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Clean Transportation Program

FINAL PROJECT REPORT

Electric Vehicle Blueprint for Twin Rivers 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-21-010 on December 08, 2021.

ABSTRACT

This project developed an electric vehicle blueprint for transitioning the entire Twin Rivers 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 phased procurement and deployment of electric buses and charging infrastructure. The blueprint includes a Workforce Development Plan that identifies key players in the Sacramento 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 faced multiple obstacles, but it has taken significant steps and made meaningful progress toward its fleet electrification goals. The report recommends that the District continue engaging with other early adopters and technology experts to explore local solutions to technology deployment, adoption, and procurement issues. The District also faces critical resource limitations, including human resource and financial capacity constraints that Covid-19 exacerbated. The report recommends that Federal, State, local governments, and relevant funding agencies recognize that these staffing challenges will make it difficult for school districts to take advantage of electric vehicle funding opportunities and meet fleet electrification goals. As the District takes the next steps in the transition, the report recommends ensuring that the newly installed Ford Pro Charging system, including the telematics integration, is fully commissioned, operational, and set up to gather, analyze and report key metrics on the fleet.

Keywords: Battery Electric Buses, School Bus Fleet Electrification, Charging Infrastructure, EV Fleet, V2GPlease use the following citation for this report: (required)

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Introduction

California school districts operate more than 24,000 school buses, posing a significant opportunity for school districts to switch to zero emissions buses, and both reduce greenhouse gas (GHG) emissions and improve air quality for their local communities. However, electrifying a district's bus fleet poses significant challenges, impacting 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 Twin Rivers Unified School District with an electric vehicle 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 plan, which documents impact assessments, charging infrastructure and site analysis, environmental and economic analysis, and any other relevant studies performed for or related to TRUSD's electric bus fleet.

Conclusions and Recommendations

As an early adopter and integrator of battery electric buses and electric vehicle supply equipment technologies, Twin Rivers Unified School District has and continues to face logistical challenges related to supply chain constraints and technology deployment, steeper adoption obstacles, and delays in the delivery of battery electric buses. The supply chain reflects global economic issues difficult for any local agency to tackle. Nonetheless, this blueprint project facilitated 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 issues. The project team recommends continuing to engage with these ongoing programs.

Like many institutions, Twin Rivers 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. 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. This blueprint includes a Workforce Development Action plan that identifies key players in the Sacramento area that

can help the District address this issue in the near- and long term. The viability of Twin Rivers Unified School District's electrification transition, and other fleet decarbonization efforts, will continue to rely on strong partnerships between government agencies, nonprofit organizations, local unions, bus manufacturers, high school and college auto technology programs, and other partners to develop targeted workforce training programs.

The District also faces critical 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 mitigate COVID-19 impacts on health, safety, and productivity for staff, faculty, and students. Other school districts share these limitations. It will be essential for the State, local governments, and relevant funding agencies to recognize that these staffing challenges will make it especially difficult for school districts to take advantage of the new electric vehicle and electric vehicle supply equipment funding opportunities and meet fleet electrification goals.

Twin Rivers Unified School District has committed to an all-electric bus fleet and has taken significant steps and made meaningful progress toward that goal. As an early adopter, the District endured obstacles, but has continued to press on with its fleet electrification goals.

Key recommendations for the next steps in the full transition to electric buses are to ensure that the newly installed Ford Pro Charging, including the telematics integration, system is fully commissioned, operational, and set up to gather, analyze and report key metrics on the fleet. Critically, to meet its fiduciary responsibility, the District must understand precisely how electric school buses perform against the original diesel fleet and how different manufacturers' electric school buses perform. At a minimum, comparisons to diesel should include quantitative factors such as total cost of ownership, first cost, miles driven, fueling cost, software and hardware costs, as well as maintenance cost.

CHAPTER 1: Introduction

Project Context

In EXECUTIVE ORDER N-79-20,[1] Governor Newsom stated, "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 approximately 1.1 million students daily, school districts can significantly reduce greenhouse gas (GHG) emissions and improve air quality for their local communities. However, systematically electrifying its bus fleet poses a significant operational challenge for any school district. 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 these planning processes 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 Twin Rivers Unified School District (TRUSD) 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 assessed opportunities for deploying innovative technologies, the long-term implications of electric fleet management and operations, and the need for community and workforce development. Specific objectives included:

[1] EXECUTIVE DEPARTMENT 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

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

Twin Rivers Unified School District (TRUSD) is a diverse school district serving students and families in the City of Sacramento. It is California's 24th largest public school system, providing PreK-12 and adult education. The District serves nearly 26,000 students in northern Sacramento County who come from families who speak 46 different languages. TRUSD includes 52 school sites: 29 elementary, 5 middle, 4 comprehensive high schools, 3 charters at 7 sites, and 7 alternative schools. In 2017, Twin Rivers became the first school district in the nation to deploy zero-emission electric school buses. The fleet is the largest owner/operator public school electric bus fleet in the country. TRUSD's experience as the national leader in deploying an electric school bus fleet and transitioning to electric school bus technology provides valuable insights for other school districts planning to convert their fleets to electric buses.

Prospect Silicon Valley (ProspectSV) focuses on the impact 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 supported over 40 startups and 25 sponsors, worked with more than 50 communities, and catalyzed $500M in venture investment and public funding. ProspectSV led this blueprint project, collaborating with the District, coordinating the technical work performed by IDeAs Consulting, and working closely with NOVAworks on engagement and workforce development activities.

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 multi-vehicle charging and car stacking solutions for parking garages and studied approaches to combining EVs with onsite photovoltaic (PV) systems to create microgrids. IdeAs gathered essential data about TRUSD'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 both public and private segments. For example, the company works with Twin Rivers Unified School District in Sacramento, California, one of the nation's largest electric school bus fleets. The deployment includes software-managed charging across multiple 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 out information directly from relevant District staff, from an on-site visit, and documents and records provided by TRUSD.

Team members interviewed Timothy Shannon, Director of Transportation, and Linda Lemon, Administrative Secretary. The conversations focused on the experience with the District's sizable EV fleet, including the approach to scale down the fleet while replacing fossil-fueled vehicles with EVs. The staff also reviewed funding plans for the program, noting grants they had already identified to support EV and EVSE investment.

Staff also explained the challenges TRUSD faces in being 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, and training existing staff, the District's critical resource limitations, such as human resource and financial capacity constraints.

The project team gathered information on TRUSD'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 TRUSD Bus and Maintenance Facility included a site walk to map out and photograph the layout of the existing infrastructure.

Overall, the team found TRUSD's record-keeping easy to follow and experienced no problems capturing the information needed for the fleet assessment. Unfortunately, telematics data was limited since the staff had only captured it for about three months. Nonetheless, the information proved helpful. The team did encounter challenges in directly correlating energy bill data with fleet charging—a typical problem when working with imperfect metering. The team incorporated all the information from the interviews and data collection into the analysis and, throughout the project, held regular check-in meetings with TRUSD staff.

Assessment of Fleet and EVSE

In this phase, the project team assessed the existing TRUSD 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 both 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
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	

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. 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 TRUSD was used to assess and compare electric vs. conventional bus costs. The team had also hoped to analyze data generated by the telematics software TRUSD had recently installed but realized insufficient data was available. Instead, the team relied on digital and paper records, efficiently organized by TRUSD.

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

Assessment of On-Site Infrastructure

Project partner, IDeAs Consulting, visited the site to assess the existing infrastructure and electrical service. They 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 TRUSD and presented the assessment results in the EV Blueprint.

Because TRUSD had already begun its fleet electrification program and had experience installing and commissioning chargers, information was relatively easy to access from TRUSD. 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.

Evaluation of Innovative Technologies

The project team analyzed new and emerging EV and EVSE technologies and systems that could provide potential economic and environmental benefits to TRUSD. 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. As a result, TRUSD has already begun work that supports climate resiliency. For example, one project improves grid resiliency by installing grid-connected direct current (DC) fast chargers that give the Sacramento Municipal Utility District access to on-site buses' EV battery capacity. Future projects include on-site solar and battery storage to support campus resiliency.

The team further advised TRUSD 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 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 Sacramento County's Climate Action Plan[2] and the regional air quality standards regulated by Sacramento Metropolitan Air Quality Management District (SMAQMD). The team showed in the EV blueprint how the District's plan supports and serves the County's policies on fleet electrification and supports the Sacramento Metropolitan Air Quality Management District's goal to reduce ozone and particulate matter in the Sacramento region.[3]

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

[2] Sacramento County. Planning and Environmental Review. Sacramento Climate Action Plan. 2022. https://planning.saccounty.gov/PlansandProjectsIn-Progress/Pages/CAP.aspx

[3] Sacramento Metropolitan Air Quality Management District. State Planning. 2017. https://www.airquality.org/air-quality-health/air-quality-plans/state-planning

functioning, health, and educational outcomes.[4] Further, they reported that heavy-duty vehicles like traditional diesel school buses emit relatively higher levels of GHGs and particulates than their 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 TRUSD plan, the team calculated the annual tonnage of GHG emissions avoided through full fleet electrification.[5] They reported that realizing the District's fleet electrification plan would also reduce ground-level ozone and particulate matter reduce the disease burden, and improve educational outcomes in the student population and communities it serves.[6]

The team researched manufacturer data and academic studies to compare fuel and maintenance costs and the total cost of ownership 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.

The team compiled financial information provided by TRUSD and found the District's proactive pursuit of grants and incentives has reduced funding requirements for fleet electrification by about 90 percent. The team also identified recently announced sources of federal and state funding the District will want to pursue in the near future.

The team also found the Sacramento region has a well-organized climate and air quality management structure and has already established a framework within which TRUSD's electrification plans fit. This integration reflects the early work undertaken by TRUSD to closely align District goals with regional climate and air quality objectives and to research the benefits and impacts supporting their continued fleet investments.

The project team recommends that school districts identify similar regional policies to help guide their fleet electrification efforts and to maintain strong relationships with regional planning efforts.

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[4] 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

[5] 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

[6] Sacramento County. Planning and Environmental Review. Sacramento Climate Action Plan. 2022. https://planning.saccounty.gov/PlansandProjectsIn-Progress/Pages/CAP.aspx

CHAPTER 3:
Community Engagement and Outreach

ProspectSV engaged multiple stakeholders in partnership with TRUSD to minimize the risks and uncertainties of designing, permitting, planning, and financing the ZEV infrastructure network, and to enable training, education, and readiness for the local community workforce to make a ZEV transition. This chapter highlights the community engagement and outreach approach undertaken by the project team and the challenges they faced in to ensuring alignment and support across stakeholders as they created the EV blueprint and the Workforce Development Plan.

Community Support Development

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. The project team then engaged key stakeholders, including the school bus vendors, utilities, local jurisdictions, planning organizations, regional workforce organizations, CBOs, and community leaders. The goal of this engagement was to help ensure the project's success and to create replicable, scalable models moving forward. The team also sought letters of support covering major aspects of TRUSD's electrification plans. These are the types of organizations the team contacted and their potential roles in the project:

- 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 the planning process 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 the planning process 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

The blueprint stakeholders aided ProspectSV's outreach efforts, especially in assessing the need to train and recruit EV and infrastructure technicians.

The project team also engaged other school districts and provided support, assistance, and lessons learned from the TRUSD experience, as indicated in Chapter 4, Knowledge Transfer.

NOVAworks leveraged its extensive network of regional CBOs, high schools, and community colleges to highlight the benefits and resulting employment opportunities of bringing the EV blueprint project to the District.

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:
Knowledge Transfer

In addition to the district and regional outreach described in Chapter 3, Prospect SV has developed a framework of technical assistance and planning resources for school districts facing similar challenges. Building on the assessment approach outlined in Table 1, the organization has combined its Empower Procurement[7] program's outreach and buyer engagement activities with the blueprint approach implemented for TRUSD.
ProspectSV is actively sharing lessons learned from the TRUSD EV blueprint and fleet electrification resources with school districts that request assistance. A list of school districts the team has assisted over the course of this blueprint project is listed in Table 2.

Table 2: School and College Districts Receiving Technical Assistance

Organization	Technical Assistance Focus
Morgan Hill Unified School District	Bus fleet transition plan
Cabrillo Unified School District	Bus fleet transition plan and white fleet assessment and transition plan development
Mountain View Whisman School District	White fleet assessment and transition plan development, market research of buses
Bakersfield School District	Bus fleet transition plan
Mt. San Antonio College	Provided EV Fleet Technical Assistance Work Package
Contra Costa Community College District	Extensive white fleet assessment and transition plan development
San Mateo County Community College District	White fleet transition support

Source: ProspectSV

The blueprint includes descriptions of the Technical Work Packages created by the project team. In addition, more than 20 small local governments have developed fleet electrification plans by applying the principles outlined in the Blueprint.

[7] Empower Procurement website. www.empowerprocurement.com

ProspectSV intends to continue this work beyond the EV blueprint project term and expand the group of partner organizations and the features of the technical assistance program. Throughout this grant, ProspectSV has built a network of contacts and engagement partners that can help it offer school districts assistance based on the lessons learned from this TRUSD project. In addition, the organization will seek opportunities to share the outcomes of this blueprint effort with members of the California Association of School Business Officials and Transportation Officials to expand the program's reach moving forward.

Outreach Channels

ProspectSV used the following channels to inform and engage the community about the EV blueprint project.

- Newsletters - ProspectSV publishes monthly newsletters via email to its broad ecosystem. Newsletters include project updates and significant organizational news.
- Social Media - Platforms, including Linkedin, Facebook, Twitter, and Instagram, are used to share project updates and announcements to ProspectSV's ecosystem.
- Website - ProspectSV's website showcases its mission, impact statements, descriptions of programs, and staff bios.

Through another channel, Peer Forums, ProspectSV engages stakeholders in events in which groups of asset managers and decision-makers in communities facing similar sustainability challenges can convene and share their experiences. For example, the Peer Forum on ZEV Fleets assembles fleet and sustainability managers facing challenges with fleet electrification transitions. The forum provides a platform to share best practices and funding opportunities for ZEV procurement and infrastructure. Some topics include ZEV Fleet Transitions, Local Government ZEV Planning, Vehicle Acquisition, Charging Infrastructure, and Electric School Bus Fleets. In addition, ProspectSV engaged school districts in ZEV Peer Forum events and shared best practices from the EV blueprint projects. Currently, there are 154 members and 86 agencies participating.

CHAPTER 5:
Project Results

This project aimed to provide TRUSD 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 TRUSD about the school bus fleet, the existing charging infrastructure, and the facility infrastructure, including the electric service. (Chapter 2 summarizes this work.) They 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. They delivered a blueprint presenting this information along with an analysis of electrification costs, pointers to potential funding sources, and recommendations for resiliency planning.

To specifically address workforce issues, NOVAworks partnered with ProspectSV and TRUSD to create a Workforce Development Plan for TRUSD. It addresses the barriers the District faces in providing current employees with the necessary training, skills development, tools, and experience to effectively run, service, and maintain zero-emission vehicles. 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 work conducted for the EV blueprint produced results that supported and strengthened TRUSD's electrification program efforts by providing new insights and connections for addressing long-term workforce development issues, identifying technology innovations for their program operations, and creating a positive response from multiple stakeholders to the District's efforts. The project team is pleased with these results and looks forward to TRUSD operating an entirely electric vehicle fleet soon.

CHAPTER 6:
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 multiple aspects of this long-term venture: accessible information, effective communication, principled financial decisions, workforce training and development plans, and environmental stewardship.

Like many institutions, TRUSD faces barriers in recruiting and training staff, accessing funding, keeping current with evolving technologies, and maintaining the goodwill and support of its community. However, in the face of these challenges, the District has chosen a leadership path, successfully growing its program by seizing available opportunities. The blueprint project provided TRUSD with the next level of structure and strategy they can adopt to realize their long-term goals.

As local governments and regional agencies support fleet electrification through clean air and clean mobility policies, and improved infrastructure, TRUSD offers a model for other school districts making this transition. The District's electrification effort exemplifies the environmental, health, and educational benefits school districts can provide their students and communities. Further, it shows how districts can improve operations and gain financial advantages.

Recommendations for TRUSD

The following recommendations, drawn from the blueprint for TRUSD, are also valuable for other school districts and blueprint drafters as they consider the later stages of full-fleet electrification.

The critical next steps for TRUSD's full transition to electric buses focus on collecting quantitative performance data of the electric buses and infrastructure and qualitative assessments of the impact of these systems. First, staff must ensure the newly installed telematics system is fully commissioned, operational, and set up to gather, analyze, and report key metrics on the fleet. This data will help the District determine precisely how TRUSD's electric school buses perform against the original diesel fleet and compare the performance of the different manufacturer buses in the fleet. The data also support tracking avoided carbon emissions, allowing the District to quantify the actual impact of its efforts. The blueprint identifies the specific performance data points to be collected and analyzed.

Gathering and analyzing this performance data is essential not only to TRUSD but to other California school districts, particularly those that lack exposure to these new technologies. Currently, manufacturers provide most of the available performance data. Unfortunately, it is based on test conditions rather than real-world conditions. Actual data collected from an early adopter is more informative and compelling than a manufacturer's recommendation.

Qualitative information on manufacturers' service, driver and rider experiences, community preferences, and other insights will help inform TRUSD's future EV and EVSE investment decisions and those of school districts throughout the state.

TRUSD has taken significant steps and made meaningful progress toward decarbonizing its fleet. With this success, TRUSD is in a position to lead other school districts as it pursues additional decarbonization goals:

- Electrify their light-duty vehicle fleet
- Electrify their medium- and heavy-duty fleet
- Electrify service vehicles, rolling stock, and lawn and garden equipment
- Procure and install additional charging and solar infrastructure

Recommendations for Workforce Training

Despite its recognized leadership in ZEV fleet development, the Sacramento region still lacks a foundation of affordable and reliable training resources. In response, Twin Rivers is embarking on an effort to "grow its own" future EV workforce by engaging the District's career technical education (CTE) office; it currently has 33 CTE pathways in grades 7 through 12.

To realize further opportunities, the Workforce Development Plan included in the EV blueprint recommends that the District work with a network of community stakeholders, including community EV training programs now in development at American River College in Sacramento and Sierra College in Rocklin.

The Workforce Development Plan recommends exploring specific grants for apprenticeship programs that train individuals to maintain electric vehicles and charging stations. TRUSD and other school districts can also benefit from establishing good relationships with local union representatives. Unions such as the National Electrical Contractors Association offer apprenticeships that provide opportunities for job seekers to earn a salary during an extended education and training period.

Finally, the District will want to keep informed of NOVAworks' collaboration with workforce development agencies in Sacramento, Alameda, and Contra Costa counties. Together they are exploring state funding streams to implement the Workforce Development Plan and to build a broader coalition to help scale this plan for other communities.

Recommendations to School Districts

School districts, especially large ones with an ongoing fleet electrification program, should devise short to medium-term strategies with long-term goals to accommodate evolving technologies, student and district needs, and community sentiment. These are early days, and 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 multiple 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.

Recommendations to the Energy Commission

This blueprint project provided valuable benefits and insights for TRUSD. The following recommendations may offer even more benefits to other school districts, with minimal additional effort from the Energy Commission 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 even a highly organized district like TRUSD faced challenges in capturing fleet data, a trend that has been experienced in working with multiple 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 Energy Commission consider issuing recommendations or guidance for fleet data capture for all school bus and service fleets. This 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 planning efforts.

Of course, the project partners all understood that fleet electrification programs require changes to operational and financial policies and procedures. However, the experience with TRUSD 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 Energy Commission take a leadership role in working with both 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 under-resourced and over-tasked 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 Energy Commission support efforts to provide fundamental training and pre-commercial 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 programs at the scale reached by TRUSD. 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 Energy Commission 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 TRUSD 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 TRUSD had 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 TRUSD.

Recommendations to Other Blueprint Drafters

ProspectSV is proud of the work accomplished with TRUSD 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 TRUSD community, there was insufficient time to engage all the relevant stakeholders, particularly Spanish-speaking populations and organizations. This was a significant missed opportunity, as roughly 42 percent of TRUSD students are Hispanic or Latino, and 14 percent speak Spanish as their first language. Other blueprint drafters will want to schedule sufficient time to engage all relevant populations in their outreach efforts. 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 to 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.[8]

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 Energy Commission's seven major areas of responsibilities are:

1. Advancing State Energy Policy
2. Achieving Energy Efficiency
3. Investing in Energy Innovation
4. Developing Renewable Energy
5. Transforming Transportation
6. Overseeing Energy Infrastructure
7. Preparing for Energy Emergencies

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.4.

GREENHOUSE GAS -- Any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs) , ozone (O3), 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 their relatively small numbers, and also produce significant amounts of air pollution.[9]

[8] Wikipedia. Battery electric bus. https://en.wikipedia.org/wiki/Battery_electric_bus

[9] 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 what its value is over time.[10]

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.[11]

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

[10] Investopedia. Total Cost of Ownership: How it's calculated with an example. https://www.investopedia.com/terms/t/totalcostofownership.asp

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

APPENDIX A:
Technical Advisory Committee Members

Name	Title	Organization
Linda Lemon	Administrative Secretary to Tim Shannon	TRUSD
Tim Shannon	Director of Transportation	TRUSD
Kaelin Sherrel	Education Specialist	SMUD
Susan Wheeler	Regional workforce development program manager	SMUD
Jacobe Caditz	Supervisor, Energy Education and Technology Center	SMUD
Jennifer-Christine Madamba	Human Resources Internship Coordinator	SMUD
Luther Jackson	Program Manager	NOVAworks
David Kaneda	Principal & Thought Leader	IDEAS Consulting
Brian Blaustein	Project Engineer	IDEAS Consulting
David McManus	Account Executive	Ford Pro
Adi Ramesh	Program Manager	Ford Pro
Dave Anderson	Sales Manager	Lion
Mark Stevens	Chief of Fleets	City of Sacramento
Denise Lee	Interim Director	SETA
Jordan Grimaldi	Project Manager	CivicThread
Tim Taylor	Executive Director	Clean Cities Coalition Sacramento
Evan Schmidt	CEO	Valley Vision

Name	Title	Organization
Chris Flores	Deputy Chief of Staff	Sacramento Regional Transit District
Hannah Bailey	Research Engineer	Ford
Amy Matsuo	Senior Manager	Marubeni
Paul Breslow	Innovation Director	EDF
Nigel Daniels	Director, Development of Strategic Initiatives	SAIC
Pam Gutman	Regional Director, Advanced Transportation and Logistics	California Community Colleges
Rachel DiFranco	Sustainability Manager	City of Fremont
Sam Steyer	CEO	Greenwork
Chris Cagle	Regional Affairs Manager	South Bay Workforce Investment Board
Bernie Kotlier	Executive Director	Labor Management Cooperation Committee, IBEW-NECA
Randy Bryant	Dean	Career Technical Education and Workforce Development, De Anza College (formerly automotive faculty)

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