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Clean Transportation Program

FINAL PROJECT REPORT

Electric Vehicle Blueprint for Berkeley Unified School District

Prepared for: California Energy Commission

Prepared by: Prospect Silicon Valley

ProspectSV

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO-20-601, entitled "Blueprints for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure." In response to GFO-20-601, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 16, 2021, and the agreement was executed as ZVI-21-009 on December 8, 2021.

ABSTRACT

This project developed an electric vehicle blueprint for transitioning the entire Berkeley Unified School District school bus fleet to zero-emission vehicles and progressing toward its sustainability goals. The blueprint documents impact assessments, charging infrastructure and site analyses, environmental and economic analyses, and innovative technology evaluations to support the district's commitment to full fleet electrification.

The blueprint includes a workforce development plan that identifies key players in the Alameda/Berkeley community to help the district provide employees with the critical skills, tools, and functional experience needed to service and maintain battery electric buses, recruit new talent, and develop training programs for a future workforce. As an early adopter, the district faces obstacles, including challenging supply chain and technology issues, constraints on expanding the charging capacity of the existing site, limited human resources, and financial capacity constraints. These challenges led the district to halt fleet electrification for the foreseeable future.

Nonetheless, the blueprint recommended several steps for the district to ease its future decision-making. These steps included managing and harnessing the data from the telematics software and addressing several technical issues. Further, if Berkeley Unified School District is to grow its electric fleet, it must have the infrastructure to support it. The team recommends that the district reengage in discussions with key partners, including the City of Berkeley and Pacific Gas and Electric Company, to gain the necessary support for its fleet electrification plans. It will also be essential for the state, local governments, and relevant funding agencies to recognize that these staff issues will make it challenging for school districts to take advantage of all the new electric vehicles and charging infrastructure funding opportunities and meet fleet electrification goals.

Keywords: Battery-electric buses, school bus fleet electrification, charging infrastructure, EV fleet, V2G, EVSE

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Introduction

California school districts operate more than 24,000 school buses, enabling them to significantly reduce greenhouse gas emissions and improve air quality for their local communities. However, electrifying a district's bus fleet poses significant challenges, affecting the entire bus operation, the district community, and the on-site and utility distribution-level electrical infrastructure. As a result, school districts must plan to manage the increased electricity demand of battery-electric buses, provide training and workforce development programs for operating and maintaining electric vehicles, and address various evolving technology and technical issues. These planning processes are complex, requiring levels of expertise and engagement school districts often don't have and find challenging to access. A comprehensive roadmap would aid school districts in reaching their sustainability goals, accessing financing, and providing resilient charging infrastructure to ensure a sustainable transition to an all-battery-electric bus fleet.

Purpose

This project aimed to provide the Berkeley Unified School District with a blueprint for transitioning its entire school bus fleet to zero-emission vehicles, including a workforce development plan. Prospect Silicon Valley led the project, working with the district, coordinating the technical work of IDeAs Consulting and Electriphi, and working closely with NOVAworks on engagement and workforce development activities.

Objectives

The project team provided a blueprint, which documents impact assessments, charging infrastructure and site analysis, environmental and economic analysis, and any other relevant studies performed for or related to Berkeley Unified School District's electric bus fleet.

Conclusions and Recommendations

Like many institutions, Berkeley Unified School District faces barriers to adequate hands-on training for current employees and technical staff who require critical skills, tools, and functional experience to service and maintain battery-electric buses effectively. The district also faces the challenge of recruiting and retaining new technically oriented staff and developing necessary training programs to retain and upskill this future workforce. The workforce development plan identifies key players in the Alameda/Berkeley community that can help the district address this issue in the near and long terms. In addition, the plan provides resources and insights for working with specific government agencies, nonprofit organizations, local unions, bus manufacturers, high school and college auto technology programs, and other partners to develop targeted workforce training programs.

As an early adopter of battery-electric buses and charging infrastructure, the district has faced some logistical challenges related to supply chain constraints and technology performance. While the supply chain challenges reflect global economic issues too large for any local agency to tackle, the blueprint project created programs and opportunities for district staff to engage with other early adopters and electric vehicle experts to explore local solutions to technology deployment, adoption, and procurement considerations. The project team recommends the district continue engaging with these ongoing programs.

Another critical challenge is infrastructure. As part of the electrical upgrade required to install its eight chargers, Berkeley Unified School District agreed with Pacific Gas and Electric Company (PG&E) that it could not upgrade the service again until 2024. This constraint on upgrading the infrastructure, combined with the planned increase in buses, limited space on the existing lot, and an existing bioswale adjacent to the bus yard, constrains the expansion of electric bus charging capacity on the site. If Berkeley Unified School District is to grow its electric fleet, it must have the infrastructure to support it. The team recommends reengaging in discussions with key partners, including the City of Berkeley and PG&E, to support its fleet electrification plans.

Berkeley Unified School District also faces resource limitations, including human resource and financial capacity constraints. COVID-19 has exacerbated these challenges with staff resignations and the organization's focus on funding to address COVID-19 impacts on health, safety, and productivity for staff, faculty, and students. In addition, staff is often overloaded and has limited time and resources to focus on additional funding for electrification and solar projects.

These challenges led the district to halt the fleet electrification for the foreseeable future. Unfortunately, given this decision and the inability to obtain data from nonfunctioning systems, the project team could not provide an in-depth analysis of the opportunities and potential solutions available to the Berkeley Unified School District.

However, the blueprint recommended several steps for the district to help make its future decision-making easier. These steps included managing and harnessing the data from the telematics software and addressing several technical issues, such as to:

- Fully install, test, commission, and implement the telematics software and train staff to use it.
- Examine the energy use data from the telematics software to determine if the system can bear additional chargers without exceeding maximum service/switchboard capacity.
- Determine the number of additional buses the district can charge by analyzing the operation schedule and route lengths to determine the number of miles driven and the associated kilowatt hours of energy required to recharge its buses.
- Work with the switchboard manufacturer to retrofit the existing switchboard to accommodate additional circuit breakers and maximize the effectiveness of the Ford Pro Depot Charging platform.

CHAPTER 1: Introduction

Project Context

In Executive Order N-79-20,[1] Governor Newsom states, "California's long-term economic resilience requires bold action to eliminate emissions from transportation, which is the largest source of emissions in the State." The order goes on to establish the goal that 100 percent of medium- and heavy-duty (MD/HD) vehicles sold and operated in the state be zero-emission by 2045. The adoption of battery-electric buses (BEBs) by California school districts presents a viable opportunity to deploy electric MD/HD fleet vehicles and move toward achieving this goal.

With more than 24,000 school buses transporting about 1.1 million students daily, school districts can significantly reduce GHG emissions and improve air quality for their local communities. However, electrifying their bus fleets can pose tremendous challenges for a school district, because it impacts the entire bus operation, including transportation directors, administrators, drivers, students, and the district community. Adopting BEB technology also affects the on-site and utility distribution-level electrical infrastructure. As a result, school districts must consider how they will manage the increased electricity demand of BEBs, provide training and workforce development programs for operating and maintaining electric vehicles, and address technical issues such as battery performance in varying routes, duty cycles, and environments.

School districts find the planning process complex, requiring levels of expertise and engagement they don't have and find challenging to obtain. A comprehensive roadmap of vehicle and charging infrastructure requirements, financial incentives, and other factors would aid school districts in reaching their sustainability goals, accessing financing, and providing resilient charging infrastructure to ensure a sustainable transition to an all-BEB fleet.

Project Goals and Objectives

This project aimed to provide the Berkeley Unified School District (BUSD) with an electric vehicle (EV) blueprint for transitioning its entire school bus fleet to zero-emission vehicles, including impact assessments, charging infrastructure and site analysis, innovative technology considerations, environmental and economic considerations, as well as community and workforce considerations.

To realize this goal, the team planned to assess opportunities for using innovative technologies, the long-term implications of electric fleet management and operations, and the need for community and workforce development. Specific objectives included:

- Analyzing the combination of technologies and systems that offer the best mix of economic, environmental, and technical performance specific to the project/region.

1 State of California Executive Order N-79-20 of September 20, 2020, https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf.

- Seeking alignment and support from community groups, community-based organizations, (CBOs), workforce groups, universities, and job programs.
- Working with community colleges, CBOs, and community leaders to develop workforce development strategies that provide the local community workforce with training, education, and readiness to develop, support, and maintain the MD/HD ZEV fleets.
- Providing outreach and engagement with school districts, local government, and fleet owners to share lessons learned.

Project Partners and Roles

Berkeley Unified School District (BUSD)**,** a diverse school district serving students and families in the City of Berkeley, is well known for its commitment to academic excellence, equity, access, and enrichment. It serves more than 9,400 students and operates 20 schools, including preschools, elementary, middle, and comprehensive high schools, a continuation high school, and an adult school. The district, eager to become a leader in using BEB technology, acquired an initial fleet of electric school buses in 2019.

Prospect Silicon Valley (ProspectSV) focuses on the effect and scalability of solutions in emerging sustainability markets. The organization engages a diverse ecosystem of corporations, startups, academic institutions, and public agencies to accelerate progress toward sustainability goals. ProspectSV has worked with more than 50 communities and catalyzed $500 million in venture investment and public funding. ProspectSV led this blueprint project, coordinating the technical work performed by IDeAs Consulting and Electriphi and working closely with NOVAworks on engagement and workforce development.

IDeAs Consulting is an electrical engineering firm specializing in sustainable electrical system design for buildings, integrating renewable energy, energy storage, and electric vehicle charging. The firm has developed sophisticated multivehicle charging and car stacking solutions for parking garages and studied approaches to combining EVs with on-site photovoltaic (PV) systems to create microgrids. IdeAs gathered essential data about BUSD's existing EV technology and infrastructure; analyzed the conditions, technologies, and opportunities for optimal charging infrastructure, energy storage, and complete electrification; and proposed recommendations for realizing a long-term plan.

NOVAworks is a federally chartered workforce agency based in Sunnyvale with a local workforce area that includes San Mateo County and the northern region of Santa Clara County. In addition, NOVAworks reaches a broader audience through an extensive network of regional and statewide partnerships. For this project, NOVAworks developed an action plan to enable training, education, and readiness for the local community workforce to transition to zero-emission vehicles.

Electriphi, a technology innovator acquired by **Ford Pro** during this project, provides operational fleet and energy management software solutions, as well as comprehensive fleet transition planning strategies. Its singular focus is enabling the transition to zero-emission vehicles (ZEV) across heavy-, medium-, and light-duty fleets in public and private segments. For example, the company works with Twin Rivers Unified School District in Sacramento, one of the nation's largest electric school bus fleets. The deployment includes software-managed charging across several electric vehicle supply equipment (EVSE) and vehicle vendors. For this project, the firm analyzed charging needs, infrastructure sizing, and charging strategies.

CHAPTER 2:
Analysis and Assessments

Staff Interviews and Data Collection

In this phase, the team sought information directly from relevant District staff, from an on-site visit, and documents and records provided by BUSD.

Team members interviewed John Calise, executive director of facilities, and Sheila Collier, transportation manager. The conversations focused on the constraints on upgrading the infrastructure and expanding the existing site. They also discussed challenges BUSD faces as an early adopter of EV and EVSE technologies, including logistical obstacles related to supply chain constraints and technology deployment, the ongoing shortage of trained personnel, training existing staff, and the District's critical resource limitations, such as human resource and financial capacity constraints.

The project team gathered information on BUSD's current fleet, including a vehicle inventory, operations and maintenance records detailing vehicle use and mileage history, an inventory of EVSE equipment, and recent electric bills. A visit to the BUSD Bus and Maintenance Facility included a site walk to map out and photograph the layout of the existing infrastructure.

The team encountered challenges in directly correlating energy bill data with fleet charging — a typical problem when working with imperfect metering. The team incorporated information from the interviews and data collection into the analysis and, throughout the project, held regular check-in meetings with BUSD staff.

Assessment of Fleet and EVSE

In this phase, the project team assessed the existing BUSD fleet, EV technology, and charging and facilities infrastructures, identifying challenges and opportunities to support the district's long-term fleet electrification plan. The team's approach to assessing a school bus fleet (as well as the white fleet) is often iterative. However, it generally requires assessing vehicles and infrastructure in a parallel fashion and includes the steps outlined in Table 1.

Table 1: Assessment Approach

Vehicle Assessment Approach	**Infrastructure Assessment Approach**
1. Collect a comprehensive list of vehicles.	1. Gather information about site(s) where vehicles may be charged
2. Classify and categorize vehicles.	2. Collect a comprehensive list of any existing chargers.
3. Investigate and confirm usage patterns and functional needs for vehicles.	3. Classify and categorize existing charger capacity and connection capability with existing and new fleet

Vehicle Assessment Approach	Infrastructure Assessment Approach
4. Prioritize vehicles based on that investigation	4. Determine viability of the site to host additional stations
5. Conduct total cost of ownership (TCO) analysis of electric vehicles compared to viable internal combustion engine replacements and/or existing vehicle	5. Match station and vehicle needs and capacity
6. Discuss and confirm TCO analysis findings with vehicle operators/fleet owner's representative	6. Identify grant, incentive and other infrastructure funding opportunities to support necessary infrastructure improvements
7. Finalize assessment and provide recommendations	7. Finalize assessment and provide recommendations

Source: ProspectSV

Ford Pro (formerly Electriphi) developed a total cost of ownership (TCO) tool for buses to help potential school district customers with EV fleet planning. (It is not meant for public use.) The tool requires data and information inputs such as vehicle characteristics, routes and schedules, utility rates, charging infrastructure, and funding incentives. The information gathered from BUSD was used to assess and compare electric vs. conventional bus costs. The team had also hoped to analyze data generated by the telematics software BUSD had recently installed but realized insufficient data were available. Instead, the team relied on digital and paper records, organized by BUSD.

The interviews, assessments, and data collection were analyzed and presented in the ZEV Impact Assessment Report.[2]

Assessment of On-Site Infrastructure

Project partner, IDeAs Consulting, visited the site to assess the existing infrastructure and electrical service. It evaluated the installed charging infrastructure relative to the requirements for full-fleet electrification and inspected on-site electrical panels and other systems to gauge the potential for upgrade. The project team reviewed this assessment with BUSD and presented the assessment results in the EV blueprint.

Although BUSD had already begun its fleet electrification program and had experience installing and commissioning chargers, information was not easy to access from BUSD. The project team recommends other districts gather site and electrical infrastructure data early in the project and seek an assessment of the existing fleet and infrastructure and a projection of EV and EVSE requirements.

[2] Prospect Silicon Valley. (2022) Berkeley Unified School District: EV Blueprint ZEV Impact Assessment Report. Available upon request.

Evaluation of Innovative Technologies

The project team analyzed new and emerging EV and EVSE technologies and systems that could provide economic and environmental benefits to BUSD. The review covered developments in charge management and EV-grid integration technology and onboard technology, such as telematics.

The team prepared a complete analysis and presented the most relevant technologies for the district in the EV blueprint.

The team further advised BUSD that new, rapidly evolving technologies can offer significant opportunities for achieving sustainability goals but require periodic review, updating training programs, and revising acquisition plans.

Environmental Benefits and Economic Impact

The team reviewed the district and regional policies designed to improve air quality and climate resilience to help assess the potential environmental benefits and economic impacts of realizing full fleet electrification. These policies included goals established by BUSD's Sustainability Plan,[3] Berkeley's Climate Action Plan[4] and the regional air quality standards regulated by Bay Area Air Quality Management District (BAAQMD).[5] The team showed in the EV blueprint how the district's plan supports and serves the city's policies on reducing GHG emissions and supports the BAAQMD's goal to reduce ozone and particulate matter in the Bay Area.[6] The project team recommends that school districts identify similar regional policies to help guide their fleet electrification efforts and maintain strong relationships with regional planning.

The team also referenced research identifying on-road motor vehicles as the primary source of ozone and particulate matter and the negative impact these pollutants have on cognitive functioning, health, and educational outcomes.[7] Further, team members reported that heavy-duty vehicles like traditional diesel school buses emit relatively higher levels of GHGs and particulates than the light-duty counterparts. In contrast, research shows that BEBs do not emit particulate matter, do not directly emit GHGs, and are more energy-efficient than traditional diesel-powered buses. Applying data and models from the recent research literature to the BUSD plan, the team calculated the annual tonnage of GHG emissions avoided through

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[3] Berkeley Unified School District. (2018). A Deeper Shade of Green: Sustainability Plan 2018. https://www.berkeleyschools.net/wp-content/uploads/2019/10/BUSD-Sustainability-Plan.pdf

[4] City of Berkeley. (2009). Climate Action Plan. https://berkeleyca.gov/sites/default/files/2022-01/Berkeley-Climate-Action-Plan.pdf

[5] Bay Area Air Quality Management District. (2023) Current Rules. https://www.baaqmd.gov/rules-and-compliance/current-rules

[6] Bay Area Air Quality Management District. (2017). 2017 Clean Air Plan: Spare the Air, Cool the Climate https://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/%20attachment-a_-proposed-final-cap-vol-1-pdf.pdf?la=en

[7] Austin, W., Heutel, G., & Kreisman, D. (2019). School bus emissions, student health and academic performance. *Economics of Education Review*, *70*, 109-126. https://econpapers.repec.org/article/eeeecoedu/v_3a70_3ay_3a2019_3ai_3ac_3ap_3a109-126.htm

full fleet electrification.[8] According to the Union of Concerned Scientists, a diesel bus emits 2,680 grams of CO_2/mile.[9] An electric bus emits 609 grams of CO_2/mile. If driven an estimated 15,000 miles per year (based on average mileage estimates[10]), electric buses would save 34 metric tons of GHGs per bus per year based on the current mix of renewable energy in the California standard grid. If the entire grid moves to renewable energy, that number increases to 44 metric tons of GHGs not emitted per year. The team reported that realizing the district's fleet electrification plan would also reduce ground-level ozone and particulate matter,[11] reduce the disease burden, and improve educational outcomes in the student population and communities it serves.

The team researched manufacturer data and academic studies to compare fuel and maintenance costs and the TCO of electric vs. diesel buses, estimate the savings the district already enjoys with the existing EV fleet, and provide the district with sufficient data to estimate future savings. Some estimates state maintenance costs savings of up to 60 percent for BEB buses over traditional diesel buses and with energy costs being reduced by up to 80 percent.[12]

The team compiled financial information provided by BUSD. The team found the district's pursuit of grants and incentives has reduced funding requirements for fleet electrification and charging infrastructure via grants from the BAAQMD and the state's Hybrid Voucher Incentive Program, totaling so far $3.2 million.[13] The district intends to finance the remaining procurements through external funding, and it will be well served by the newly available grants, tax credits, and other funding sources the team helped identify.

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[8] Electric School Bus Initiative. (2022). The Evidence is Clear: Electric School Buses are the Best Choice to Reduce Emissions. September 1, 2022. https://electricschoolbusinitiative.org/evidence-clear-electric-school-buses-are-best-choice-reduce-emissions

[9] Houston, S. (2019). *Electric Utility Investment in Truck and Bus Charging: A Guide for Programs to Accelerate Electrification.* Union of Concerned Scientists. http://www.jstor.org/stable/resrep24102

[10] Environmental Defense Fund. (2021). *Electric School Bus.* https://blogs.edf.org/energyexchange/wp-content/blogs.dir/38/files/2021/02/ElectricSchoolBusFactSheet.pdf

11 City of Berkeley. 2009. *Climate Action Plan*. https://berkeleyca.gov/sites/default/files/2022-01/Berkeley-Climate-Action-Plan.pdf

12 "How to Electrify the School Bus Fleet in the U.S." June 1, 2021. *School Transportation News*, www.stnonline.com/partner-updates/how-to-electrify-the-school-bus-fleet-in-the-u-s/.

13 Markovich, Ally. October 10, 2021. "Berkeley's Yellow School Buses Are Going Green." *Berkeleyside*, www.berkeleyside.org/2021/10/10/electric-school-buses-berkeley-unified.

CHAPTER 3:
Community Engagement and Outreach

ProspectSV engaged several stakeholders in partnership with the district to minimize the risks and uncertainties of designing, permitting, planning, and financing the ZEV infrastructure network and enable training, education, and readiness for the local community workforce to make a ZEV transition. This chapter highlights the community engagement and outreach undertaken by the project team to ensure alignment and support across stakeholders in creating the EV blueprint and the workforce development plan.

Community Support Development

ProspectSV engaged key stakeholders, including the school bus vendors, utilities, local jurisdictions, planning organizations, regional workforce organizations, CBOs, and community leaders. This engagement sought to help ensure the success of the project and create replicable, scalable models moving forward.

In the planning phase, ProspectSV researched area organizations and potential partners, compiled a list of contacts with help from project partners, and determined roles and responsibilities for outreach and engagement. Next, it requested letters of support, followed up with these and other contacts, and adjusted the process and message to ensure that future activities engaged the appropriate point of contact. The team contacted:

- Utilities to support grid delivery, reliability, and resiliency and address impacts of EV charging on utility rates.
- Local jurisdictions and planning organizations to ensure their involvement in infrastructure planning and permitting.
- Regional workplaces, business owners, and operators to engage them in planning and educate them on the benefits of ZEV transportation.
- Regional community-based organizations, community leaders, California Native American tribes, and potentially affected residents to engage them in planning and educate them on the benefits of ZEV transportation.
- Financial institutions to ensure they were educated, involved, and committed to participating in the implementation of the EV blueprint.

Outreach efforts engaged other school districts and provided support, assistance, and lessons learned from the BUSD experience. The blueprint stakeholders helped inform other engagement strategies for school districts and were especially useful in assessing and asserting training and recruitment needs for BEB vehicle and infrastructure technicians.

NOVAworks leveraged its extensive network of regional community-based organizations, high schools, and community colleges to highlight the benefits and resulting opportunities of bringing the EV blueprint project to the district. Initial engagement targets included the Alameda Workforce Development Board to provide workforce support for the BUSD.

Informal Technical Advisory Committee

ProspectSV engaged with the informal technical advisory committee's (TAC) domain experts to disseminate information during substantive project updates, request input, and encourage information sharing. Appendix A lists the members of the TAC.

CHAPTER 4:
Project Results

Workforce Development Plan

NOVAworks partnered with ProspectSV and BUSD to create a workforce development plan (WDP) for BUSD. It addresses the barriers BUSD faces in providing current employees with the necessary training, skills development, tools, and experience to run, service, and maintain zero-emission vehicles (ZEVs) effectively. It also addresses the district's challenges in recruiting and retaining new technically oriented staff and developing necessary training programs to retain and upskill this future workforce.

The Berkeley/Alameda County region offers many resources essential for developing, maintaining, and expanding an EV fleet. These resources include the regional community college system, which is building a virtual Northern California fleet academy to ensure that automotive faculty at 14 colleges in the greater San Francisco Bay Area understand the emerging ZEV skill demands. In addition, the Alameda County workforce agency has existing community, industry, government, and educational relationships. There are also potential synergies with the City of Oakland and strong interest from the East Bay Clean Cities Coalition.

What's missing is a focal point to help align regional ZEV fleet development resources. To address this gap, the WDP recommends that these community institutions coalesce and catalyze existing resources and expertise to form a transparent and inclusive community of practice (COP) that supports the ongoing development and growth of the BUSD ZEV fleet.

A Berkeley/Alameda County ZEV Community of Practice

Successful and sustainable ZEV fleet adoption requires the participation of several community stakeholders that form a community of practice (COP). They include representatives from:

- Local government.
- Regional utilities.
- Vehicle manufacturers.
- Workforce development boards.
- Green energy consortia, including Clean Cities coalitions.
- Educational institutions, including universities, community colleges, adult school, K-12.
- Labor unions, particularly the International Brotherhood of Electrical Workers and related apprenticeship programs.
- Technical training centers.
- Community-based organizations representing diverse populations.

A Berkeley/Alameda County ZEV COP would initially support BUSD's goals of building training capacity and establishing clear career pathways for the region's diverse populations. The COP could then replicate the Berkeley model for development by other regional ZEV fleets. In addition to leveraging existing internal resources, the COP would leverage statewide emerging practices and explore potential sources of funding and expertise.

The WDP recommends that the COP focus its talent outreach on solidifying partnerships with community-based organizations. The project team reached out to several regional organizations and received commitments to serve as community engagement hubs for the EV blueprint initiative. These hubs will leverage institutional relationships with targeted community-based organizations. Potential engagement hubs include the Alameda County Workforce Board, the East Bay Clean Cities Coalition, and the City of Berkeley.

The WDP identifies additional prospective community-based organization partners that help youth build careers in the emerging green economy, such as buildOn, Faith in Action East Bay, and Rising Sun Center for Opportunity. It also identifies innovative companies, such as Greenwork, which connects job seekers with training, and community college programs, such as NextGen Auto, which develops in-depth training courses and materials.

Jobs Creation

While California will likely have an electric transportation workforce of 68,000 by 2024,[14] the outlook for ZEV fleet vehicle and infrastructure employment growth is unclear. According to industry and education experts, increased electrification will likely not create new job titles or a large number of net new jobs. For example, certified electricians will install new charging stations. Electrical companies will install power lines and repairers will lay the wires. Existing fleet technicians will repair and maintain the ZEVs.

However, incumbents and new entrants in the ZEV ecosystem will need additional training. The national Electric Vehicle Infrastructure Training Program (EVITP)[15] provides training for certified electricians. The curriculum covers Internet Protocol (IP) networking of charging stations; installing, commissioning, and maintaining electric storage devices, and first responder safety and fire hazard measures. In addition, community college graduates of auto technology programs will need algebra, physics, and computer science training to compete for emerging ZEV technician roles.

Generally, there will be jobs available for new entrants with the right skills, primarily fleet technicians and electricians. Many jobs will be in the Berkeley-Alameda County ZEV ecosystem, not necessarily at the school district, and will support the Berkeley school district's ongoing electrification efforts.

EV Blueprint

This project aimed to provide BUSD with an EV blueprint for transitioning its entire school bus fleet to zero-emission vehicles, including impact assessments, charging infrastructure and site analysis, innovative technology considerations, environmental and economic considerations, as well as community and workforce considerations.

The project team collected information from BUSD about the school bus fleet, existing charging infrastructure, and facility infrastructure, including the electric service. (Chapter 2 briefly summarizes this information.) Team members assessed the district's fleet electrification plans in light of its infrastructure and specific challenges and performed an in-depth analysis of emerging and relevant EV and charging infrastructure technology. The Blueprint presented this

14 "New Report Finds California Electric Transportation Workforce Will Nearly Double by 2024." April 22, 2021. Green Car Progress, https://www.greencarcongress.com/2021/04/20210422-aee.html.

15 Electric Vehicle Infrastructure Training Program https://evitp.org/

information along with an analysis of electrification costs, pointers to potential funding sources, and recommendations for resiliency planning.

The blueprint also acknowledged the challenges BUSD faced and continues to face in realizing its goal for complete electrification of its school bus fleet. The project team addressed as many of these challenges as possible but was often limited by insufficient information.

As noted, the BUSD set aside BEB and infrastructure procurement as well as planning for expansion for the foreseeable future. For these reasons, the project team could not provide recommendations on detailed plans. However, the blueprint presented several recommendations to help the district gather the necessary data and insight to make informed decisions once it begins planning.

CHAPTER 5:
Conclusions and Recommendations

An EV blueprint provides school districts with an essential, organized approach to planning and realizing fleet electrification and building a shared understanding of a district's goals with community organizations and stakeholders. A blueprint synthesizes aspects of this long-term venture: accessible information, effective communication, principled financial decisions, workforce training and development plans, and environmental stewardship.

Like many institutions, BUSD faces barriers to adequate hands-on training for current employees and technical staff who require critical skills, tools, and functional experience to service and maintain BEBs effectively. The district also faces the challenge of recruiting and retaining new technically oriented staff and developing necessary training programs to retain and upskill this future workforce. The workforce development plan identifies key players in the Alameda/Berkeley community that can help the district address this issue in the near and long terms. In addition, the plan provides resources and insights for working with specific government agencies, nonprofit organizations, local unions, bus manufacturers, high school and college auto technology programs, and other partners to develop targeted workforce training programs.

As an early adopter of battery-electric buses and charging infrastructure, the district has faced logistical challenges related to supply chain constraints and technology deployment. While the supply chain challenges reflect global economic issues too large for any local agency to tackle, the EV blueprint project created programs and opportunities for district staff to engage with other early adopters and EV experts to explore local solutions to technology deployment, adoption, and procurement issues. The project team recommends the district continue engaging with these ongoing programs.

Another critical challenge concerns infrastructure. As part of the electrical upgrade required to install its eight chargers, BUSD agreed with PG&E that it could not upgrade the service again until 2024. This constraint on upgrading the infrastructure, combined with the planned increase in buses, limited space on the existing lot, and an existing bioswale adjacent to the bus yard, constrains expansion of the electric bus charging capacity on the site. If BUSD is to grow its electric fleet, it must have the infrastructure to support it. The team recommends discussions with key partners, including the City of Berkeley and PG&E, to support its fleet electrification plans.

These challenges led the district to halt the fleet electrification effort for the foreseeable future. Unfortunately, given this decision and the inability to obtain data from nonfunctioning systems, the project team could not provide an in-depth analysis of the opportunities and potential solutions available to the BUSD.

However, the EV blueprint recommended several steps for the District to help make its future decision-making easier. These steps included managing and harnessing the data from the telematics software and addressing several technical issues.

Recommendations for BUSD

The blueprint also provided a list of recommendations for managing and harnessing the data from the telematics software:

- Fully install, test, commission, and implement the telematics software.
- Train staff to use the telematics software; document and video record the training for subsequent training.
- Develop comparisons to diesel bus operation for BUSD operations management, including quantitative factors such as total cost of ownership, first cost, miles driven, fueling costs, software and hardware, and maintenance costs.
- Report on the performance of each electric bus, including predictive maintenance recommendations, battery degradation, and recharge speed.
- Provide individual driver performance reporting to drivers and the transportation manager.
- Once the electric school bus fleet is fully operational and before purchasing more electric school buses or installing more chargers at the site, the district should work with the telematics provider in planning further electrification. The work should study charging patterns and determine the best options for adding electric school buses and chargers, optimal circuiting strategies and controls, and the estimated maximum number of buses that can be charged at the site with the current utility service size limitations and bus types used by BUSD.
- Develop a prioritized list of the next bus purchases targeted (Type "A" or "D") and estimate a schedule of replacement requirements for obsolete buses.
- Coordinate with the City of Berkeley to clarify city requirements for when chargers need to be installed for Type "D" buses adjacent to the bioswale area.
- Structure a similar effort for transitioning to light-duty vehicle fleet electrification.

Recommendations for Workforce Training

The WDP recommends that the COP consider the NextGen Auto program as a primary resource and template for engaging prospective employees in ZEV-related training and employment opportunities. The program supports the industry's rapid shift to ZEVs by amplifying the region's college training capacity and opportunities for connections with leading employers. The target audiences for the NextGen Auto campaign are high school students, their parents, and returning and/or displaced workers ages 19 to 34+. In addition, the top targets are underserved minority and female students.

Berkeley training programs should include apprenticeships offering opportunities for students to earn and learn simultaneously. For example, the International Brotherhood of Electrical Workers (IBEW) Local 595 operates apprenticeship programs with electrical contractors represented by National Electrical Contractors Association. The five-year program includes classroom instruction, on-the-job training, and paid employment.[16]

16 IBEW Local 595 apprenticeship program, https://www.ibew595.org/index.cfm?zone=/unionactive/view_article.cfm&HomeID=254085&page=Apprenticeships.

In addition, the South Bay Workforce Investment Board (SBWIB) in Hawthorne (Los Angeles County) is launching its Energy Flex apprenticeship program. It will train individuals to maintain electric vehicles and charging stations. The program includes 2,000 hours of paid on-the-job training over 12 months and a minimum of 144 hours of classroom training. SBWIB is working with Zeem Solutions, a Southern California electric vehicle leasing company, as its key employer partner. Under a grant from the California Department of Industrial Relations, the district could participate in the Energy Flex opportunity and receive compensation for participant training support and institutional staff time, according to Chris Cagle, regional affairs manager at SBWIB.

BUSD should also engage the union representatives of its incumbent workers to inquire about jointly sponsored apprenticeships and other training opportunities.

The district can also consider applying for a grant from the state's High Road Training Partnerships (HRTP) initiative, which helps build industry partnerships that deliver equity, economically resilient communities, and job quality.[17] In addition to the workforce boards, this HRTP approach could include other partners, such as ProspectSV, regional colleges, and community-based nonprofits.

Finally, the district should remain informed of efforts such as NOVAworks's engagement with workforce development agencies in Richmond, Alameda County, and Sacramento (Sacramento Employment and Training Agency).

Recommendations to Other School Districts

School districts with nascent fleet electrification programs like BUSD should develop flexible strategies with long-term goals to accommodate evolving technologies, student and district needs, and community sentiment. These are early days, and the integration of electric buses, charging infrastructure, and on-site energy resources will surely evolve quickly. School districts should remain aware of these changes and the advantages they bring, and they should be prepared to adjust plans as their needs evolve.

Rather than drafting highly detailed plans covering an entire fleet, a district should create a phased timeline covering a series of bus/vehicle deliveries and infrastructure installations. Staff would meet before each phase begins to debrief, troubleshoot, and fine-tune plans.

Grants and incentives to fund school-fleet electrification often require different levels of engagement with community organizations and stakeholders. School districts need to establish these relationships well before applying for grants.

School districts undertake significant groundwork before launching an EV transition, including organizing and making records accessible, researching manufacturers' product documentation, reviewing local utility requirements, and researching and applying for grants. Therefore, increasing capacity and bandwidth to take on these tasks through additional staffing or hiring qualified contractors is crucial for project success.

17 "The High Road Training Partnerships (HRTP)." California Workforce Development Board, https://cwdb.ca.gov/initiatives/high-road-training-partnerships/.

Recommendations to the California Energy Commission

This blueprint project provided valuable benefits and insights for BUSD. The following recommendations may offer even more benefits to other school districts, with minimal additional effort from the California Energy Commission (CEC) or blueprint drafters.

ProspectSV suggests redesigning the guidance for the scope of work for blueprint projects to encourage flexibility so that the blueprint can be tailored to needs that are discovered as the team gathers data about the fleet and gains familiarity with the organization and community. This can minimize work that isn't necessary for one project, but made sense during planning, and ensure that the resulting blueprint provides value.

The team found that BUSD faced challenges in capturing fleet data, a trend that has been experienced in working with school districts and other organizations in California. In response, ProspectSV made fleet data capture a central focus of the technical assistance it provides to school districts in the early stages of transition. In addition to offering results of completed blueprint efforts, the project team recommends the CEC consider issuing recommendations or guidance for fleet data capture for all school bus and service fleets. These recommendations may take the form of recommended data structure identifying the kinds of fleet inventory and telemetry data that yield insights for EV planning, or a fleet inventory spreadsheet tool that provides a starting point for users to begin preparing for blueprints or similar plans.

Of course, the project partners all understood that fleet electrification programs require changes to operational and financial policies and procedures. However, the experience with BUSD revealed that successful arguments justifying the changes differ substantially between these two functions. It's essential to pose the right argument to the right people in each organization. Therefore, to ensure the scalability of such projects, ProspectSV recommends the CEC take a leadership role in working with the California Association of School Transportation Officials and the California Association of School Business Officials. Relaying all available guidance and resources to these networks will benefit all schools across the state. Indeed, ProspectSV's Knowledge Transfer activities indicate that a more integrated statewide program could help drive significant results for all California school districts.

California school districts are underresourced and overtasked even before taking on the complex transition to fleet electrification. They are still grappling with the available opportunities and the necessary information, resources, funding, and process. The knowledge gap opens doors for many consultants, fleet service providers, and technology companies to offer assistance as a prelude to doing business. ProspectSV recommends the CEC support efforts to provide fundamental training and precommercial assistance to all California school districts, preparing them to approach commercial offers with a greater command of the facts.

It may take several years for many school districts to develop the capabilities and resources necessary to implement successful programs, as evidenced by the challenges faced by BUSD. For example, many lack the bandwidth, capacity, or staff resources for fundraising or operations planning to implement an EV fleet procurement program. To address this need more quickly and efficiently, the CEC should consider supporting efforts to centralize the kind of technical assistance and resources offered by ProspectSV and make it more broadly available.

Finally, the project team suggests including outreach and workforce development aspects of the BUSD blueprint as recommended content in future efforts. Even if used to confirm the

engagement of local workforce and community partners, having their vocal support in fundraising and other aspects of program development may prove highly useful. The project team found that BUSD had not already undertaken significant work developing workforce and regional stakeholder relationships before the blueprint effort; however, the steps taken in this effort brought new insight for BUSD.

Recommendations to Other Blueprint Drafters

ProspectSV is proud of the work accomplished with BUSD and other project partners and collaborators. Still, no project is perfect, and writing this final report has helped identify a few things the team would do differently if given the chance.

One missed opportunity was to make a final presentation to the community, stakeholders, and district staff that the team engaged in the initial phases of the project. Such a forum would have allowed the team to further socialize the blueprint recommendations and receive final feedback.

While the team engaged diverse organizations in the BUSD community, there was insufficient time to engage all the relevant stakeholders, particularly the disabled populations and organizations. This was a significant missed opportunity as BUSD does not provide service to general education students across the district but rather only "provides within their attendance zones to all elementary school children who live beyond the one-and-a-half-mile walking distance." It is also provided to certain special education and Two-Way Immersion program students. Other blueprint drafters will want to schedule sufficient time to engage all relevant populations in their outreach. Reaching out to the entire population should be a priority.

Finally, other blueprint drafters should begin a comprehensive process of information gathering as early in the project as possible and allow sufficient time for clients to locate the information and meet with clients as needed to address any issues and expedite their process.

GLOSSARY

BATTERY-ELECTRIC BUS (BEB) — A battery-electric bus is an electric bus that is driven by an electric motor and obtains energy from on-board batteries. Battery electric buses offer the potential for zero-emissions, in addition to much quieter operation and better acceleration compared to traditional buses. They also eliminate infrastructure needed for a constant grid connection and allow routes to be modified without infrastructure changes.[18]

CALIFORNIA ENERGY COMMISSION (CEC) — The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's seven major areas of responsibilities are:

1. Planning and policy development.
2. Renewable energy growth.
3. Energy efficiency.
4. Energy innovation.
5. Cleaner transportation.
6. Responsible electricity infrastructure.
7. Emergency response.

ELECTRIC VEHICLES (EV) — A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

ELECTRIC VEHICLE CHARGING STATION (EVSE) — Infrastructure designed to supply power to EVs. EVSE can charge a wide variety of EVs, including BEVs and PHEVs.

GREENHOUSE GAS — Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs). (EPA)

MEDIUM- AND HEAVY-DUTY (MD/HD) VEHICLES weigh more than 10,000 pounds and include school and public transit buses, freight, and other fleet vehicles. These vehicles produce a disproportionately large portion of the state's greenhouse gas emissions, given the relatively small numbers, and produce significant amounts of air pollution.[19]

METRIC TON -- a unit of mass equal to 1000 kilograms.

PG&E — The acronym for Pacific Gas and Electric Company, an electric and natural gas utility serving central and Northern California.

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18 Wikipedia. "Battery Electric Bus," https://en.wikipedia.org/wiki/Battery_electric_bus.

19 California Energy Commission. "Medium- and Heavy-Duty Vehicles," https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-funding-areas/medium.

TOTAL COST OF OWNERSHIP (TCO) is the purchase price of an asset plus the costs of operation. Assessing the total cost of ownership means taking a bigger picture look at what the product is and the respective value is over time.[20]

VEHICLE-TO-GRID (V2G) involves drawing unused power from the car into the smart grid. V2G, which is also known as vehicle-grid integration (VGI), can help the energy grid supply electricity during peak hours. It can also create an extra power source when weather-dependent renewable energy sources are not available. For example, a home that uses solar power cannot generate electricity at night, but an electric vehicle could provide a secondary source of power if needed.[21]

ZERO-EMISSION VEHICLE (ZEV) — Vehicles which produce no emissions from the on-board source of power (for example, an electric vehicle).

20 Investopedia. Total Cost of Ownership: How It's Calculated With an Example," https://www.investopedia.com/terms/t/totalcostofownership.asp.

[21] IEEE Innovation at Work. Vehicle to Grid (V2G) Technology https://innovationatwork.ieee.org/vehicle-to-grid-v2g-technology/

APPENDIX A:
Technical Advisory Committee

Table A.1: Technical Advisory Committee Members

Name	Title	Organization
Sheila Collier	Transportation Manager	BUSD
Stephen Collins	Facilities Maintenance Manager	BUSD
Sofia Peltz	Sustainability Program Coordinator	BUSD
Stephen Williams	Vehicle Equipment Mechanic Supervisor	BUSD
John Calise	Facilities Director	BUSD
Robert Castillo, Yazid Kahil & Brian Richmond	Vehicle Equipment Mechanics	BUSD
Luther Jackson	Program Manager	NOVAworks
David Kaneda	Principal & Thought Leader	IDeAs Consulting
Brian Blaudstein	Project Engineer	IDeAs Consulting
David McManus	Account Executive	Ford Pro
Adi Ramesh	Program Manager	Ford Pro
Hannah Bailey	Research Engineer	Ford Pro
Amy Matsui	Senior Manager	Marubeni
Paul Breslow	Innovation Director	EDF
Nigel Daniels	Director, Development of Strategic Initiatives	SAiC
Kim Dinapoli	AZ Bus Sales, Blue Bird	Bluebird
Sarah Moore	Sustainability Program Manager	City of Berkeley
Rhonda Boykin	Interim Director	Alameda County Workforce Development Board
Pam Gutman	Regional Director	College of Alameda - Advanced Transportation & Logistics
Julia Hatton	CEO	Rising Sun

Rachel DiFranco	Sustainability Manager	City of Fremont
Richard Battersby	Executive Director	East Bay Clean Cities Coalition
Sam Steyer	CEO	Greenwork

Source: ProspectSV