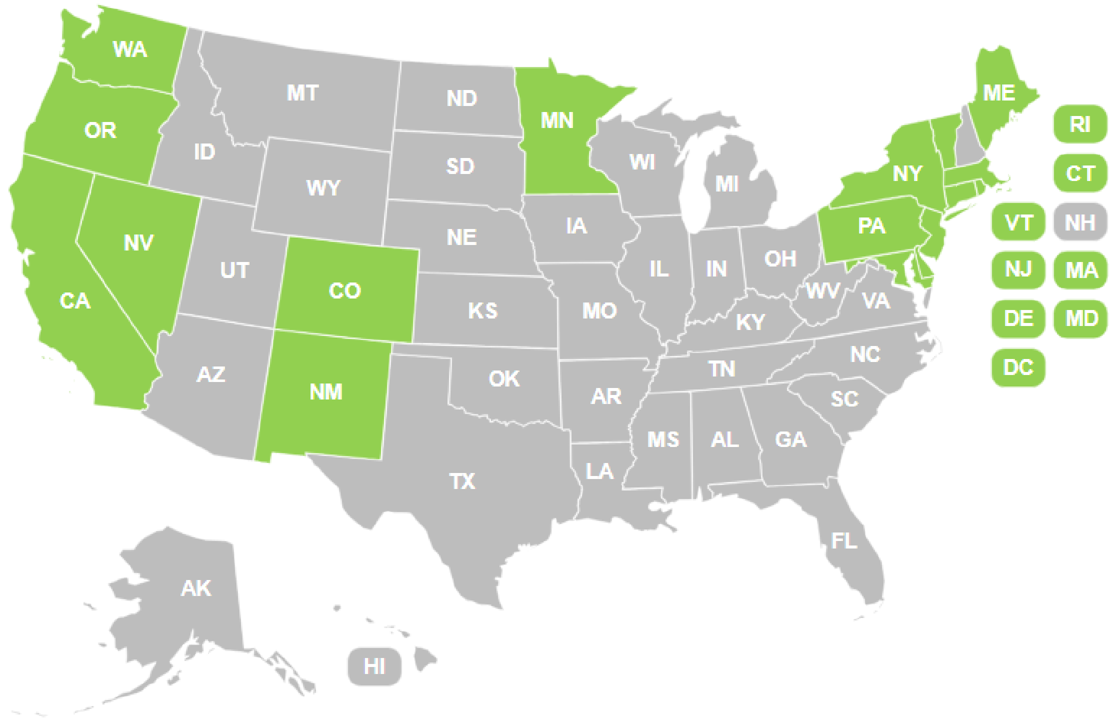

Figure 1. States Adopting CARB Regulations Under Section 177 of the Clean Air Act

2.2.2 INNOVATIVE CLEAN TRANSPORTATION REGULATION

The ICT Regulation, adopted by the CARB in December 2018, mandates that all public transit agencies retire Internal Combustion Engine (ICE) vehicles within their fleet by 2040. This regulation establishes a phased approach, requiring transit agencies to incrementally increase the percentage of new bus procurements that must be ZEBs, starting with 25% in 2023 and escalating to 100% by 2029.

The ICT Regulation aims to significantly reduce GHG emissions and other pollutants from the transit sector, which is responsible for a significant portion of California's air quality issues. By implementing this regulation, CARB seeks to promote innovative solutions that enhance public transportation while also addressing environmental concerns.[13]

[12] Advanced Clean Cars II | California Air Resources Board

[13] California Air Resources Board: https://ww2.arb.ca.gov/resources/fact-sheets/innovative-clean-transit-ict-regulation-fact-sheet

It is important to emphasize that the ICT regulation is an unfunded mandate, as California state funds fall short in supporting the required transition.

The ICT Regulation is designed to provide flexibility and support for transit agencies during this transition. It includes provisions for exemptions and compliance options that allow agencies to adapt their plans based on economic conditions and technological advancements. This flexibility is crucial as it recognizes the challenges transit agencies may encounter while transitioning from conventional diesel fleets to advanced zero emission technologies. The regulation encourages collaboration among transit agencies, fuel providers, and local governments to develop the necessary infrastructure and support systems for ZEB deployment.

2.2.3 CLIMATE ACTION PLAN FOR TRANSPORTATION INFRASTRUCTURE

The California State Transportation Agency (CalSTA) developed the Climate Action Plan for Transportation Infrastructure (CAPTI) in July 2021, in collaboration with many different state agencies. CAPTI is the result of Executive Order N-79-20, signed by Governor Newsom in 2019 and again in 2020, targeted at reducing GHG emissions.[14] CAPTI includes recommendations on how to invest billions in state discretionary transportation dollars annually to address climate change while supporting public health, safety, and equity.[15] The state renewed its commitment by releasing CAPTI 2.0 in February 2025.

2.3 LOCAL AND REGIONAL POLICY

2.3.1 LOCAL PLANNING & POLICY

MST primarily operates within Monterey County serving all incorporated cities and a large portion of the unincorporated county. MST also serves Santa Cruz, Santa Clara, and San Luis Obispo Counties. Many of these agencies are advancing local policies geared towards zero emission and sustainable transit initiatives. These cities are aligning their transportation strategies with California's broader climate goals and CARB regulations, demonstrating a commitment to reducing GHG emissions and improving air quality. The following table illustrates the diverse sets of policies related to transportation and transit electrification for various agencies where MST operates.

Table 2. Local Initiatives

Jurisdictions	Relevant Documents	Relevant Initiatives
Monterey County		
Carmel-by-the-Sea	Climate Action Plan General/Coast Land Use Plan	• Community electrification initiatives/improved transportation[16] • Protect environmental quality • Encourage alternative modes of transportation[17]

[14] Executive Department State of California: https://www.gov.ca.gov/wp-content/EO N-79-20
[15] California State Transportation Agency CAPTI Overview: https://calsta.ca.gov/subject-areas/climate-action-plan
[16] City of Carmel-by-the-Sea Climate Action Plan (2022): https://ci.carmel.ca.us/sites/main/files/file-attachments/climate adaptation plan
[17] City of Carmel-by-the-Sea General Plan/Coastal Land Use Plan: https://ci.carmel.ca.us/post/general-plan

Jurisdictions	Relevant Documents	Relevant Initiatives
Monterey	Climate Action Plan	• GHG emission reduction strategies to reach 2030 & 2050 goals – includes supporting community and city transportation measures[18]
Salinas	Climate Action Plan	• Support equitable GHG emission reduction strategies[19]
San Luis Obispo County		
Paso Robles	General Plan	• Support offering more travel choices to reduce GHG emissions in the community[20]
Santa Cruz County		
Watsonville	Climate Action & Adaptation Plan	• GHG emission reduction goals – includes supporting community and city transportation measures, facilitating EV master plan, and promoting mass transit use • Significant support for electrification shift
Santa Clara County		
Gilroy	General Plan	• Natural resource conversation/GHG emission reduction • Support changing regional transit operations[21]

2.4 REGIONAL PLANNING & POLICY

2.4.1 2045 METROPOLITAN TRANSPORTATION PLAN/SUSTAINABLE COMMUNITIES STRATEGY

The Association of Monterey Bay Area Governments (AMBAG) is the Metropolitan Planning Organization (MPO) for the Monterey Bay Area. The Metropolitan Transportation Plan (MTP) offers solutions to the region's transportation

[18] City of Monterey Climate Action Plan (2016): https://files.monterey.org/Climate Action Plan
[19] City of Salinas Climate Action Plan: https://www.visionsalinas.org/climateactionplan
[20] City of Paso Robles General Plan (2019): https://www.prcity.com/Adopted-Circulation-Element
[21] City of Gilroy General Plan 2040 (2020): https://www.cityofgilroy.org/Gilroy-2040-General-Plan

needs through 2045, with the Sustainable Communities Strategy (SCS) built on a set of integrated policies, strategies, and investments working synchronously with the objectives of the MTP.

The MTP's vision and strategies emphasize regional progress towards resilient, equitable solutions for Monterey Bay Area residents and highlights SB 375, California's Sustainable Communities and Climate Protection Act, mandating the development of a SCS.[22] At the core of SB 375 is the goal to coordinate transportation investments with land use patterns, enabling the region to make informed decisions about investing limited resources while improving access to destinations and offering alternative transportation options, including ZEBs.

To develop the SCS, AMBAG collaborated with local and regional partners to gather information and devise strategies for a feasible goal and actionable MTP/SCS. AMBAG also engaged the public and regional stakeholders to identify regional priorities. Within this framework, the MTP/SCS sets forth a vision for less carbon intensive vehicle fleets.[23] Through partial zero and ZEV technologies, the 2045 MTP/SCS promotes a sustainable future through reduced tailpipe emissions from vehicles on the road.

2.4.2 CENTRAL COAST ZERO EMISSION VEHICLE STRATEGY

In 2023, AMBAG collaborated with the Santa Barbara and San Luis Obispo Association of Governments to develop the Central Coast Zero Emission Vehicle Strategy (CCZEVS). While the focus of this study is meeting the needs of interregional travelers along major travel corridors in unincorporated areas, the study recognizes that serving disadvantaged communities (DACs), multifamily housing (MFH), and drivers without home charging remains a substantial barrier to EV adoption, and in many cases, these charging needs will overlap. Counties and municipalities in the study area may choose to prioritize the installation of charging infrastructure in either location. However, serving DACs, MFHs, and others without home charging will take a multi-pronged approach. In some cases, the solution may not be charging infrastructure at all but zero-emission public transit, shuttle services, and micro-mobility. Throughout the CCEVS, ZEV initiatives are integrated into the main strategies, such as transit agency ZEB procurement planning initiatives.

Within the study, an approach to overcoming barriers and gaps for the Central Coast Region to transition to a decarbonized transportation future is offered. These solutions include approaches to electrical grid capacity concerns relating to ZEV infrastructure for heavy-duty vehicles, such as transit buses. The study also emphasizes the need for jurisdictions within the Central Coast to participate in regulatory proceedings regarding the decarbonization of transportation efforts across jurisdictional, county, state, and service area bounds.

Due to the nature of transportation, the entities working on the CCEVS recognize that planning for the transition to zero-emission technologies will require coordination across borders and boundaries of counties, cities, utility service territories, transit agencies, and more. For this reason, they recommend a collaborative approach to ZEV planning. Some of the goals and activities that they suggest collaborating on regularly include:

- Providing important data that helps member counties, cities, and communities be more competitive for ZEV-related grants and programs and collaborating on grant and funding opportunities where appropriate
- Measuring progress toward increasing the number of charging stations in desired areas
- Measuring and recording equity impacts
- Measuring progress toward ZEV adoption by vehicle class and type
- County or corridor specific goals

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[22] California Air Resources Board: https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-climate-protection-program

[23] Association of Monterey Bay Area Governments 2045 MTP/SCS (2022): https://ambag.org/sites/MTP-SCS-2045

- Estimating GHG reduction[24]

Through collaboration with MST and other regional partners, the Monterey Bay Area region is paving the way for a cleaner, more efficient transit system that meets the evolving needs of their communities while addressing climate challenges.

2.4.3 MONTEREY BAY AIR RESOURCES DISTRICT

The AB2766 program, established by the Monterey Bay Area Resources District (MBARD), allocates funds from a $4.00 vehicle registration surcharge to projects aimed at reducing motor vehicle emissions. These projects include vehicle electrification, traffic management systems, and incentives for ZEVs. Historically, MST received up to $400,000 annually from this program for bus replacements. However, MBARD has recently adopted a broader distribution strategy for these funds, making it a less reliable source for MST to finance zero-emission buses.[25]

2.5 PROVIDING SERVICE IN DISADVANTAGED COMMUNITIES

MST has secured funding for and submitted purchase orders to Gillig for 12 BEBs in December 2023 and 1 additional BEB in 2024, targeting deployment in areas compatible with BEB technology. The implementation focuses on SB535 communities, which are state-designated disadvantaged areas identified through CalEnviroScreen's environmental and socioeconomic indicators.[26]

2.5.1 CURRENT DEPLOYMENT STATUS

While BEBs have been strategically deployed on routes that can accommodate their range limitations, not all SB535 routes will be immediately served. Current technology constraints limit the coverage of SB535 routes. However, vehicle acquisitions from 2027 onward will feature enhanced range capabilities, enabling expanded service to these communities.

2.5.2 FUTURE PLANNING

The deployment of ZEBs to additional routes will be evaluated based on several key factors, including:

- Range requirements;
- Ridership patterns; and
- Available seating capacity.

This strategic approach will ensure optimal utilization of ZEBs while maintaining service quality in DACs.

2.5.3 UTILITY ENGAGEMENT

California state utility providers have played a significant role in supporting California's commitment towards vehicle electrification and the deployment of charging stations across the state.

2.5.3.1 Pacific Gas and Electric

In the MST service area, Pacific Gas and Electric (PG&E) is actively involved in electrification efforts, providing essential infrastructure and incentives that support electrification initiatives. PG&E has launched several programs aimed at supporting local transit entities in their electrification goals. These initiatives include financial incentives for the installation of charging infrastructure, helping cross barriers of robust upfront infrastructure costs.[27] Some

[24] Santa Barbara County Association of Governments, CCZEVS (2023): https://ambag.org/sites/default/files/
[25] Monterey Bay Area Resources District, AB2766: https://www.mbard.org/ab2766-motor-vehicle-emission-reduction-grants
[26] CalEPA SB-535-Designation
[27] Pacific Gas and Electric EV Fleet Program: https://www.pge.com/en/clean-energy/electric-vehicles/ev-fleet-program

financial incentives have required that charging infrastructure be made available to the public; however, this has limited the ability of MST to accept funding.

PG&E also collaborates with MST to assess energy needs, working to ensure that adequate charging capacity is available at transit facilities. PG&E has demand response programs that help manage energy usage during peak times, optimizing costs and enhancing grid reliability. It should be noted, however, that the timeframe for PG&E to complete electric infrastructure upgrades can be lengthy, and this process is best begun as soon as possible.

2.5.3.2 Central Cost Community Energy

Central Coast Community Energy (3CE), formerly Monterey Bay Community Power (MBCP), also developed an Electrification Program Roadmap in 2019 which included MBCP staff and key stakeholders including the Monterey Air Resources Board (MBARD), AMBAG, and representatives of local government agencies including the cities of Santa Cruz, Watsonville, and San Luis Obispo. This electrification roadmap identifies methods of collaboration on electrification initiatives throughout the region, including the deployment of ZEBs.[28]

2.6 PEER AGENCY REVIEW

MST is part of a broader network of transit agencies in California that are actively implementing ZEB initiatives in response to CARB's ICT regulation. Peer agencies such as SamTrans, Sunline Transit, Riverside Transit, and Los Angeles County Metropolitan Transit Authority (METRO) are leading the change in transitioning their fleets to cleaner technologies, showcasing innovative approaches and strategies.

SamTrans is transitioning its diesel bus fleet to a 100% zero-emission fleet by 2034, six years ahead of the state mandate. This transition includes the integration of both BEBs and hydrogen fuel cell buses FCEBs to reduce GHG emissions and enhance operational flexibility and resilience.[29] The California Transportation Commission (CTC) allocated $15 million dollars from the Transit and Intercity Rail Capital Program (TIRCP) to support the purchase of 108 new ZEBs for the agency. SamTrans is also investing in infrastructure upgrades, such as managed charging systems, to optimize energy use and reduce costs.[30] Additionally, SamTrans is committed to implementing an equitable workforce development and community engagement approach to ensure a smooth transition to ZEBs, as outlined in their ICT Rollout Plan.[31]

SunLine Transit Agency has been at the forefront of ZEB adoption, operating a fleet that includes FCEBs and battery electric buses BEBs. They have developed a comprehensive training program for workforce development focused on ZEB maintenance and operation, supported by funding from CARB and the California Energy Commission.[32] This initiative aims to ensure that personnel are well-equipped to handle the complexities of new technologies, thereby enhancing operational efficiency and service reliability.

Riverside Transit Agency is also making significant strides in electrification. They have committed to integrating BEBs into their fleet, with plans to deploy several units in the coming years. The agency is actively collaborating with local utility companies to develop necessary charging infrastructure, addressing one of the primary

[28] Monterey Bay Community Power (2019): https://3cenergy.org/wp-content
[29] SamTrans ZEB (2024): https://www.samtrans.com/zeb
[30] SamTrans News (2024): https://www.samtrans.com/news/
[31] SamTrans ICT Rollout Plan (2020): https://ww2.arb.ca.gov/sites/SamTrans-ICT-RolloutPlan.pdf
[32] Alternative Fuels Data Center: https://afdc.energy.gov/case

challenges faced by transit agencies as they transition to ZEBs. Their efforts include participation by federal and state-funded programs aimed at reducing the costs associated with infrastructure development.[33]

LA METRO has launched an ambitious plan to transition its entire fleet to ZEVs by 2030. This includes extensive pilot programs or BEBs and FCEBs, along with investments in charging and fueling infrastructure. METRO's approach emphasizes community engagement and sustainability, ensuring that their initiatives align with broader climate goals while meeting the transportation needs of Los Angeles residents. In July 2024, the FTA awarded $77.5 million to METRO for ZEBs and charging infrastructure through the USDOT's Low or No Emission grant program, becoming the second largest award recipient in the country. The funds will support METRO's procurement of BEBs, installation of chargers, and expanded workforce development.[34]

These peer agencies exemplify how transit networks in California can effectively implement ZEB initiatives through strategic planning. Their experiences provide valuable insights in navigating fleet transitions that comply with federal and state regulations, as well as enhance service delivery across the service area.

[33] Riverside Transit Agency (2024): https://www.riversidetransit.com

[34] Los Angeles Metro (2024): https://www.metro.net/about/federal-transit-administration-awards-77-5-million-to-metro-for-zero-emission-bus-and-charging-infrastructure-project

3 EXISTING CONDITIONS

3.1 OPERATING & MAINTENANCE FACILITIES

MST currently operates fixed-route services out of four (4) total facilities, namely, Clarence J Wright (CJW) O&M Facility, South County (SCO) O&M Facility, Thomas D. Albert Operations Facility (TDA), which are directly operated by MST, and Joe Lloyd Way (JLW) which is currently leased by MST and operated by MST's contract transportation provider. Fixed-route transit services operated out of all four facilities were evaluated as part of the transition strategy, with a focus on MST's three directly operated facilities.

3.1.1 CLARENCE J WRIGHT (CJW) O&M FACILITY

CJW is an MST-owned O&M facility located in Salinas. This facility includes a bus maintenance building with 3 service bays, gasoline and diesel fueling infrastructure, and an outdoor bus parking area. At a maximum, 50 buses can be stored and serviced at CJW with the existing infrastructure. A satellite image of the facility is shown in **Figure 2** with parking and maintenance facilities labeled.

Figure 2. CJW O&M Facility Aerial View of Existing Layout

MST currently has two (2) 80 kW BYD chargers, two (2) 62.5 kW ChargePoint CPE-250 chargers on-site at CJW, and three (3) additional chargers are planned to be installed before the end of 2025. An additional O&M facility in Salinas is being designed to include hydrogen and electric charging infrastructure, but the specific site has not yet been identified.

3.1.2 SOUTH COUNTY (SCO) O&M FACILITY

SCO is an MST-owned O&M facility located in King City. This facility includes a bus maintenance building with 4 maintenance bays, gasoline fueling infrastructure, a bus wash, and an outdoor bus parking area. At a maximum, 100 buses can be stored and maintained at SCO with the existing infrastructure. A satellite image of the facility is shown in **Figure 3** with parking and maintenance facilities labeled in orange and blue, respectively.

Figure 3. SCO O&M Facility Aerial View of Existing Layout

MST plans to install both electric and hydrogen fueling infrastructure on-site at SCO, but a date has not yet been identified for implementation. MST was recently awarded an LCTOP grant for a project that will upgrade this facility to safely accommodate and enable maintenance work on FCEBs; this project is expected to be completed in 2028 or sooner.

3.1.3 THOMAS D. ALBERT (TDA) O&M FACILITY

TDA is an MST-owned O&M facility located in Monterrey. This facility includes a bus maintenance building with 6 maintenance bays, administrative offices, gasoline fueling infrastructure, a bus wash, and an outdoor bus parking area. At a maximum, 60 buses can be stored and maintained at TDA with the existing infrastructure. A satellite image of the facility is shown in **Figure 4** with parking and maintenance facilities labeled.

Figure 4. TDA O&M Facility Aerial View of Existing Layout

MST currently has one (1) 80 kW BYD charger, one (1) 50 kW electric trolley charger, three (3) 62.5 kW ChargePoint CPE-250 chargers on-site at TDA, and six (6) additional chargers are planned to be installed before the end of 2025. Hydrogen fueling is also planned for this facility, but a date for building hydrogen fueling infrastructure has not yet been identified. MST is in the process of upgrading this facility so the workforce can perform maintenance work on FCEBs. These upgrades are expected to be completed in 2026.

3.1.4 JOE LLOYD WAY (JLW) O&M FACILITY

JLW is a contractor O&M facility located in Seaside that currently houses all of MST's cutaway vehicles. A satellite image of the facility is shown in **Figure 5**, with different parking areas labeled. MST does not have direct access to the maintenance areas of the properties; MST currently leases this property as a park-out for cutaways but all maintenance is performed by the contractor at this site. Additionally, there are no plans to upgrade electrical for BEB chargers at these properties.

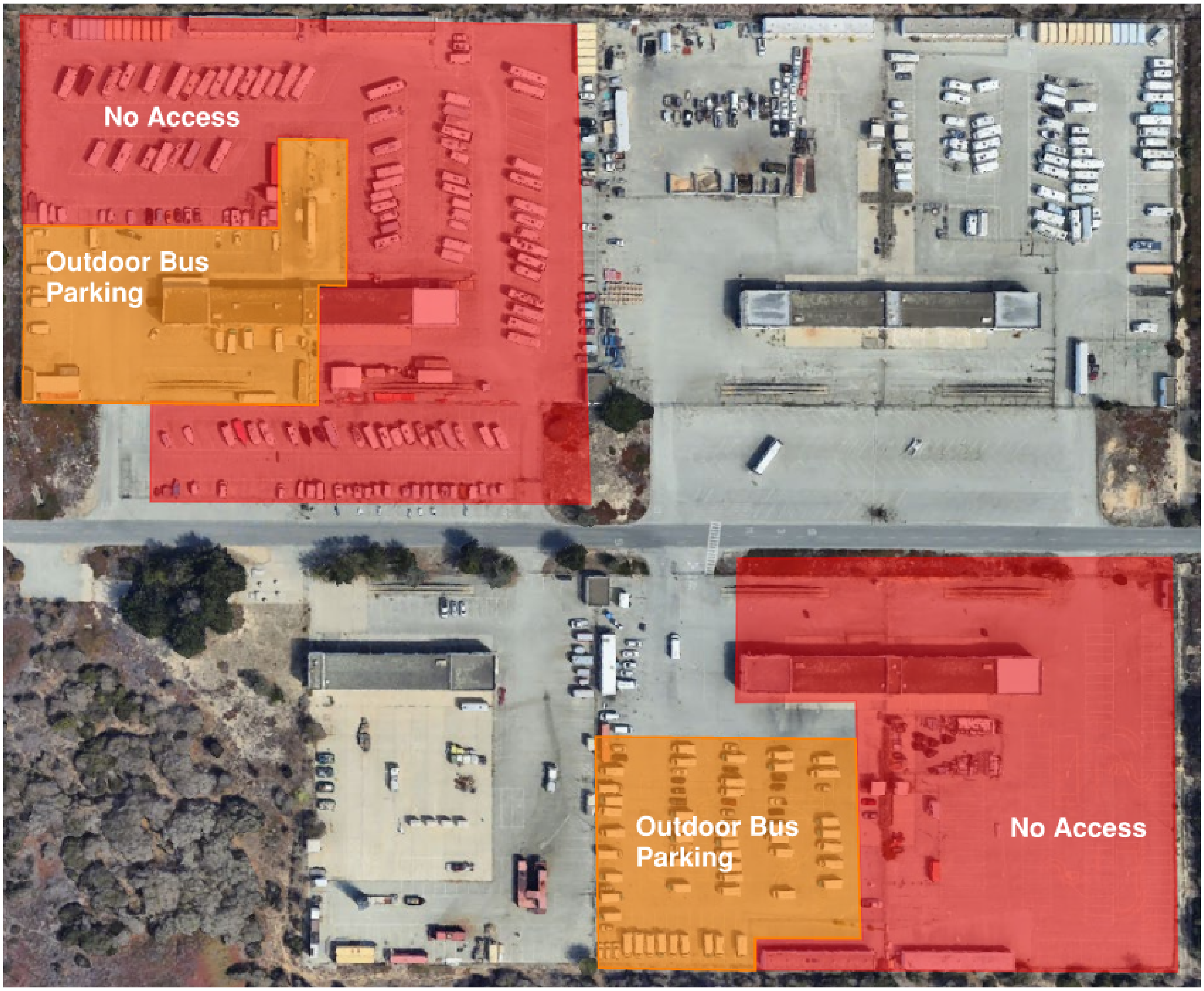

Figure 5. JLW Contractor Facility Aerial View of Existing Layout

3.2 FLEET COMPOSITION

3.2.1 BUS FLEET

A summary of MST's current fixed-route fleet count by assigned facility is shown below in **Table 3**. The overall fleet is largely made up of biofuel- and gasoline-fueled vehicles, with two (2) 40' Gillig BEBs and two (2) 30' BYD BEBs. The biofuel fleet is comprised of a mix of 35' and 40' Gillig low floor buses, and the gasoline fleet is a mix of various cutaway models in varying lengths.

Table 3. Existing Fixed-Route Fleet Inventory

Fuel Type	Length	Fleet Size by Facility				Total
		CJW	SCO	TDA	JLW	
Heavy-Duty Low Floor						
Biofuel	35′	15	2	13	-	**30**
Biofuel	40′	17	11	15	-	**43**
Battery Electric	30′	2	-	-	-	**2**
Battery Electric	40′	2	-	-	-	**2**
Trolley						
Biofuel	30′	-	-	3	-	**3**
Biofuel	35′	-	-	5	-	**5**
Battery Electric	30′	1				**1**
Cutaway						
Gasoline	22′	-	-	-	8	**8**
Gasoline	23′	-	-	-	15	**15**
Gasoline	25′	-	-	-	19	**19**
Gasoline	28′	-	-	-	6	**6**

3.3 FIXED-ROUTE SERVICE OPERATIONS

The MST Regional System Map (**Figure 6**) illustrates the extensive network of routes operated by MST. This comprehensive system serves a diverse area, connecting coastal communities like Monterey and Carmel with inland cities such as Salinas, King City and Gilroy. Key features of MST's fixed-route service operations include:

1. **Geographic Coverage**: The system spans a large portion of Monterey County, providing vital connections between urban centers, suburban areas, and rural communities.
2. **Route Diversity**: MST operates a mix of local, express, and regional routes, meeting a wide array of travel needs within the service area.
3. **Major Corridors**: The map highlights several major transit corridors, including routes along Highway 1 connecting coastal towns, and inland routes serving the Salinas Valley.
4. **Intermodal Connections**: The system offers connections to other transportation modes, including intercity bus services, enhancing regional mobility.
5. **Diverse Topography**: The service area encompasses diverse terrain, from coastal flatlands to hillier regions, which can impact energy consumption and vehicle performance.

MST's diverse and expansive network underscores the importance of performing energy modeling to assess the feasibility of zero emission vehicles and their capacity to maintain or improve current service levels across all route types and terrains.

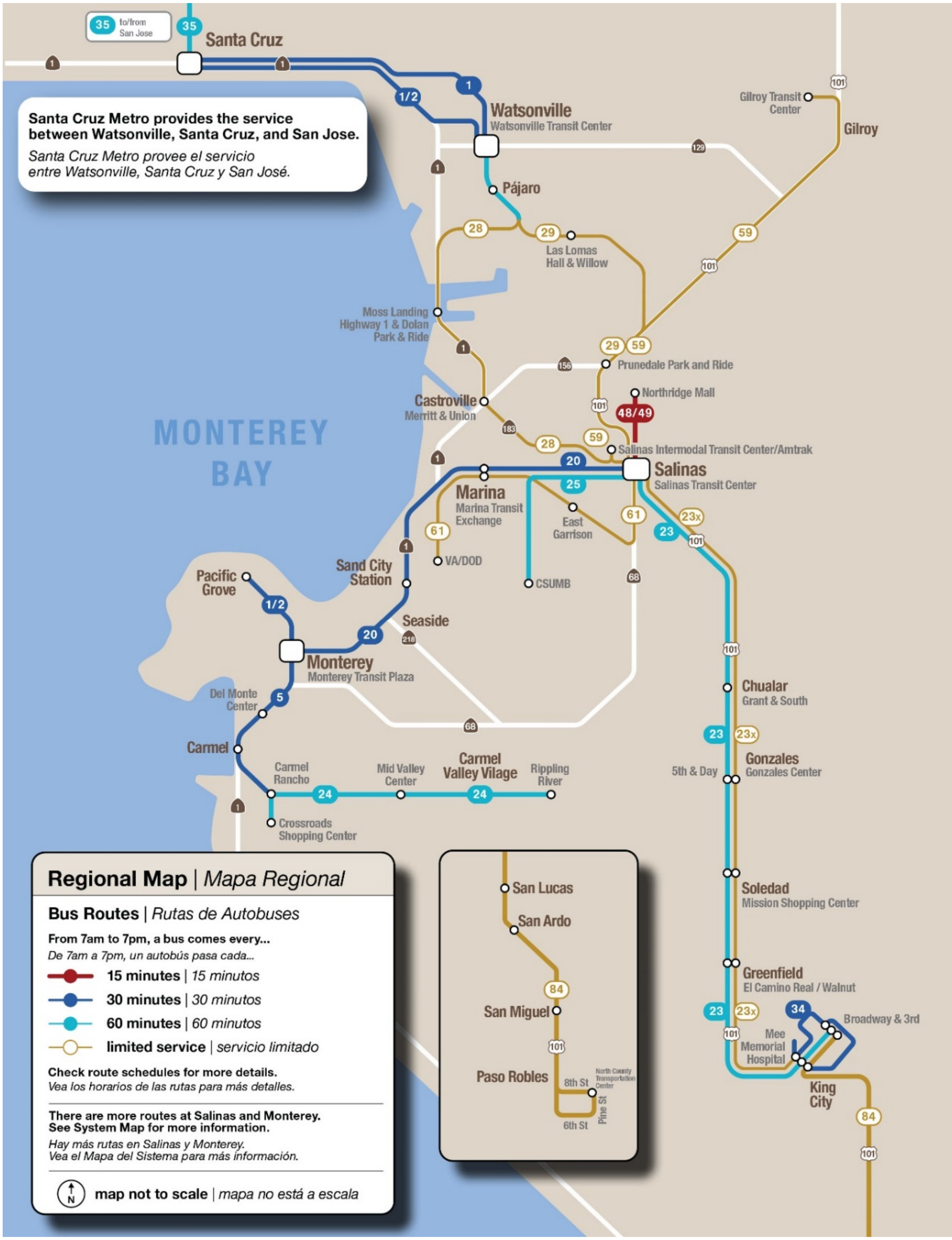

Figure 6. MST Regional System Map[35]

4 SYSTEM LEVEL PLANNING

4.1 ZERO EMISSION BUSES AND FUELING OPTIONS

As transit agencies look for a zero-emission technology to replace diesel buses, there are two primary options: battery electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs). BEBs are currently the most popular zero emission bus because they utilize the electric grid as a source of fuel, which is universally available and relatively easy to access. One shortfall is the limited range of BEBs compared to conventional diesel buses; for agencies with longer range requirements, BEBs may not be capable of directly replacing buses assigned to long duty cycles at a 1-to-1 replacement ratio. In some cases, it's not possible to adjust the service profile of these longer blocks to accommodate the range capabilities of today's available BEBs. For extended range requirements, either additional vehicles become necessary, or on-route charging would need to be introduced at layover points along current routes.

On-route charging is an enhancement that can greatly improve the feasibility of BEBs; they can extend the range of a BEB and facilitate one-to-one replacement of diesel vehicles when the routes are conducive to this charging strategy. This is particularly helpful with circular routes where the same on-route charger can be used by a vehicle multiple times throughout the day. En-route charging infrastructure would be ideally located at places such as transit centers where buses operating on multiple routes all have scheduled layover time.

Hydrogen FCEBs are the other primary option for a zero-emission transition. The greatest benefit of FCEBs is that their range is comparable to diesel buses. However, the challenge with deploying FCEBs is locating a source of hydrogen, since this fuel is not as readily available as electricity. FCEBs use a drivetrain like that of a BEB as shown in **Figure 7**. However, they have a small battery on-board instead of a large battery. The small battery is recharged by an on-board fuel cell that generates electricity from hydrogen as the vehicle travels. The energy density of hydrogen is much higher than a battery, which allows for the range of these vehicles to closely match a conventional diesel bus.

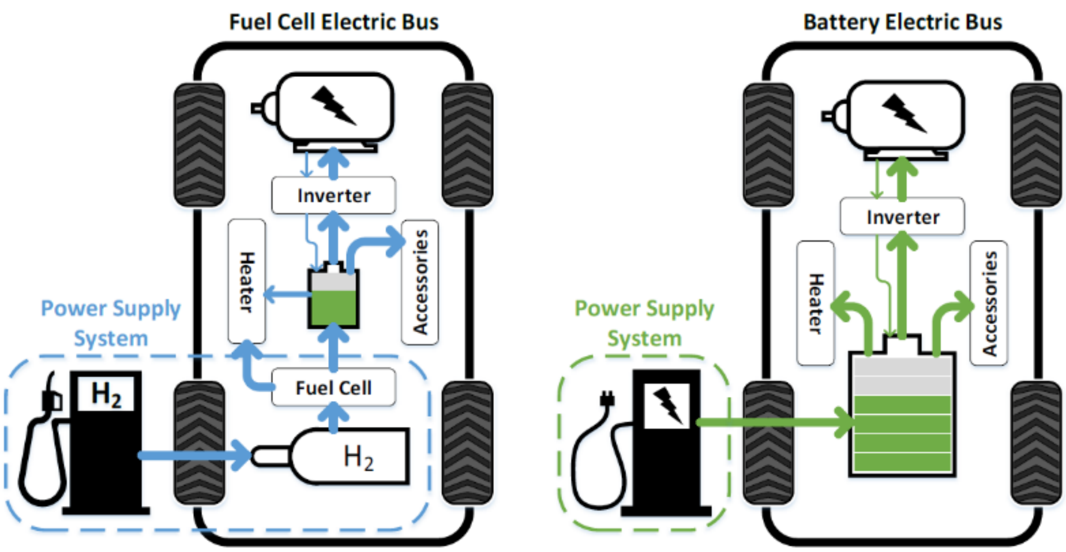

Figure 7. BEB and FCEB Vehicle Technology Comparison

4.2 ENERGY CONSUMPTION ANALYSIS

Understanding energy consumption is a key component of fleet transition planning, as it informs the choice of vehicle technology, infrastructure requirements, finances, and fleet replacement strategies. The following sections outline the methodology and key findings. This modeling evaluated whether the optimal fueling strategy is depot charging only, a mix of depot and on-route charging, and/or hydrogen fuel cell and identifies potential strategies that best complement MST's service and fleet plans. Simulations were performed at the granular level, so that the strategy can inform individual vehicles, routes, and blocks as well as the full MST fleet.

Scenarios modeled included:

- Baseline (diesel)
- BEB with depot charging only
- BEB with depot and on-route charging
- FCEB with depot refueling

Multiple iterations of these scenarios were also conducted to inform the key findings summarized below, as well as the full detailed model results in **Appendix A**: Energy Modeling Analysis.

4.2.1 METHODOLOGY & ASSUMPTIONS

The energy modeling analysis for MST's fixed-route service was completed using Zero+, HDR's proprietary energy consumption modeling tool, to provide a comprehensive understanding of the potential impacts BEB and FCEB technologies may have on MST's current fleet and operations. Energy consumption is impacted by several factors including slope and grade of the bus routes, number of vehicle stops, anticipated roadway traffic, and ambient temperature. Zero+ also analyzes variables known to impact lifetime vehicle performance like energy density, battery degradation, operating environment, auxiliary loads like heating and air conditioning, and lifecycle of bus batteries.

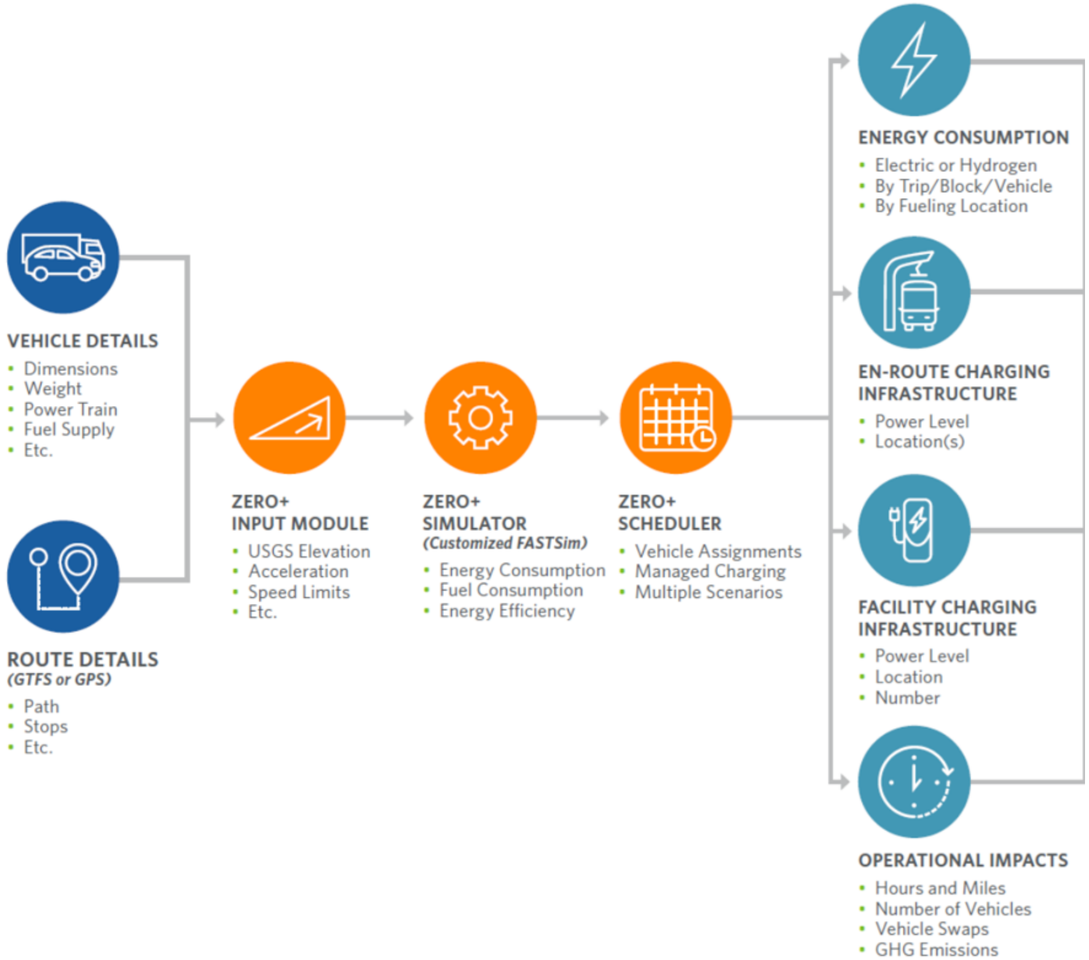

Figure 8. Zero+ Inputs, Outputs, and Modeling Flow Chart

Examining each vehicle individually drives decisions for the right technology at the system, depot, route, and block levels. This analysis balanced impacts to operations, overall fleet size, and infrastructure requirements and will ultimately provide MST with the critical information necessary to make a data-driven determination of the preferred ZEB transitional technologies and deployment pace.

4.2.2 BLOCK FEASIBILITY

The energy modeling analysis performed reveals varying degrees of feasibility for ZEB implementation across MST's different vehicle types and routes. Most service blocks operated by either trolleys or full size conventional 35′ or 40′ buses were feasible with BEBs and/or FCEBs; there are currently no service blocks operated by cutaways that are feasible without significant increases to the overall fleet size. The tables below outline block feasibility by modeled scenario.

Table 4. Weekday Block Feasibility, Depot Charging Only

	BEB Only	BEB or FCEB	FCEB Only	Neither BEB nor FCEB
Cutaway/Shuttle Bus	-	-	-	16
Trolley Bus	-	-	-	4
35' Conventional Bus	-	8	4	2
40' Conventional Bus	-	30	14	1

Table 5. Weekday Block Feasibility, Depot & On-Route Charging at MTP

	BEB Only	BEB or FCEB	FCEB Only	Neither BEB nor FCEB
Cutaway/Shuttle Bus	-	-	-	16
Trolley Bus	4	-	-	-
35' Conventional Bus	-	11	2	1
40' Conventional Bus	-	39	5	1

4.2.3 FLEET REQUIREMENTS

To determine the fleet requirement at each facility, both weekday and weekend service were modeled; **Table 6** below indicates the maximum peak vehicle requirement by vehicle type across all service days at each facility. In addition to the number of vehicles needed to operate revenue service, MST will procure additional ZEBs to accommodate bus swaps for the four (4) service blocks that cannot be feasibly transitioned one-to-one.

Table 6. Peak Active Vehicle Requirement by Facility

Assigned Facility	BEB Trolley	35' BEB	40' BEB	40' FCEB
CJW	-	5	13	1
SCO	-	-	6	3
TDA	4	5	5	9
Total	**4**	**10**	**24**	**13**

4.2.4 INFRASTRUCTURE AND ENERGY REQUIREMENTS

To determine the recommended depot charging infrastructure at each facility, a depot charging only scenario was considered. While the minimum depot charger requirement when utilizing on-route chargers is less than if on-route chargers were not utilized, basing infrastructure on a depot charging only scenario ensures the whole fleet can be recharged overnight if one or more on-route chargers is out of service. It is assumed that all plug-in chargers will be equipped with three dispensers each, while the on-route inductive chargers will only have one plate dispenser per charger. At each facility, there will be a dedicated plug-in dispenser for each active bus.

Table 7. Recommended Charging Infrastructure by Facility

Charger Location	Charger Quantity	Dispenser Type	Charger Power Output
CJW O&M Facility	6	Plug-In Overhead Retractable Cable Reel	150 kW
SCO O&M Facility	3	Plug-In Overhead Retractable Cable Reel	150 kW
TDA O&M Facility	4	Plug-In Overhead Retractable Cable Reel	150 kW
MTP On-Route Facility	3	Wireless Inductive	450 kW

Table 8. Estimated Peak Power Demand by Facility

Charger Location	Minimum Managed Peak Demand	Maximum Managed Peak Demand	Maximum Unmanaged Peak Demand
CJW O&M Facility	150 kW	600 kW	900 kW
SCO O&M Facility	450 kW	450 kW	450 kW
TDA O&M Facility	150 kW	500 kW	750 kW

4.2.5 COURSE OF ACTION

Based upon the modeling results, MST plans to proceed with a mixed fleet of BEBs and FCEBs. Initially, MST will focus on transitioning as much service as feasibly possible with BEBs, then operate FCEBs on the blocks not feasible with a BEB. There were four (4) blocks identified as infeasible with both BEBs and FCEBs; for this service, MST plans to procure additional buses to accommodate bus swaps mid-block.

The modeling revealed that even with on-route charging, transitioning the cutaway fleet to BEBs remains infeasible without nearly doubling the fleet size to accommodate bus swaps. To defer a transition to ZEB cutaways until the technology matures, MST plans to replace cutaways with new gasoline cutaways until 2029 when California mandates all vehicle purchases must be zero emission; when the next replacement cycle is reached, MST plans to replace with BEBs unless a FCEB equivalent is available for consideration.

5 OPERATIONAL PLANNING & DEPLOYMENT

The following sections highlight critical fleet and infrastructure implementation needs, including actions that will be taken to effectively deploy ZEBs and ensure efficient future operations. The fleet deployment plan highlights each phase of the plan, offering a purchase schedule and insight into the phased deployment effort. The facility and infrastructure plan for the depot facility is also provided, covering existing conditions and facility infrastructure implementation. The feasibility of on-route charging is also considered, with potential locations that may be beneficial for MST to assess in the future.

5.1 FLEET DEPLOYMENT PLAN

MST plans to integrate ZEBs into the fleet in several phases to reach a complete zero emissions fleet by 2040 in compliance with California ICT regulations. In Phase 1, Phase 2, and Phase 3, the number of vehicles purchased includes the peak vehicle requirement, or number of active buses required to operate service, plus a 20% spare ratio. In Phase 4, the remainder of the fleet in addition to the 20% spares purchased in earlier phases, will be transitioned to ZEB.

Phase 1 (2025-2028): BEBs purchased in Phase 1 will be one-to-one replacements of existing 35' and 40' biofuel buses with 35' and 40' BEBs, respectively. Vehicle charging will take place overnight and be supported by plug-in chargers at the vehicles' respective depot facilities. All revenue service transitioned during this phase can be operated by BEBs without the need for on-route charging, bus swaps, or modifications to current revenue or non-revenue operations.

Phase 2 (2029-2030): BEBs purchased in Phase 2 will be one-to-one replacements of existing 35' and 40' biofuel buses with 35' and 40' BEBs, respectively, and one-to-one replacements of existing trolleys with battery electric trolleys. In this phase, three (3) 450kW wireless inductive on-route chargers will be added at Monterey Transit Plaza (MTP) to supplement overnight charging at the vehicles' respective depot facilities. All revenue service transitioned during this phase can be operated by BEBs without the need for bus swaps or modifications to current revenue or non-revenue operations but will require the use of on-route charging.

Phase 3 (2031-2033): In Phase 3, FCEBs will be added to the fleet, replacing all 35' and 40' biofuel buses that cannot be feasibly transitioned to BEB; replacements will be one-to-one with 37.5 kg 40' FCEBs. Initially, all FCEBs will be refueled at TDA; if assigned to a different facility, vehicles will deadhead to TDA to refuel before returning to their respective assigned facilities. Once hydrogen fueling infrastructure is operational at SCO, FCEBs will also refuel at this facility.

Phase 4 (2034-2037): In Phase 4, the remainder of the existing fleet will be converted to BEBs and FCEBs; these replacements will be in addition to the spare buses accounted for in Phases 1 through 3. All vehicles purchased in this phase will utilize existing charging or hydrogen refueling infrastructure on an as-needed basis as these vehicles will not regularly operate in revenue service.

Table 9 below summarizes the total number of heavy-duty vehicles purchased in each phase of the transition, as well as the number of chargers required in each phase.

Table 9. Heavy Duty Vehicle and Charger Quantities by Program Phase

		Vehicles				Chargers	
	Years	35' BEBs	40' BEBs	Trolleys	40' FCEBs	Depot Plug-In	On-Route Inductive
Phase 1	2025-2028	7	21	-	-	9	-
Phase 2	2029-2030	3	6	5	-	4	3
Phase 3	2031-2033	-	-	-	16	-	-
Phase 4	2034-2037	16	2	3	10	-	-

The vehicle purchases are further dissected in **Table 10**, which shows the quantity of each bus type that must be purchased in each year to achieve a 100% ZEB heavy duty fleet by 2040.

Table 10. Initial Procurement Schedule, Purchase Year

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
BEB 35'	5	2			3					5	4	4	3
BEB 40'	2	5	7	7		6							2
BEB Trolley					4	1				2			
FCEB 40'							5	5	6		4	4	2
Heavy Duty Subtotal	**7**	**7**	**7**	**7**	**7**	**7**	**5**	**5**	**6**	**7**	**8**	**8**	**7**
Gasoline Cutaway	10	10	11	11									
Total Bus Purchases	**17**	**17**	**18**	**18**	**7**	**7**	**5**	**5**	**6**	**7**	**8**	**8**	**7**
% ZEB Purchases	**39%**	**39%**	**41%**	**41%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

To remain compliant with ICT purchase regulations and defer the transition of cutaways, MST will be able to purchase a maximum of 42 new gasoline cutaway vehicles before 2029. ICT regulations require at least 25% of all new bus purchases between 2025-2028, and 100% of all new bus purchases must be ZEB beginning in 2029. **Table 10** above shows the maximum number of gasoline cutaways that can be purchased each year. If MST wants to purchase additional gasoline cutaways above the proposed 42, the procurement schedule would change and additional ZEBs would need to be purchased before 2029 to meet ICT requirements.

Current industry trends and future supply chain forecasts suggest that there is a two-year lead time for ZEBs from procurement to delivery. **Table 11** and **Figure 9** show how the fleet composition by fuel type changes throughout the transition and are both in terms of the vehicles' predicted delivery year. By adhering to the proposed procurement schedule, MST will place its final ZEBs in service in 2039. In years past 2039, MST will continue to purchase ZEBs, including a transition to electric cutaways, as vehicles in the active fleet reach the end of their useful life.

Table 11. Heavy Duty Transit Fleet Composition by Fuel Type, Delivery Year

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Biofuel	74	67	60	53	46	39	34	29	23	16	8	0	0
BEB	12	19	26	33	40	47	47	47	47	54	58	62	67
FCEB	0	0	0	0	0	0	5	10	16	16	20	24	26

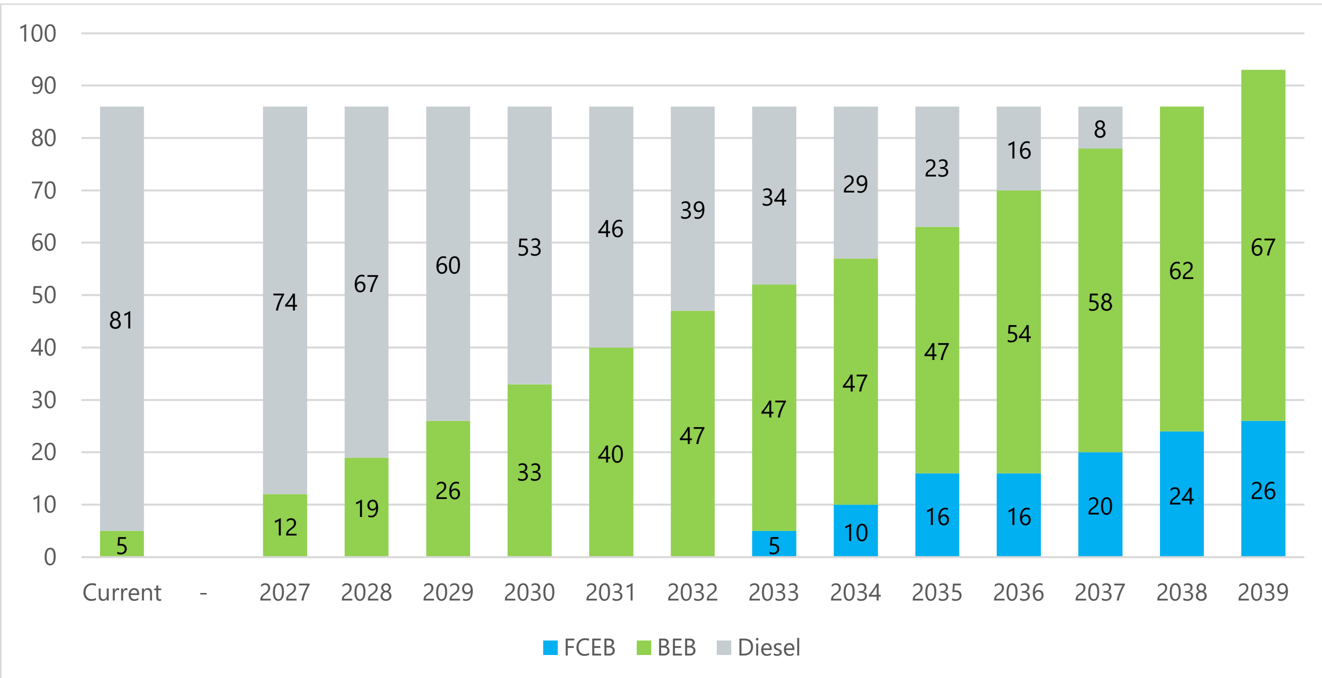

Figure 9. Heavy Duty Fleet Composition by Fuel Type, Present to Full Transition

In **Table 12** below, the charger procurement schedule is shown by facility, and each charger will have three dispensers. Due to the relatively short duration of the transition and number of chargers recommended in each phase, it is also assumed that all chargers required in any given phase will be installed in the first year of that respective phase. The three wireless inductive on-route chargers will also be procured in 2029 along with the plug-in depot chargers.

Table 12. Charger Procurement Schedule by Location, Purchase Year

Location	Charger Type	2025	2026	2027	2028	2029	2030	2031	2032	2033
TDA	Plug-In	2				3				
CJW	Plug-In	4				3				
SCO	Plug-In	3								
MTP	Inductive					3				
	Total	**9**				**9**				

5.2 FACILITY & INFRASTRUCTURE PLAN

The following sections provide a brief overview of the anticipated charging and hydrogen fueling infrastructure necessary to support MST's transition to a 100% zero emissions fleet. All three MST-owned facilities will be outfitted with BEB charging infrastructure, and TDA and SCO will have hydrogen fueling infrastructure. Though MST currently stores cutaway buses at the JLW facility, it is not considered in this section as this portion of the fleet will not yet be transitioned.

5.2.1 CLARENCE J WRIGHT (CJW) O&M FACILITY

As part of the transition to zero emissions, MST plans to construct a gantry structure over the existing outdoor bus parking area to serve the dual purpose of allowing overhead retractable cable reel plug-in dispensers and provide surface area for a future solar array. **Figure 10** below shows one potential location where charger cabinets could be installed, but exact placement should be determined based on a future detailed design study and in close coordination with the utility company to ensure feasibility.

Build gantry system over existing outdoor bus parking area and utilize overhead retractable cable reel plug-in dispensers with charging cabinets remotely collocated where there is space available on the property. Plan to equip gantry system with roof-mounted solar panels to support microgrid.

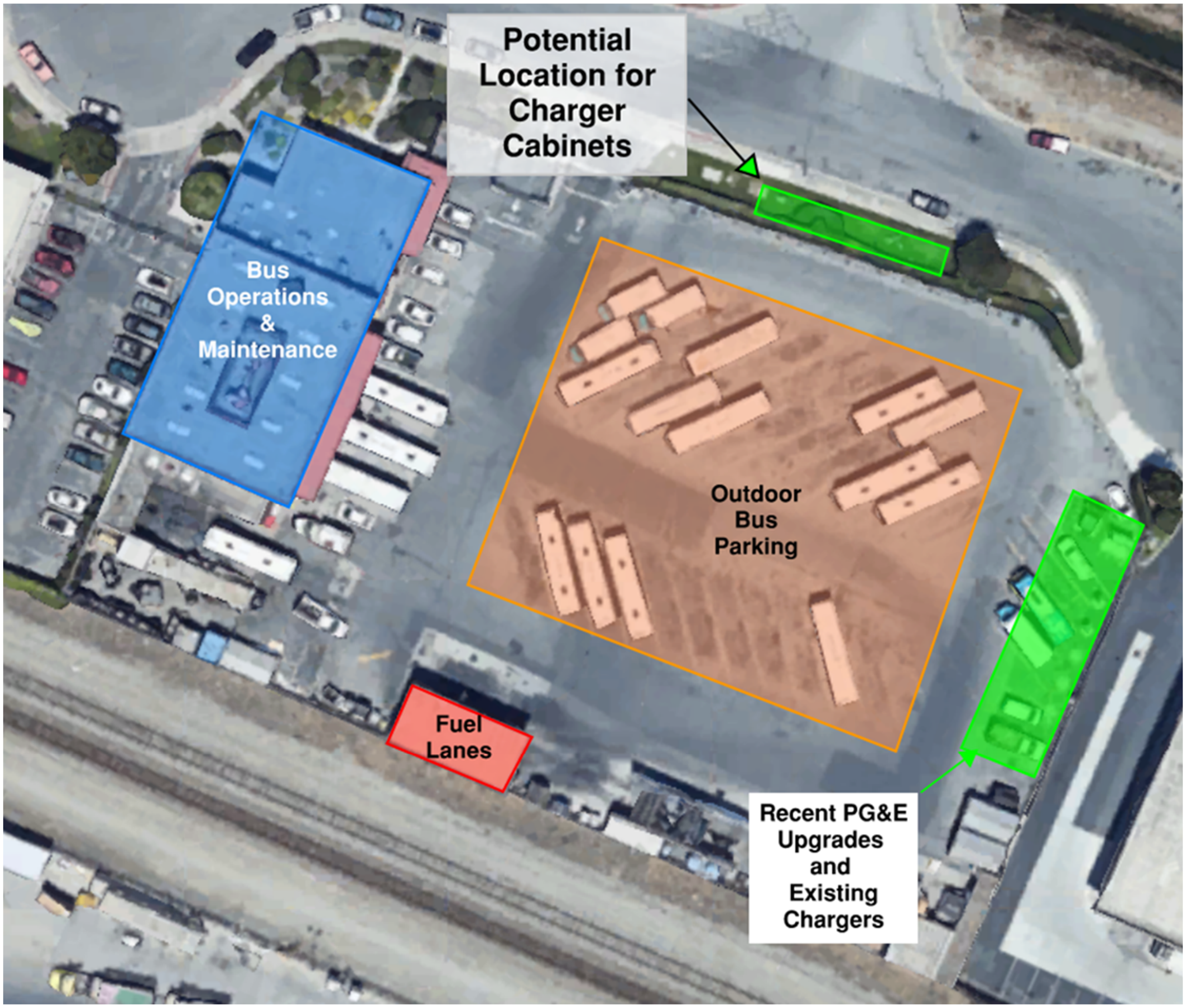

Figure 10. CJW Facility Future Charging Infrastructure Conceptual Layout

5.2.2 SOUTH COUNTY (SCO) O&M FACILITY

MST's South County O&M Facility currently has a large amount of space available for various charger configurations. While space likely exists to accommodate ground-mounted pedestal dispensers, MST plans to construct a gantry structure over the existing outdoor bus parking area for overhead retractable cable reel dispensers, with charger cabinets remotely collocated where space is available. This will allow MST to explore opportunities to install solar at the SCO facility in the future, like the other O&M facilities considered in this study. **Figure 11** below shows one potential location where charger cabinets could be installed, but exact placement should be determined based on a future detailed design study and in close coordination with the utility company to ensure feasibility.

Figure 11. SCO Facility Future Charging Infrastructure Conceptual Layout

5.2.3 THOMAS D. ALBERT (TDA) O&M FACILITY

Infrastructure planning at the TDA O&M Facility will include both charging infrastructure and hydrogen fueling infrastructure. MST plans to construct a gantry structure over the existing outdoor bus parking area to serve the dual purpose of allowing overhead retractable cable reel plug-in dispensers and provide surface area for a future solar array. Additionally, a mobile hydrogen refueling station is also planned to be installed in the corner of the property adjacent to the existing bus wash. **Figure 12** shows potential areas identified for infrastructure installation, but the exact placement of the chargers and hydrogen mobile refueling station are subject to adjustment because of detailed design being undertaken by Kimley Horn in a concurrent Study.

Figure 12. TDA Facility Future Charging & Hydrogen Fueling Infrastructure Conceptual Layout

6 WORKFORCE DEVELOPMENT

The Federal Transit Administration (FTA) mandates that applicants for zero-emission project funding under its Buses and Bus Facilities Competitive Grant Program and Low or No Emission Grant Program develop a comprehensive Zero Emission Fleet Transition Plan. This plan includes an examination of the impact on the current workforce, identifying skill gaps, training needs, and retraining requirements to operate and maintain zero-emission vehicles and infrastructure without displacing existing workers.[36] MST has utilized this tool to facilitate compliance with FTA and evaluate its workforce structure.

1. Skills, Training, and Credentials Required

MST has identified that maintaining and operating the proposed fleet, Gillig BEBs, requires specialized training provided by the OEM. This training focuses on battery maintenance, electric drive systems, and safety protocols, including safely powering down vehicles, high-voltage PPE usage, high-voltage protocols, and emergency response procedures.

2. Skills Assessment of Existing Workers and Identifying Skill Gaps

Given the introduction of new technology, MST anticipates that all employees will require training tailored to their job functions. Training should include an overview of ZEB technology and environmental benefits, comparisons between biofuel/gasoline systems and ZEBs, basic operations of BEB and FCEBs, safety education, and emergency operations protocols.

Training is required for drivers, mechanics, operations staff, and external parties like first responders. Each group has distinct training needs; for example, high-voltage safety is universal but other topics are group-specific. Mechanics face greater challenges in transitioning to ZEBs than other staff groups.

- ***Bus Operators*****:** Training may focus on safe operating procedures for ZEBs, efficient driving techniques to optimize battery range, emergency protocols specific to ZEBs, and supervised behind-the-wheel training.

- ***Maintenance/Technical Staff:*** Training should cover high-voltage safety protocols and certifications, battery management systems, troubleshooting and diagnostics, component-specific repair and maintenance (e.g., power electronics), preventative maintenance, and use of high-voltage PPE.

- ***Charging and Infrastructure Staff*****:** Training will look to include charging station operations and safety protocols, scheduling and managing ZEB charging for fleet availability, basic troubleshooting of charging infrastructure, and safety operations.

- ***Supervisors/Management*****:** Training should provide an overview of ZEB operations, maintenance schedules, challenges, performance monitoring (e.g., battery health), safety oversight, compliance with regulations, and emergency operation.

First responders will receive specialized training due to the unique hazards presented by BEBs and FCEBs compared to traditional diesel buses. MST has already developed a comprehensive training program for first responders in Monterey County to facilitate emergency preparedness best practices for ZEBs and plans to

[36] FTA ZEM Fleet Transition Plan | Workforce Evaluation Tool: https://www.transportcenter.org/ZEB.

continue this program. Additionally, towing operators will require specific training on safely handling ZEBs during towing operations. This includes understanding the differences between towing electric buses versus diesel buses to establish safety for both the tow truck driver and the bus itself.

4. Training Plan Implementation

MST's training plan includes strategic partnerships and resources to equip employees with the necessary skills to operate and maintain ZEBs effectively.

Implementation and Scheduling

- Training Calendar: Develop a calendar to stagger training sessions, allowing for rotations that minimize workforce disruptions.
- On-the-Job Training (OJT): Assign experienced mentors to provide continued learning and support during shifts.
- Testing and Certification: Incorporate assessments and certifications, especially for high-voltage safety and specialized maintenance skills.
- Manufacturer Partnerships: Leverage partnerships with ZEB manufacturers to confirm training aligns with the specific technical requirements of the agency's fleet.

Continuous Learning and Refresher Training

- Refresher Courses: Schedule regular refresher courses for all personnel to reinforce ZEB knowledge and incorporate technology updates.
- Advanced Training Modules: Offer optional advanced modules for in-depth knowledge on emerging ZEB technologies, diagnostics, and repairs.
- Knowledge Sharing Platforms: Develop a resource portal or forum where team members can access ZEB manuals, troubleshooting guides, and video demonstrations.

Evaluation and Adjustment

- Performance Monitoring: Track metrics related to training effectiveness, such as reduction in maintenance errors, efficiency improvements, and operator confidence.
- Feedback Loop: Gather feedback from trainees and trainers to improve training content and delivery methods.
- Ongoing Support: Establish a team or point-of-contact for troubleshooting and further learning as ZEB technology evolves.

5. Selection Process for Training Programs

To initiate the training process, MST will look to the OEM for training on the specific vehicles and equipment purchased. As a member of the California Transit Training Consortium (CTTC), MST collaborates closely with the CTTC to develop and deliver transit-specific maintenance training programs. The CTTC provides access to a suite of maintenance training to members and other organizations who join the Consortium. The CTTC actively seeks out opportunities to create training programs for specific vehicles, equipment, and related programs. As part of the process, MST evaluates the training and provides feedback of its success to the OEMs and the CTTC. MST's Chief Operating Officer (COO) currently serves as the vice chair for the CTTC and plays a pivotal role in the CTTC's efforts to identify industry-specific training problems and solutions.

6. Role of Training Resources in Workforce Development

Training resources are crucial in attracting, training, and developing new workers within the agency, fostering a skilled and capable workforce. These resources are essential to recruiting efforts as they demonstrate the agency's commitment to employee growth and long-term career development, which is increasingly important in a competitive labor market. To facilitate a smooth integration for new hires and encourage internal mobility, MST will consider deploying training resources in the following ways:

- **Structured Onboarding Programs:** Comprehensive materials introducing new hires to MST's organizational culture, values, and operational standards. By providing hands-on training, mentorship, and access to technical resources, MST enables new hires to contribute effectively and feel supported in their roles from the outset.
- **Skill Development/Certification Programs:** Training resources should allow employees to develop specific competencies related to zero-emission technologies, safety protocols, and customer service. This not only enhances the skills of new employees but also aligns with the agency's goals to transition to more sustainable practices.
- **Continued Learning/Career Advancement:** Providing clear career paths and supporting continued learning is a key element in attracting motivated candidates. Training resources should enable new employees to enhance their skills while positioning the agency as an organization that invests in the professional growth of its workforce. To uphold a commitment to the current workforce, several strategies may be implemented alongside the new training initiatives.
- **Reskilling and Upskilling:** Leveraging the knowledge and experience of long-standing employees, mentorship initiatives should pair seasoned workers with new hires. This approach not only supports knowledge transfer but also fosters a collaborative environment, helping retain the expertise of the existing workforce. MST's Mentors in Motion (MIM) program was established in 2024 to accomplish these goals. The MIM is led by MST's frontline workers and the leadership of their bargaining unit, the Amalgamated Transit Union (ATU). MST provides administrative support to the ATU to support the MIM program.
- **Apprenticeship Programs:** MST is actively working on an Apprenticeship program with its educational partner, Hartnell College. The goals of the apprenticeship are to develop skilled maintenance technicians from within the organization, to support MST's transition to zero-emission fleets, to bridge the skills gap, and to promote workforce retention and growth.
- **Inclusive Workforce Planning:** As new roles are created or adapted, the agency may prioritize placements that enable both new and existing employees to find growth opportunities without redundancy or displacement. This approach aligns with the agency's commitment to a stable and engaged workforce that benefits from expansion and evolution, rather than being displaced by it.

Through targeted training resources and inclusive workforce development practices, the agency will be positioned to attract and retain talent while honoring the contributions and roles of the existing workforce.

7. Engagement with Current Workforce

MST engages closely with ATU leadership in developing transition strategies. This collaboration facilitates workforce needs being met throughout the transition process.

8. Funding for Training Needs

MST seeks grant funding to support offsetting total training costs. In addition, a portion of MST's annual budget is allocated specifically for training purposes.

6.1 SKILLS ASSESSMENT, CATEGORIZATION, AND GAP IDENTIFICATION

MST categorizes operational staff into four groups: Coach Operations Support, Coach Operations, Coach Maintenance Support, and Coach Maintenance. Each category has specific skill requirements assessed to identify gaps.

- **Coach Operations Support (COS)**: Staff in this category would include those who are critical to bus operations but do not directly interact with the buses.
- **Coach Operations (CO)**: Staff in this category would include operational staff who directly interact with the buses but do not perform any vehicle maintenance.
- **Coach Maintenance Support (CMS)**: Staff in this category include operational staff who directly interact with the buses and are responsible for the assignment and oversight of maintenance functions.
- **Coach Maintenance (CM)**: Staff in this category include operational staff who directly interact with the buses and perform routine and unplanned maintenance functions.

Table 13 below provides an overview of MST's current staffing positions and the operational category they fall within.

Table 13. MST Current Staffing Structure

Job Title	Role Category	# of EEs	# Approved Positions	Union
Coach Operator	CO	114	116	ATU
Suburban Board Operator	CO	0	10	ATU
Mechanics	CM	24	25	ATU
Utility Service Person	CM	12	13	ATU
Inventory Clerk	CM	4	4	ATU
Maintenance Manager	CMS	1	1	MSTEA
Maintenance Superintendent	CMS	0	1	MSTEA
Fleet Supervisor	CMS	4	4	MSTEA
Transportation Manager	COS	1	1	MSTEA
Communications Systems Supervisor	COS	1	1	MSTEA

Job Title	Role Category	# of EEs	# Approved Positions	Union
Communications Systems Specialist	COS	6	6	MSTEA
Operations Superintendent	COS	2	2	MSTEA
Operations Supervisor	COS	8	8	MSTEA
Risk and Security Manager	COS	1	1	MSTEA
Safety/Training Officer	COS	1	1	MSTEA
Transit Trainers	COS	3	3	MSTEA
Facilities Manager	COS	1	1	MSTEA
Facilities Technicians	COS	10	10	ATU

MST could consider implementing a comprehensive skills assessment across these categories. The skill assessment will use a combination of self-assessment tools alongside supervisor evaluations aimed at identifying current capabilities and areas needing further development. Through the skills assessment, retraining efforts needed to support MST's evolving zero-emission fleet can be identified.

6.2 TRAINING CURRICULUM

6.2.1 CURRENT BUS OPERATOR TRAINING

MST's in-house bus operator training program spans 8-weeks. It consists of 40 hours of classroom instruction coupled with 30 hours of behind-the-wheel-sessions designed specifically around enhancing driver proficiency when navigating California's complex urban landscapes. In addition, the program also includes a range of topics, including the following:

- Safety
- Emergency Management
- De-escalation
- MST Policies and Standard Operating Procedures
- Electronic Vehicle Inspections and Vehicle Defect Reporting
- Mobile Data Terminal
- Radio Operation
- ADA Compliance, including Ramp/Lift Deployment and Mobility Aid Securement
- Commercial Driver License (CDL) Preparation
- Commercial Motor Vehicle (CMV) Proficiency Familiarization
- Bus Route Familiarization
- Human Trafficking Warning Signs and Reporting Responsibilities

6.2.2 FUTURE BUS OPERATOR TRAINING NEEDS

Bus operators will directly interact with ZEBs and bus chargers but are not responsible for any maintenance or repair. However, this subset of staff needs to be familiar with ZEBs and their associated charging systems, complete standard trainings offered by the OEMs and be aware of the safety protocols for using ZEBs and related charging infrastructure.

Bus operators will also need to be retrained to operate ZEBs and leverage the regenerative braking systems, which allows the bus to reclaim kinetic energy as the bus slows down and convert it to electrical power to recharge the battery; in doing so, the operational range on a single charge can be extended. This technology also assists in slowing down the bus, reducing reliance on and extending the life of traditional brakes. Bus operators should also complete trainings aimed at familiarizing them with plugging in a bus and verifying the charge session is active.

Bus operators are the first line of defense in proactively identifying bus issues that will require corrective maintenance. They should have extensive knowledge of all dash indicator lights and safety procedures so they can diagnose any potential roadside issues. They should be made aware of the following signs of an impending issue:

- Popping or crackling noises originating from the battery boxes
- Puffs of smoke, usually whitish in color, emanating from the battery storage boxes
- The bus fails to power up when first turned on

If a bus operator notices signs of popping noises or smoke while in service, the bus should be evacuated immediately, and first responders should be notified. If the ZEB fails to power up on the first attempt, the operator should immediately notify maintenance staff.

Safety trainings can be provided by the vehicle OEMs and/or in-house by trained trainers. It is common practice to implement a 'train-the-trainer' model, in which the OEM-provided training is taught to in-house staff who take knowledge back, incorporate it into in-house training curriculum, and train agency bus operators and maintenance technicians. This often reduces the overall cost of training operators and technicians by avoiding higher, marked up labor rates for OEM personnel, as well as associated travel expenses.

6.2.3 CURRENT MAINTENANCE TECHNICIAN TRAINING

MST's training curriculum for maintenance technicians covers a wide range of topics. Training includes high-voltage safety certifications for maintenance technicians, alongside modules covering emergency management procedures and ADA compliance requirements to ensure safe operation under diverse conditions encountered within public transit environments. Additionally, MST's contract operator, may also offer some level of BEB training for drivers and maintenance technicians; MST should explore whether the contractor offers any training and, if so, would access to training through existing contracts be possible.

6.2.4 FUTURE MAINTENANCE TECHNICIAN TRAINING NEEDS

While ZEBs require significantly less maintenance than their diesel counterparts, regular maintenance of some vehicle components is still necessary. If bus maintenance will be performed in-house, maintenance staff will typically require the most training as they have frequent, in-depth interactions with ZEBs. Training for ZEB maintenance should include electric/electronic principles, general ZEB familiarization, and OEM-specific trainings relevant to ZEB models within the MST fleet.

6.2.4.1 Electrical and Electronic Principles

Essential training to introduce staff to basic electrical and electronic skills includes topics such as:

- The ability to read basic wiring diagrams
- Safely handle low-voltage batteries
- Troubleshoot and repair basic circuit faults, wiring and terminals
- Inspect and test relays and gateway modules
- Demonstrate proficient use of digital multi-meters (DMM), oscilloscope and graphing multimeter
- The ability to inspect and test capacitors, diodes, and other electronic modules
- Differentiate between direct current (DC) and alternating current (AC)

MST should encourage existing mechanics to study for, and obtain ASE A6, T6, or H6 certification in low-voltage systems, as this should be a prerequisite to high-voltage training. Trainings regarding high-voltage and arc flash safety protocols following NFPA 70E standards and OSHA requirements should be a prerequisite to any hands-on vehicle training.

6.2.4.2 General ZEB Familiarization

Many ZEB components, such as air brakes, foundation parts, steering, wheel end components, and ADA access systems, are like those on diesel buses, and maintenance staff will not require extensive retraining to work on these components. Maintenance staff will need to learn procedures for the proper use and inspection of personal protective equipment (PPE) and Lock-Out-Tag-Out (LOTO) procedures for ZEBs. For other components and systems specific to ZEBs, APTA has developed an extensive Zero-Emission Bus Maintenance Training Recommended Practice, which can serve as a resource for developing training.

6.2.4.3 OEM-Specific Training

OEM-specific training will include gaining knowledge of numerous system functions such as system familiarization, high voltage sub-systems, battery storage systems, troubleshooting and diagnostics, and routine preventative maintenance requirements. Purchasing OEM training alongside new ZEB purchases is recommended as standard practice.

6.3 RECRUITMENT AND DEVELOPMENT

MST is committed to fostering a dynamic and skilled workforce to support its transition to a ZEB fleet. This commitment involves strategic recruitment and development initiatives designed to attract new talent while enhancing the skills of existing employees. MST's approach focuses on creating opportunities for professional growth and equipping the workforce to meet the demands of evolving transit technologies.

6.3.1 PROGRAM OPPORTUNITIES

Internships, Mentorships, and Apprenticeships

MST actively participates in the California Transit Works (CTW) program and has launched the Mentors in Motion (MIM) apprenticeship program in collaboration with the Amalgamated Transit Union (ATU). These programs aim to develop coach operators and skilled maintenance technicians from within the organization, supporting MST's transition to zero-emission fleets while bridging existing skills gaps. Additionally, MST has partnered with Hartnell College to draft an apprenticeship program specifically for vehicle maintenance mechanics, fostering a pipeline of qualified professionals.

Partnerships with Educational Institutions and Other Organizations

MST collaborates with local technical schools and community colleges, such as Hartnell College, to provide students with hands-on experience in public transit operations. These partnerships are crucial for developing a workforce that is knowledgeable about the latest transit technologies and practices.

MST is a member of the California Transit Training Consortium (CTTC), a consortium of public transit agencies, colleges, universities, and private partners that collaborate to design, develop, and deliver cost-effective technical training for the public transit industry. The CTTC's mission is to advance the skills of transit the transit workforce by preparing them for the future. Consortium members have access to high-quality, professional technical training through online and in-person opportunities. Every training course that CTTC provides has been created, vetted, and approved by CTTC members who have extensive knowledge and experience in each area of focus. Colleges, universities, and trade skills collaborate with the CTTC to deliver many of the courses offered by the consortium and often serve as the pipeline for hiring quality, skilled employees.

Inclusive Hiring Practices

MST prioritizes inclusive hiring practices by ensuring that recruitment efforts do not violate federal and state laws. While internal applicants are considered for certain positions, MST also opens opportunities to external candidates, promoting diversity and inclusivity within the workforce. Positions are advertised internally through MST emails and breakroom postings before being made available externally.

Career Development and Advancement

To support career development, MST offers structured onboarding programs that introduce new employees to organizational culture, values, and operational standards. These programs include hands-on training, mentorship, apprenticeship, and access to technical resources, enabling new hires to contribute effectively from the outset.

Reskilling and Upskilling Initiatives

MST is dedicated to providing reskilling and upskilling opportunities for existing employees. Advanced training programs align with technological updates, ensuring that current staff remain integral to operations even as new hires are onboarded. The MIM program pairs seasoned workers with new hires, facilitating knowledge transfer and fostering a collaborative environment.

Through these comprehensive recruitment and development strategies, MST aims to attract and retain talented individuals while honoring the contributions of its existing workforce. By investing in employee growth and development, MST positions itself to meet the evolving transit landscape.

7 FINANCIAL PLANNING

The total cost to transition MST's fleet to ZEBs is anticipated to be large; **Table 14** below lists the estimated unit and extended capital costs for vehicles, chargers and fueling infrastructure, and related utility infrastructure necessary to support the operation of BEB charging equipment. Additional expenses for facility modifications, including but not limited to site, civil, and electrical work can also be anticipated, although the costs are not quantified in this table. This estimate also excludes the purchase of any future ZEB cutaways, which are currently planned to be gasoline replacements during the next replacement cycle; MST should look for ways to proactively allocate future funds for the purchase of ZEB cutaways to account for the cost premium over gasoline cutaways.

Estimates in the table below are sourced from recent quotes or executed purchase agreements for BEBs and FCEBs from MST and other peer agencies like SamTrans.

Utility infrastructure costs are provided as a high level, conservative, rough order of magnitude estimate for budgetary purposes, and includes the procurement and installment of any transformers, meters, and switchboards that may be needed. There are additional costs and components that may be required as part of any utility upgrades that will require MST coordinate directly with the utility to receive a detailed estimate of these costs.

Table 14. Capital Cost Assumptions in Current Year Dollars

	Unit Cost	Install Cost	QTY	Extended Cost
Vehicles				
BEB 35'	$1,300,422		26	$33,810,972
BEB 40'	$1,300,422		29	$37,712,238
BEB Trolley	$531,000		8	$4,248,000
FCEB 40'	$1,560,000		26	$40,560,000
Gas Cutaway	$143,000		42	$6,006,000
Fueling				
Wireless Inductive Charger	$450,000	$150,000	3	$1,800,000
Depot Plug-In Charger	$165,000	$127,500	13	$3,802,500
Mobile H2 Fueling	$2,250,000	$250,000	2	$5,000,000
Utility Infrastructure				
TDA	$150,000		1	$150,000
CJW	$150,000		1	$150,000
SCO	$100,000		1	$100,000
MTP	$250,000		1	$250,000
			Total	**$133,589,710**

APPENDIX A: ENERGY MODELING ANALYSIS

The energy modeling analysis for MST's fixed-route service was completed using Zero+, HDR's proprietary energy consumption modeling tool, to provide a comprehensive understanding of the potential impacts BEB and FCEB technologies may have on MST's current fleet and operations. Energy consumption is impacted by several factors including slope and grade of the bus routes, number of vehicle stops, anticipated roadway traffic, and ambient temperature. Zero+ also analyzes variables known to impact lifetime vehicle performance like energy density, battery degradation, operating environment, auxiliary loads like heating and air conditioning, and lifecycle of bus batteries. This analysis result in outputs indicating energy needed for BEBs and FCEBs, related infrastructure needs, and operational impacts.

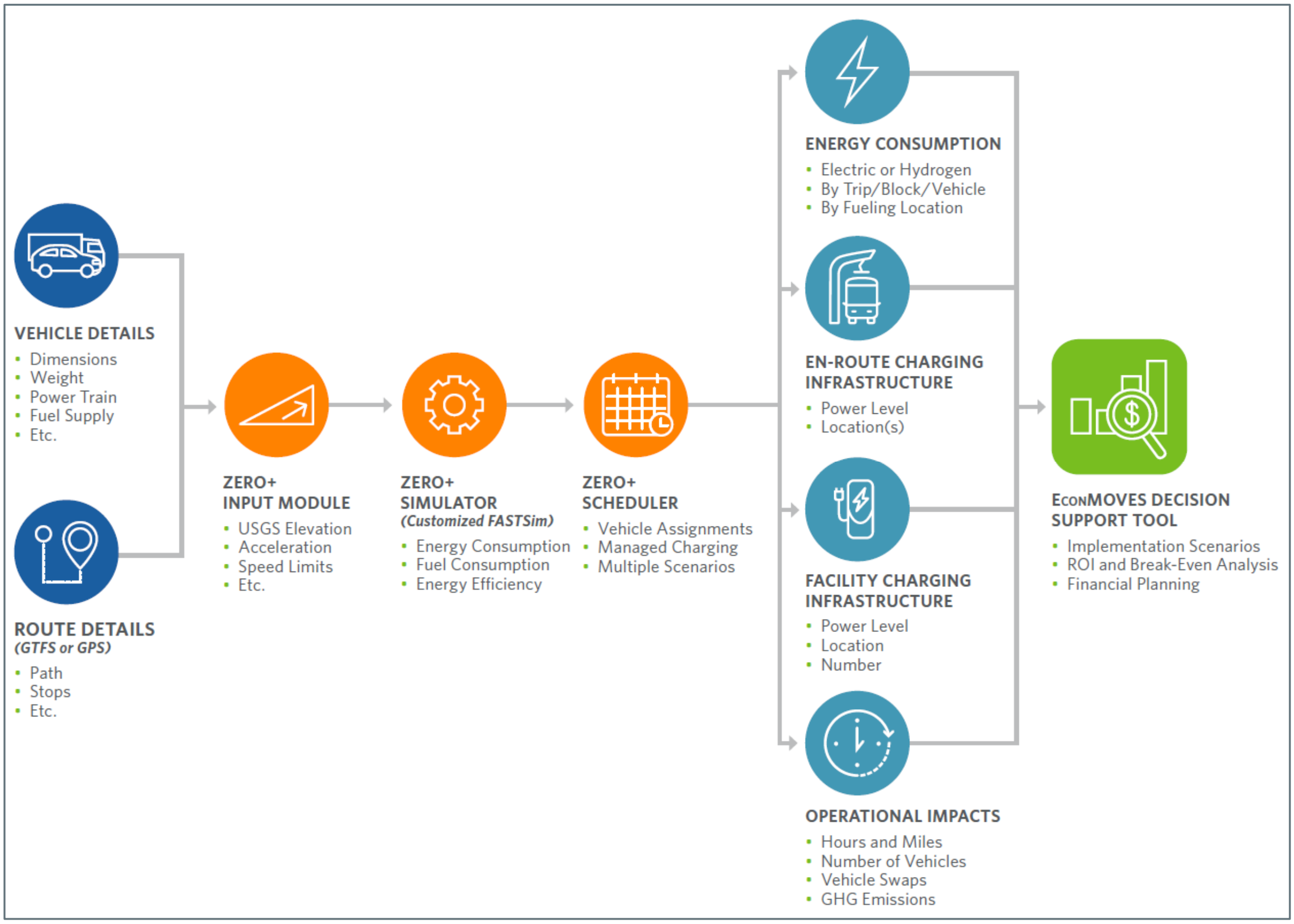

Figure 13. Zero+ Fleet Optimization Analysis Flow Chart

ASSUMPTIONS AND METHODOLOGY

The set of assumptions and variables used to develop MST's custom energy models for BEBs and FCEBs are provided in **Table 15** and **Table 16**, respectively. The model utilizes detailed technical specifications for available BEB and FCEB models; when MST procures vehicles, it should be confirmed that vehicles meet or exceed specifications modeled in this analysis to ensure operational feasibility.

BATTERY ELECTRIC BUSES

The BEB energy consumption analysis takes several factors into consideration to ensure the model provides a realistic view of anticipated BEB performance, such as increased vehicle weight from passenger capacity, increased HVAC loads to heat the passenger cabin on cold days, and a decreased battery capacity at the end of the useful life of the vehicle. These considerations provide a worst case operational scenario to mitigate the likelihood of a stranded asset, but better performance of the vehicles is to be expected at the beginning of the BEBs' useful life.

Table 15. Zero+ BEB Model Assumptions

Variable	Input
Service Data	GTFS Data (October 2024)
Vehicles Modeled	
Cutaway/Shuttle Buses	Optimal EV (S1) 123 kWh
Trolley Buses	Hometown Manufacturing (Villager Electric Trolley) 226 kWh
35' Conventional Buses	35' Gillig BEB 686 kWh
40' Conventional Buses	40' Gillig BEB 686 kWh
End-of-Life Battery State of Health	80% (maximum battery degradation)
Energy Reserve	20% state of charge (SOC)
HVAC System	(OPTIONAL) Diesel auxiliary heater
Ambient Temperature	37°F (cold weather, 10^{th} percentile)
Passenger Capacity	100% seated
Depot Charger Power	150 kW @ 95% efficiency

A 20% reduction in battery capacity was applied to reflect battery end of life assumptions. This is consistent with bus OEM warranties which typically warrant the batteries to 80% of nameplate capacity; if battery life degrades below 80% of nameplate capacity within the warranty period, the battery packs are replaced by the OEM at no charge to the customer. In addition to battery degradation, the model swaps out any vehicle that goes below the 20% state of charge (SOC) energy reserve. This is to account for both the fact that vehicles typically cannot use the last 10% SOC of a battery pack without a reduction in power to the wheels, as well as reduce range anxiety for operators by providing a commonly used agency level of safety to assure vehicles will make it back to the depot.

Diesel heating was analyzed with the 10th percentile ambient temperature when HVAC loads are the highest, at full seated capacity, and at the end of the vehicle's life, representing a "worst-case scenario" to understand how BEBs will perform in challenging conditions. During the coldest temperatures in winter months, BEBs with diesel heaters would draw the highest auxiliary loads from the battery to heat the vehicle cabin, making the 10th percentile ambient temperature the most challenging. Operationally, diesel auxiliary heaters will typically have the option to operate in either electric or diesel mode. This provides the flexibility to run the heater from battery power or diesel as needed. On the most challenging days, heating could rely on diesel mode to maintain service, but it can be swapped to electric mode for more mild days, where there is minimal demand for heating.

HYDROGEN FUEL CELL ELECTRIC BUSES

The FCEB energy consumption analysis also takes factors impacting the overall efficiency of FCEBs into account to mitigate the likelihood of a stranded bus. Similar to the BEB analysis, this includes ambient temperature, seated passenger capacity, and minimum fuel reserves; however, degradation of the fueling capacity does not apply to the operation of FCEBs.

Table 16. Zero+ FCEB Model Assumptions

Variable	Input
Service Data	GTFS Data (October 2024)
Vehicles Modeled	
35' Conventional Buses	40' New Flyer Xcelsior Charge H2 (37.5 kg)
40' Conventional Buses	40' New Flyer Xcelsior Charge H2 (37.5 kg)
Maximum Fuel Level	90%
Minimum Fuel Reserve	10%
HVAC System	Electric auxiliary heater
Ambient Temperature	37°F (10th percentile)
Passenger Capacity	100% seated

BEB ANALYSIS

MST's fleet includes cutaway/shuttle buses, trolley buses, 35' conventional buses and 40' conventional buses. Due to the unique operating considerations of each vehicle type, each vehicle was modeled separately in the Zero+ analysis. For each of the four vehicle types below, results include the percent increase in non-revenue hours, the % increase in non-revenue miles, the percent increase in peak vehicle requirement, and the percent of existing service that can be transitioned with a 1:1 vehicle replacement ratio.

Depot Charging Only

MST's existing service was modeled assuming buses would utilize depot only charging. This scenario allows the Zero+ model to identify which existing service blocks can be electrified without an increase in peak vehicle requirements, the need for enroute charging, or the need for schedule modifications to maintain the same level of service. The depot only charging scenario assumes that all buses would charge at their currently assigned facilities.

Outlier Results

The Zero+ model was initially run with every vehicle block ID and the applicable replacement battery electric vehicle. However, two routes, Route 34 - King City and Route 24 – Crossroads Carmel – Carmel Valley, required 27 vehicle swaps and 7 vehicle swaps, respectively, to complete their current service.

Route 34 is a circulator route with a large deadhead on the front and back ends of the service block; this leads to an already depleted bus by the time the bus begins revenue service. This results in the model currently sending out a replacement bus after only a short time in revenue service because each replacement bus is also depleted when meeting the current bus on-route.

Route 24 is an out-and-back route, also containing a lengthy deadhead distance on the front and back ends of the service block. Although the deadhead distance is not as long as route 34, it still results in a depleted battery after only a few trips back and forth for revenue service. Replacement buses must travel the same deadhead distance when swapping, resulting in 7 different swaps throughout the day.

Given the impractical nature of transitioning both routes with today's technology, these two blocks were removed from the analysis presented below.

Weekday Results

The results below reflect MST's weekday service, which require a higher increase in non-revenue hours, non-revenue miles and peak vehicle requirements than MST's weekend service. While this section details the feasibility of transitioning weekday service to BEBs, the **Summary of Findings** includes a summary for both weekday and weekend service. Overall feasibility is determined

CUTAWAYS/SHUTTLE BUSES

❌ **Not Feasible**

Transitioning MST's current cutaway fleet to BEBs using the Optimal EV S1 is challenging. Relative to a diesel baseline, MST would require a substantial increase in non-revenue hours and miles, and a significant increase in peak vehicle requirements as shown in **Figure 14**. The increase in non-revenue hours and miles is driven by the need to drive the vehicle back to the depot mid-shift for a vehicle swap. The challenge of transitioning cutaways/shuttle buses to BEBs is not unique to MST; today's cutaway/shuttle bus BEB technology is unable to meet the needs of many transit agencies at a 1:1 basis.

- Revenue Hours & Miles remain the same
- Non-Revenue Hours: **194% increase**
- Non-Revenue Miles: **189% increase**
- Peak Vehicle Requirement: **71% increase (+10)**

  - **0% of service** can be transitioned 1:1

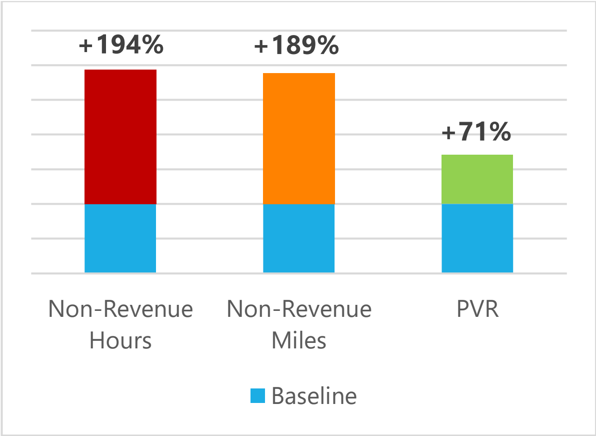

Figure 14. Weekday Depot-Only Charging, Cutaway/Shuttle Buses

TROLLEY BUSES

☑ **Feasible**

Relative to a diesel baseline, transitioning MST's current trolley fleet to BEBs using the Hometown Vehicle Manufacturing Villager Electric Trolley will work on a 1:1 basis, with no increase in non-revenue hours, miles, or peak vehicle requirement required. This portion of the fleet could be transitioned to a BEB fleet today without the need for any changes to fleet or operations to maintain the same level of service.

35' CONVENTIONAL BUSES

☑ **Partially Feasible**

Relative to a diesel baseline, MST can transition its 35' vehicles to BEB with modest increases in non-revenue hours, non-revenue miles, and one additional vehicle. **Figure 15** illustrates this depot-only charging scenario. Modeling in this scenario allows for the buses that could be recharged during the day and reused later in the day during subsequent bus swaps to reduce the total fleet increase required to maintain the same level of service.

- Revenue Hours & Miles remain the same
- Non-Revenue Hours: **15% increase**
- Non-Revenue Miles: **14% increase**
- Peak Vehicle Requirement: **9% increase (+1)**

  - **86% of service** can be transitioned 1:1

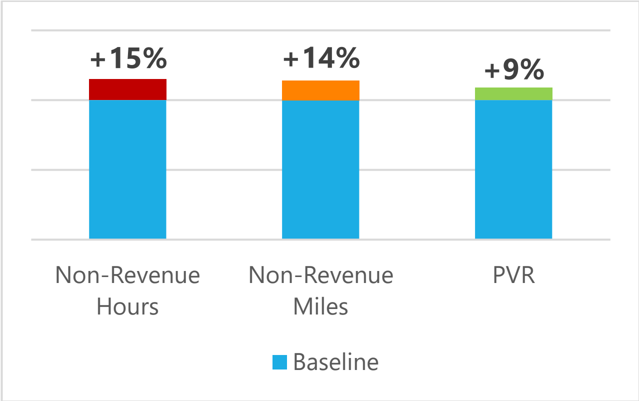

Figure 15. Weekday Depot-Only Charging, 35' Conventional Buses

40' CONVENTIONAL BUSES

☑ **Partially Feasible**

Relative to a diesel baseline, MST can transition its 40' vehicles to BEB with slightly more increases in non-revenue hours and non-revenue miles than 35' conventional buses, and two additional vehicles. **Figure 16** illustrates this depot-only charging scenario.

Operating Requirements:

- Revenue Hours & Miles remain the same
- Non-Revenue Hours: **27% increase**
- Non-Revenue Miles: **28% increase**
- Peak Vehicle Requirement: **6% increase (+2)**

  - **82% of service** can be transitioned 1:1

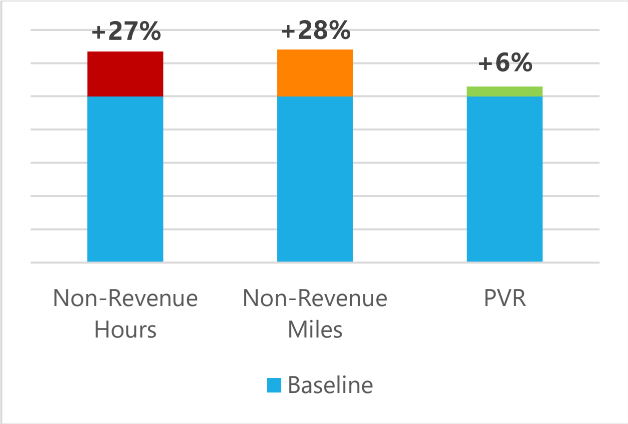

Figure 16. Weekday Depot-Only Charging, 40' Conventional Buses

BEB CHARGING INFRASTRUCTURE

The charging infrastructure required and power usage profile for each garage location is below. For each facility, the chargers required are the minimum quantity of chargers needed to meet each service and for most facilities, would require overnight vehicle swaps. The hourly power usage profile for each location reflects the minimum quantity of chargers required at each facility with vehicle swaps.

Table 17 highlights the quantity and power level of each charger required at each facility, along with the weekday peak load based on charging strategy described above. The subsequent figures highlight weekday power usage profiles for each facility. The charging infrastructure requirements indicate the *minimum* requirement; in reality, additional chargers may be installed to increase operational flexibility and reduce potential labor constraints.

Table 17. Chargers Required by Facility

Facility	Minimum Chargers Required	Minimum Weekday Peak Load
Thomas D. Albert Operations Facility (TDA)	4 x 150 kW	600 kW
Clarence J Wright (CJW) O&M Facility	4 x 150 kW	600 kW
South County (SCO) O&M Facility	3 x 150 kW	450 kW

Figure 17 below shows the power demand profile at the TDA O&M facility on a weekday. The graph depicts charging primarily occurring during the overnight hours while vehicles return to the garage at the end of the day with a reduced amount of charging taking place during the day. The use of chargers mid-day would be required to recharge vehicles for reuse later in the day to minimize the number of additional buses required to maintain the same level of service.

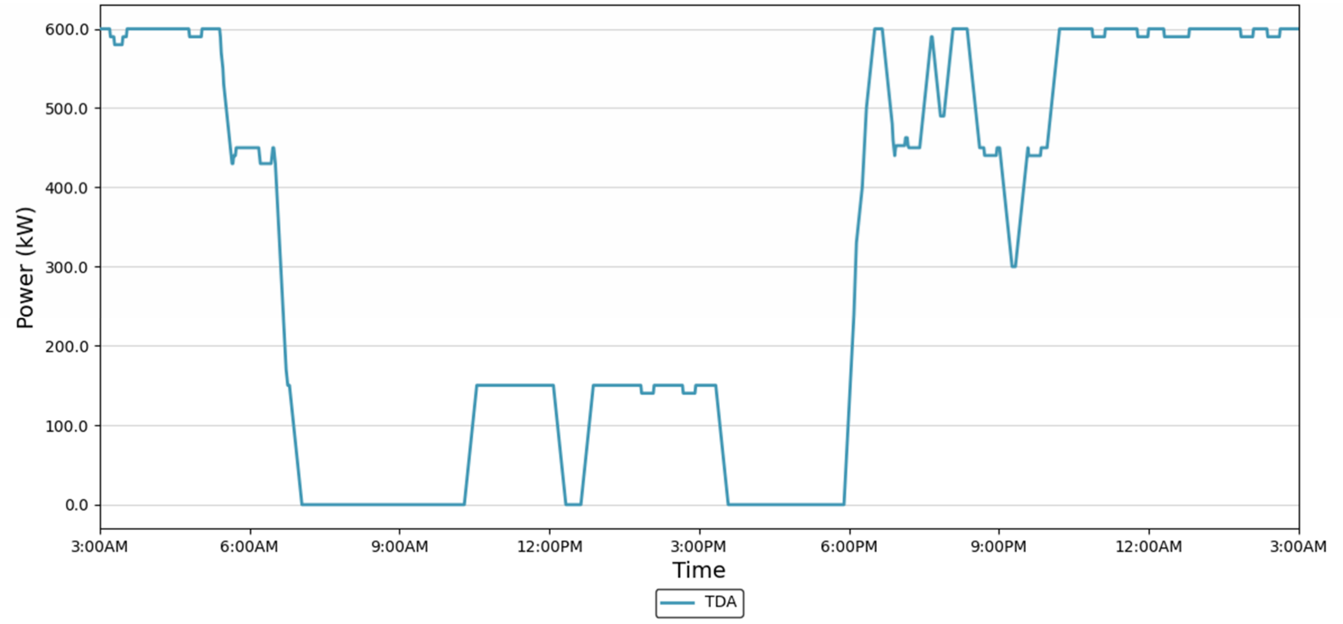

Figure 17. Weekday Power Usage Profile, TDA

Figure 18 shows the daily power demand profile at the CJW O&M facility; like TDA, most vehicle charging occurs overnight with a few periods of time during the day where one charger is in service.

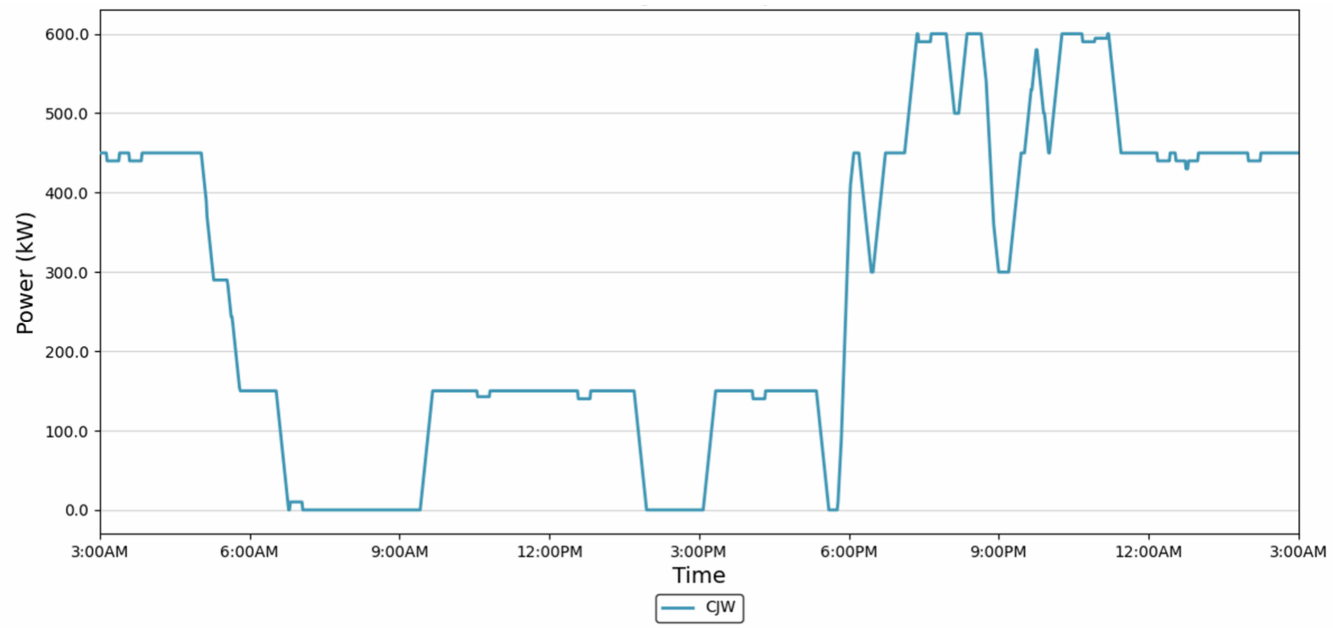

Figure 18. Weekday Power Usage Profile, CJW

Figure 19 below shows the power demand profile at the SCO O&M facility; unlike the other two facilities, charging at this location primarily takes place during the day.

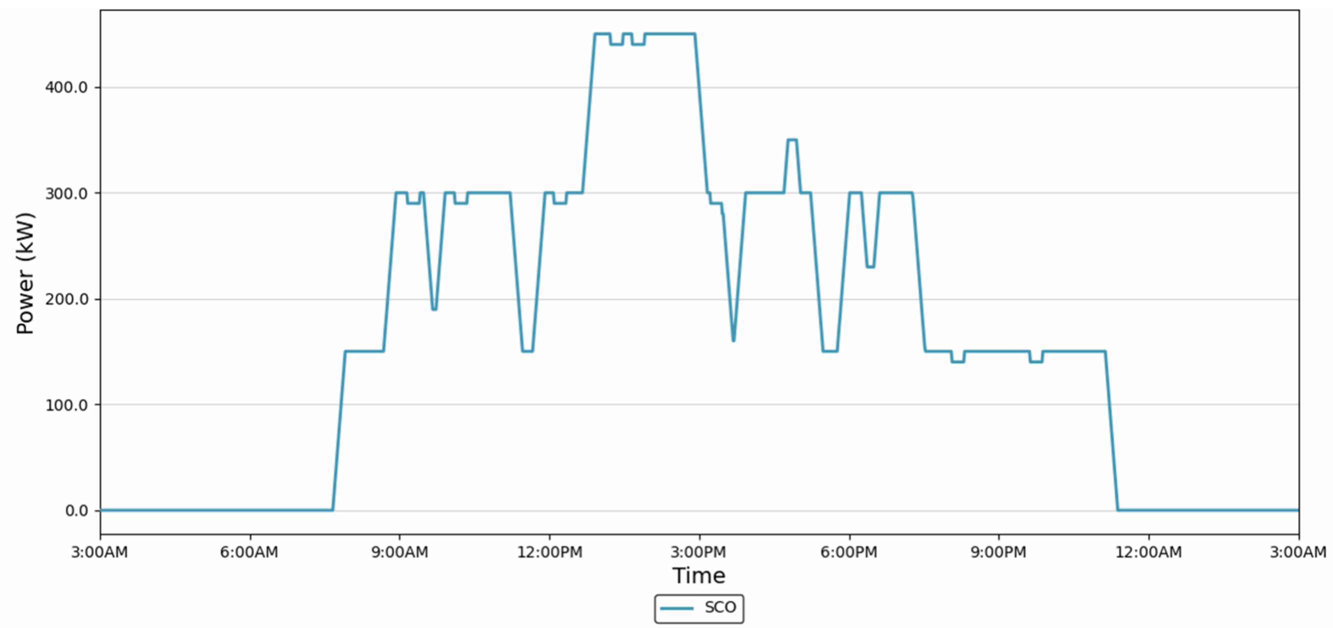

Figure 19. Weekday Power Usage Profile, SCO

FCEB ANALYSIS

There are less FCEB models available on the market today than BEBs for MST's fleet. Currently, there are no FCEB cutaways, trolleys, or 35′ buses readily available on the open market. Cutaways and trolleys were not modeled for FCEB replacement, and 35′ FCEBs were modeled as 40′ FCEBs as there are no 35′ FCEBs currently available. The modeling results detailed below are reflective of weekday service, but total hydrogen fuel requirement and block feasibility for both weekday and weekend service are included in the **Summary of Findings**.

35′ AND 40′ CONVENTIONAL BUSES

☑ **Feasible**

Relative to a diesel baseline, to fully transition MST's 35′ and 40′ conventional buses into 40′ FCEBs would require a modest increase in non-revenue hours and miles, but no additional vehicles. **Figure 20** illustrates this hydrogen FCEB scenario.

- Revenue Hours & Miles remain the same
- Non-Revenue Hours: **7% increase**
- Non-Revenue Miles: **8% increase**
- Peak Vehicle Requirement: **0% increase**

➢ **95% of service** can be transitioned 1:1

While a small portion of service would require a vehicle swap, the configuration of the current schedule allows for a bus to be refueled and reused in service later in the day, eliminating the need for an additional bus to maintain the same level of service.

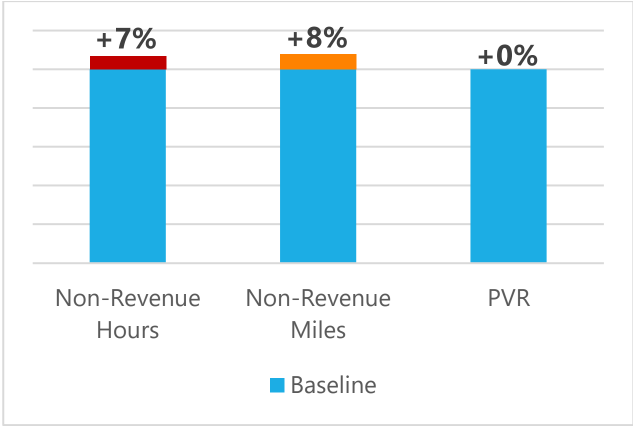

Figure 20. Hydrogen Fuel Cell, 35' and 40' Buses

HYDROGEN FUELING INFRASTRUCTURE

Hydrogen fueling infrastructure would be required at one or more O&M facilities to refuel FCEBs. Based on the modeling, **Table 18** shows the amount of hydrogen fuel that would be required to refuel all 35′ and 40′ buses assigned to each facility. Hydrogen fueling infrastructure would include, at a minimum, liquid hydrogen storage tanks and refueling dispensers.

Table 18. Weekly H2 Fuel Requirement by Facility

Facility	Weekly H2 Requirement
CJW	2,101 kg
SCO	1,109 kg
TDA	2,480 kg

SUMMARY OF FINDINGS

The energy modeling analysis performed reveals varying degrees of feasibility for ZEB implementation across MST's different vehicle types and routes. In the visual below, each vehicle block begins its day with a full state of charge (green) and the color of the block gradually changes color to red as the vehicle operates service and the battery state of charge declines. A blue box indicates that a vehicle swap is required to continue service on each block, a block without a blue box indicates that the route doesn't require a vehicle swap to complete its service throughout the day.

Figure 21 highlights a state of charge (SoC) heatmap for each weekday vehicle block if it were to transition to BEBs. This includes all cutaways/shuttle buses, trolley buses, and 35' and 40' conventional buses in MST's service, exclusive of routes 24 and 34 which were identified as outliers above. All vehicle blocks with two or more vehicle swaps in the graphic below are MST's cutaways/shuttle buses, which aren't operationally feasible to transition with today's technology.

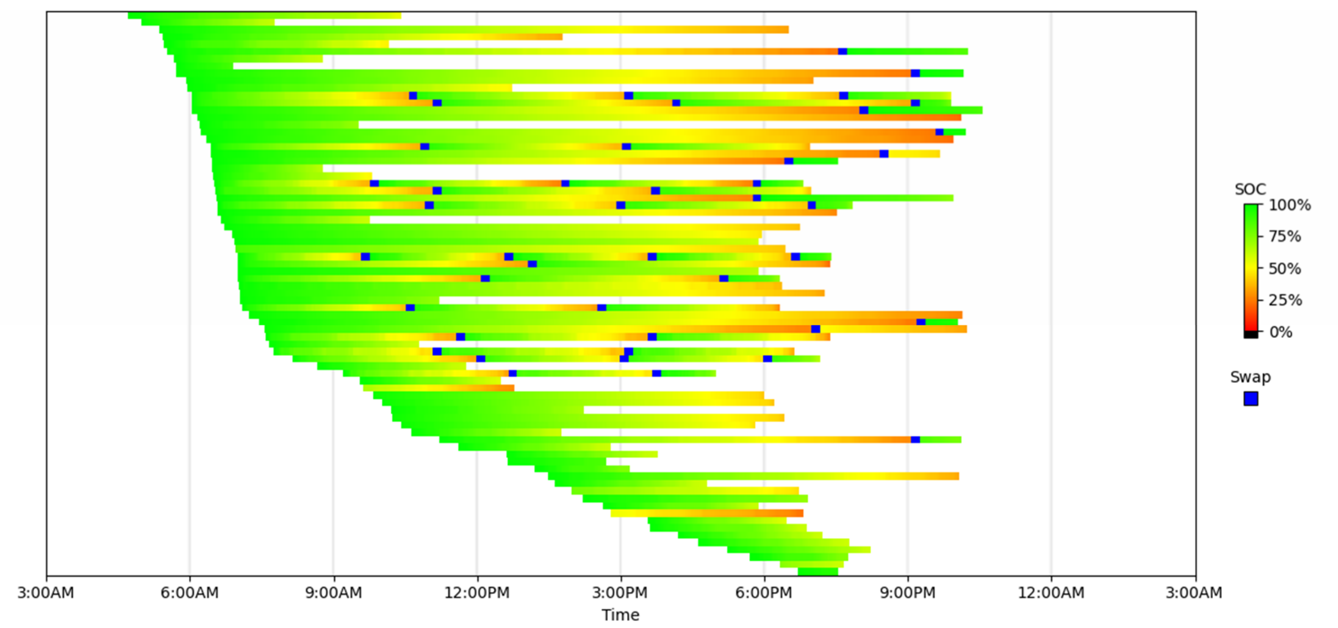

Figure 21. SoC Heatmap by Block for All Vehicle Types

Each of the tables below highlight weekday and weekend vehicle splits for each of the BEBs, where weekday swaps are reflective of the heatmap in **Figure 21** above. The tables below show the number of blocks that need to be split by assigned garage; a table reflective of the Contract Transportation facility is excluded as solely cutaways are assigned to this facility and none of the cutaways can be feasibly transitioned to BEBs at this time.

Table 19. Vehicle Swaps, Thomas D. Albert (TDA) Operations Facility

TDA	Weekday	Saturday	Sunday
No Swaps	15	14	14
1 Swap	7	-	-

Table 20. Vehicle Splits, Clarence J Wright (CJW) O&M Facility

CJW	Weekday	Saturday	Sunday
No Swaps	17	2	2
1 Swap	-	4	4

Table 21. Vehicle Splits, South County (SCO) O&M Facility

SCO	Weekday	Saturday	Sunday
No Swap	17	2	2
1 Swap	-	4	4

Table 22 highlights the weekday block feasibility for transitioning each of MST's four vehicle types to either BEB or FCEB at a 1:1 replacement ratio. Currently, no cutaways or shuttle buses can be transitioned to BEB or FCEB, all trolley buses are able to be transitioned to battery electric buses, and most 35' and 40' conventional buses are able to be transitioned to either BEB or FCEB.

Table 22. Weekday Block Feasibility

	BEB Only	BEB or FCEB	FCEB Only	Neither BEB nor FCEB
Cutaway/Shuttle Bus	-	-	-	16
Trolley Bus	4	-	-	-
35' Conventional Bus	-	12	-	2
40' Conventional Bus	-	37	7	1

Table 23 highlights the weekend block feasibility for transitioning each of MST's four vehicle types to either BEB or FCEB, no cutaways or shuttle buses can be transitioned to BEB or FCEB, all trolley buses are able to be transitioned to battery electric buses, and most 35' and 40' conventional buses are able to be transitioned to either BEB or FCEB.

Table 23. Weekend Block Feasibility

	BEB Only	BEB or FCEB	FCEB Only	Neither BEB nor FCEB
Cutaway/Shuttle Bus	-	-	-	12
Trolley Bus	4	-	-	-
35' Conventional Bus	-	8	-	2
40' Conventional Bus	-	15	2	2