CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

School Bus Replacement Program/Clean Transportation Program

FINAL PROJECT REPORT

Redwood City School District Final Report

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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.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- 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.

Senate Bill 110 (Chapter 55, Statutes of 2017) created the School Bus Replacement Program, appropriating up to $75 million from the California Clean Energy Jobs Act (Proposition 39), an initiative that voters approved in 2012. The statute authorizes the CEC to provide school bus replacement grants to school districts, County Offices of Education, and Joint Power Authorities operating the oldest school buses in disadvantaged communities.

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-17-607 to provide funding opportunities under both the School Bus Program to fund projects that replace the oldest diesel school buses in California with electric vehicle school buses and the Clean Transportation Program to fund infrastructure projects that support the electric vehicle school buses. In response to GFO-17-607, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards (February 6, 2019) and the agreement was executed as ARV-19-065 on July 17, 2019.

ABSTRACT

Redwood City Elementary School District submitted an application to receive grant funding under the California Energy Commission Solicitation GFO-17-607 to replace seven old diesel school buses. Redwood City Elementary School District was awarded funding for seven vehicle-to-grid ready electric school buses and the supporting electric vehicle charging infrastructure. Redwood City Elementary School District purchased seven electric school buses and installed twelve (12) chargers through the California Energy Commission. All seven buses were placed into service by March 11, 2022 and districts were offered workforce training to help support the successful deployment of the new electric fleet. The old, diesel-powered buses were also dismantled and removed from service. This project found that the electric school buses reduced greenhouse gas emissions by 4113.68 short tons and that the electric school buses had a cost savings of $37,752.30 during the reporting period.

Keywords: GFO-17-607, grant funding, electric school bus, diesel, greenhouse gas emissions, cost savings, vehicle-to-grid, electric vehicle charging infrastructure, workforce training.

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EXECUTIVE SUMMARY

The priority of Redwood City Elementary School District has always been student health and educational success. Redwood City Elementary School District embraces continuous improvements to its transportation department and fleet to help keep students safe and healthy. This project sought to replace old diesel school buses with zero-emission electric school buses. The replacement buses will improve air quality and reduce school energy and maintenance costs while providing students with necessary school transportation.

The first stage focused on installation of charging infrastructure. This included coordinating with the local utility company, production of engineering and design drawings by subcontractors, purchasing charging equipment, and construction of the charging station. The electric vehicle charging infrastructure is located and maintained at the Maintenance, Operation, and Transportation facility located at 601 James Avenue, Redwood City, CA.

The second stage dealt with the procurement of electric school buses. Redwood City Elementary School District applied for and was awarded grant funding for the purchase of seven new electric school buses. Redwood City Elementary School District selected a school bus manufacturer, placed a purchase order for bus procurement, and placed the buses into service by March 11, 2022.

The third stage required Redwood City Elementary School District to scrap the old diesel school buses within 12 months from the delivery of the new electric school buses. This disposal is to ensure that the old diesel school buses do not continue to produce emissions.

The final stage involved 12 months of data collection on the electric school buses. These data were used to analyze the economic and environmental impacts that resulted from the electric for diesel school bus replacement.

Redwood City Elementary School District's electric school buses have helped save money on fuel and maintenance costs. The new buses have also improved the health of students by reducing their exposure to toxic air contaminants. Redwood City Elementary School District recommends school districts across the state to replace their old diesel-polluting school buses with clean, all-electric school buses.

CHAPTER 1: Introduction

Background

Senate Bill 110 (Chapter 55, Statutes of 2017) appropriated funds to establish the School Bus Replacement Program at the California Energy Commission (CEC). The CEC provided one-time funding of $75 million from Proposition 39 for the replacement and scrappage of old diesel school buses in disadvantaged and low-income communities throughout California.

To allow wider coverage of the program, the funds were distributed among four regions in California: Northern California, Central California, Southern California, and Los Angeles County. Additional funding of almost $14 million from the CEC's Clean Transportation Program was leveraged to provide the necessary charging infrastructure schools would need to operate the buses. Also, $1 million in Clean Transportation Program funds were set aside for workforce training and development to ensure proper operation and maintenance of the buses in the years to come.

The CEC received more than 200 applications for more than 1,600 diesel school buses requested for replacement, some buses as old as 1978. CEC staff then evaluated the buses based on three factors: age of bus, applicant's percentage of free and reduced-price meals recipients, and applicant's disadvantaged community score according to the CalEnviroScreen 3.0. From the applications received, an initial list of ranked buses was released in November 2018.

The second phase of the program included selecting a manufacturer or dealer that could design, construct, and deliver electric school buses. In November 2018, the CEC released a solicitation to establish a bulk purchase price for replacement buses. Applications were evaluated and scored for the technical evaluation portion based on the following criteria:

- Relevant experience and qualifications
- Project readiness and implementation
- Client references
- Battery and fuel range
- Warranty, service, and support
- Innovation
- Economic benefits to California
- Ability to leverage funding

Applications passing the technical evaluation advanced to the next screen, where the lowest-cost bid was selected for each school bus type (Type A[1], Type C[2], Type D[3], and each type with or without chair lifts). The bus bid forms were ranked in order from lowest to highest cost per bus by type. Table 1 shows the manufacturer's awarded bids.

Table 1: School Bus Replacement Program Awarded Bids

Applicant	Bus Type	Bid Amount
The Lion Electric Co.	Type A Without Chair Lift	$271,389
A-Z Bus Sales, Inc. – California (Micro Bird)	Type A With Chair Lift	$293,424
The Lion Electric Co.	Type C Without Chair Lift	$321,184
The Lion Electric Co.	Type C With Chair Lift	$329,627
The Lion Electric Co.	Type D Without Chair Lift	$332,009
The Lion Electric Co.	Type D With Chair Lift	$339,370

Source: CEC

Once the manufacturers were selected, CEC staff was able to allocate funding based on bid price, using the rank list to determine which applicants would be awarded buses. From the initial rank list of buses, the CEC was able to fund 228 electric school buses, with an additional $60,000 in infrastructure funding per bus.

Recipients also had the option to procure their buses outside the CEC awarded manufacturer bid, as long as the recipients used their own established procurement procedures while adhering to all applicable state and local laws and terms and conditions of the grant agreement.

School Bus Replacement Program Objectives

The School Bus Replacement Program is helping schools throughout the state transition from old, polluting diesel school buses to electric school buses, reducing exposure to harmful emissions and helping the state reach its climate and air quality goals. This program also

[1] A Type "A" school bus is a van conversion or bus constructed utilizing a cutaway front section vehicle with a left-side driver's door. This definition includes two classifications: Type A-I, with a Gross Vehicle Weight Rating (GVWR) less than or equal to 14,500 pounds; and Type A II, with a GVWR greater than 14,500 pounds and less than or equal to 21,500 pounds.

[2] A Type "C" school bus is constructed utilizing a chassis with a hood and front fender assembly. The entrance door is behind the front wheels. A "type C school bus" also includes a cutaway truck chassis or truck chassis with cab, with or without a left side door, and with a GVWR greater than 21,500 pounds.

[3] A "type D school bus" is a body installed upon a chassis, with the engine mounted in the front, midship or rear, with a gross vehicle weight rating of more than 10,000, designed for carrying more than ten persons. The engine may be behind the windshield and beside the driver's seat; it may be at the rear of the bus, behind the rear wheels, or midship between the front and rear axles. The entrance door is ahead of the front wheels. A type D school bus has a maximum length of 45 feet.

supports the state's overall energy goals such as the Low Carbon Fuel Standard target for 2030 and the Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) target goal to reduce greenhouse gas emissions 40 percent below the 1990 level by 2030. The agreement objective is to purchase electric school buses to replace diesel buses that will be removed from service and scrapped and install or upgrade electric bus charging infrastructure at grant recipient transportation sites.

CHAPTER 2:
Project Details

Electric School Bus Funding

Redwood City Elementary School District was awarded $2,402,378 to replace seven old diesel school buses with seven all-electric school buses, as well as purchase and install the associated charging infrastructure. The district selected five Type A, one Type A with wheelchair lift, and one Type D, based on the following needs:

- Total cost of bus (CEC share)
- Quoted bus range and battery capacity (kWh)
- Bus Route Profiles
- Upgrade Options Available

Redwood City Elementary School District is responsible for transporting 590 students per year, with an average route distance of 25 to 30 miles. Redwood City Elementary School District has a fleet composed of 12 school buses, featuring a total of seven electric school buses and five diesel buses.

Redwood City Elementary School District decided to procure electric school buses from A-Z Bus Sales because this is the vendor the District has previously purchased school buses from and was the only vendor offering the Bluebird Microbird and Blue Bird T3RE, which is the all-electric version of their current school buses. Besides the Type A bus with the wheelchair life, none of the other buses had additional upgrades. The total cost for the seven new electric school buses was $2,021,126.53. Of that total, 98 percent was covered by the CEC. Figure 1 below shows one of the district's new electric school buses funded by the CEC.

Figure 1: Redwood City Elementary School District Electric School Bus

Source: Redwood City Elementary School District

The replaced diesel buses must be scrapped and removed from service within 12 months from delivery of the new bus. Each district was required to show proof of scrappage, which included photographs of bus/engine destruction, vehicle identification number, engine serial number, and method used to dismantle the engine and non-engine components. Figure 2 illustrates one of the acceptable methods of scrapping the chassis of a vehicle. As of June 12, 2023, all seven of Redwood City Elementary School District buses had been scrapped.

Figure 2: Example of Acceptable Method to Dismantle Vehicle Chassis

Source: Redwood City Elementary School District

Infrastructure Funding

The CEC's Clean Transportation Program allocated $14 million to the School Bus Replacement Program to fund electric school bus charging infrastructure. The CEC provided up to $60,000 per awarded bus for purchase and installation of the associated infrastructure. This allocation enabled Redwood City Elementary School District to install 12 Level 2 80A chargers. The infrastructure was completed February 2, 2022, the chargers were installed and commissioned February 9, 2022, and final Authorities Having Jurisdiction Inspection for the project occurred March 11, 2022.

The CEC worked with electric utilities, both public and private, to assist in upgrading electrical infrastructure required to charge the awarded buses while emphasizing the need to plan for future electrical capacity needs. Electric vehicle supply equipment (EVSE) was required to be, at a minimum, a Level 2 ENERGY STAR®-certified, networked charger capable of charging a vehicle at a minimum of 6.2 kilowatts (kW); however, the CEC recommended electric vehicle supply equipment capable of charging at 19.2 kW. These high capacity 19.2 kW chargers only require 6–8 hours of charging time to power a school bus battery from 0 to 100 percent, as indicated by the school bus manufacturers selected for the School Bus Replacement Program.

Networked EVSE provides recipients with the ability to set charging for buses to off-peak-demand hours, provide remote diagnostics, and allow remote start of connected vehicles.

Obstacles, Delays, and Lessons Learned

Being an early adopter for new technology usually means there will be challenges and more planning effort to get a successful project in place. Redwood City Elementary School District is pleased to be a leader in the community and share lessons from their project. Many of the situations which caused problems for the District have been identified across multiple projects and are now being worked on by the market. Even with the technology maturing, there are several different entities involved in transportation electrification projects which require open communication and project management. Redwood City Elementary School District will carry lessons learned into future transportation electrification projects and hopes their project will highlight important factors for other Districts to consider.

Delays and Project Timeline Lessons

The project saw delays to initial kickoff due to COVID-19 restrictions on non-essential work and general supply chain shortages, including school buses and key electrical equipment. The infrastructure installation was initially planned to be complete in August 2021, which was when the electric school buses were scheduled for delivery. The schedule was extended due to long permitting approval time, lead times on infrastructure equipment, and utility upgrade schedule. The infrastructure was complete in early February 2022, six months after the initial plan. While the infrastructure was being completed, the District used temporary mobile charging provided by A-Z Bus Sales to begin operating select buses.

At project initiation, the District heard that charging equipment could have long lead times and they chose to directly purchase chargers from BTCPower to ensure the chargers would be delivered to the contractor within the project schedule. With more vendors ramping up production, this may no longer be necessary for Level 2 chargers. Lastly, school bus lead times delayed integrating buses into routes at the beginning of the 2021-2022 academic year. Buses were initially expected to arrive in August 2021. Due to continued delays in supply chain, buses arrived between September 13, 2021 and February 17, 2022. The District remained flexible and was able to continue using the diesel buses, while also using the extra time to further plan electric school buses on routes and prepare drivers.

Electric School Bus Obstacles and Lessons Learned

The District's electric school buses were some of the first generations and OEMs have made positive modifications based on lessons learned from operation. However, the buses experienced some initial operational issues and the District's bus distributor, A-Z Bus Sales, worked with the bus and battery teams to address issues as they came up. Within the first month of operation, some of the buses were regularly experiencing issues powering on. The electric drivetrain vendor, Ecotuned, helped diagnose the issue. Redwood City School District received a laptop that allows them to better diagnose issues themselves; this laptop was delayed and eventually arrived in summer 2022. The District is able to use the laptop to communicate with Ecotuned and diagnose most issues, as well as update the firmware on the buses.

Within the first year of operation, the buses had some operational issues that the District was not able to diagnose in-house. To resolve the issues, the buses either received firmware updates or were transported to the dealership or the battery management vendor site. The primary issues involved buses breaking down while on route or not powering on at all to start a route. The transportation manager was able to work with the appropriate teams to find a solution to quickly restore power to the buses and stay operational while, the battery management and drivetrain vendor continued to work on resolving the overall problem. The main challenge working through bigger issues was transporting the buses to off-site facilities which sometimes may be beyond the capable electric range and require on-road charging or a tow if the bus is not operational. To ensure continued transportation services, the District delayed scrapping diesel buses until there was confidence in the electric bus operation and recommends other school districts have a backup plan in place while the technology continues to mature or delay non-urgent repairs until school breaks. All of the issues described above were covered under warranty, except the cost to tow a bus if that was needed.

Within the second year of operation, the issues were less frequent, less severe, and over-air firmware updates helped resolve most issues, which was helpful to reduce repair downtime. This provided a positive outlook for future school districts that may be preparing for newer generation electric school buses. The only major issue that remains at the time of this report is with the air conditioning which causes the buses to overheat. The current solution has been to bypass the air conditioning while working on a longer solution that will re-establish air-conditioning to all buses. All repairs continue to be under warranty and the manufacturers continue to help resolve any further bus issues.

There are two operation and maintenance aspects that are likely only applicable to these first generation buses. The first aspect was replacing the Type A Micro Bird G5 buses' two-speed transmission. When the buses were initially delivered, the transmissions were scheduled for periodic replacements. The communicated plan from A-Z Bus Sales is that the next transmission replacement should be good for the life of the vehicle, and it is expected that newer generations of the bus will come equipped with the newer transmission. The cost of the replacement is covered under the bus warranty. Second, the EVSE vendor needed to develop custom operation rules specific to the early generation of Micro Bird and Blue Bird electric school buses to be compatible with smart charging goals, as defined in the grant. The requirement provided to the CMS vendor was that EVSEs would be able to avoid charging during PG&E's peak Time of Use period, 4:00 – 9:00 PM. While the chargers and software are able to successfully accomplish that in isolation, after several months of communication and testing with the buses, it was determined that the bus firmware commands the vehicle to power down when the battery management system does not detect power from a charger. While meant to preserve the battery, the unintended impact is that the bus is not available to accept a "start charging" command at 9:00 PM without someone physically unplugging and plugging in a charger. Based on communication from the OEM, it is expected that this will be addressed on future generations of the buses. For over a year, the District had a dedicated staff who would plug buses in at 9:00 PM while this was being worked on. The issue was eventually resolved in partnership with BTCPower and EVGateway using a work-around that minimizes charging during 4:00 – 9:00 PM peak hours. The important lesson learned is to clearly outline goals, responsibilities, and expectations in contracts and discussions because while the EVSE are *capable* of this type of operation, it required more steps to accomplish it in reality. We would like to think the technology is plug-and-play, but the market has shown that

it is not that mature yet. It will be important for utilities who might plan to prohibit charging during peak periods to consider customers with these limitations.

EVSE Infrastructure and Charge Management Software Lessons Learned

The lessons learned for EVSE are vast; some may be applicable to future school districts, while others are specific to this project. First, the project received additional funding from the PG&E EV Fleet program, which required coordinating the acceptable equipment and agreement terms and conditions for both programs and oversight early in the project design, as well as towards project close-out. It was very beneficial for the District that the CEC program allowed for rolling reimbursement. The PG&E program was purely rebate, and funds were not reimbursed until the full project was completed and commissioned, which could be a challenge for Districts lacking the upfront funds to cover project expenses.

The District's transportation yard is space-constrained and school buses are double parked. Currently, buses that are double parked cannot easily access a charger without some maneuvering and bus parking rotation. This is not currently a blocking problem, as the District was able to charge all seven electric buses. However, in the future, the transportation yard layout will need to be reassessed as the District continues to electrify the full bus fleet. From this project, it was learned that it is critical to supply the design team with information on the vehicle charging port locations, especially if chargers are going to be shared by multiple parking spots. Additionally, if double parking is used, it is crucial to take specific measurements of bus parking and port location to compare with charger cable length.

The project benefitted from having numerous conversations with BTCPower prior to software selection and hardware installation. At the time of kick-off, there were very few other school district projects to seek advice from, and these conversations were the District's best effort to get ahead of challenges. As an early adopter, the project would have benefitted from better defining project needs and successful outcomes with EVSE vendors to ensure the right representatives were involved in discussions. There were various potential and real obstacles that occurred in regards to the EVSE, whether it be through installation or performance, where communication with the EVSE and software OEMs was critical. One success was that BTCPower recommended providing a charger pedestal to the contractor so the bolting was aligned correctly. One improvement, as outlined above for smart charging, would have been to clearly outline successful outcomes for charge management, not just capabilities, in discussions and in the contract. The District is fortunate that BTCPower continued working through a smart charging solution. Another communication and process improvement would be to perform test notifications and ensure that all the correct District staff have proper access to the EVSE portal after installation. It took several months for us to realize that the Transportation Manager did not have the correct authorization in the portal, which helped with remotely addressing charger issues and identifying problems sooner.

Having separate companies provide the hardware and charge management software has led to added project management for the District and, in some instances, delayed resolution when issues arise. Having open protocol hardware allows the District to select from different software providers in the future, but that advantage also comes with added coordination, at times, with two separate entities. More recently, the triage of support services between the

entities has improved, but it would be beneficial to more clearly set expectations for responsible parties.

The District also experienced some issues with the charger hardware, and was in coordination with the charging manufacturer to resolve these issues if a remote restart was not able to solve the problem. The District notified BTCPower that they observed serious concerns with some charger cables about one and a half years after installation. The District stopped using the affected chargers while BTCPower scheduled a maintenance provider and worked on a solution. BTCPower replaced all seven cables and inspected the units for underlying issues. This remains an on-going problem that BTCPower is aware of and working to address. All materials and labor were covered under the 5-year premium maintenance plan that the District purchased, but otherwise, the parts and labor for cable replacements are not generally covered.

CHAPTER 3:
Workforce Training Funding

In anticipation of the CEC's School Bus Replacement Program, in 2018 the CEC began to work with California school districts, county offices of education, and joint power authorities to understand the importance and role of school bus training for zero-emission school bus technology. Many school districts expressed the need for training of school bus maintenance and service technicians, as well as training for bus operators for battery-electric technology.

In 2019, the CEC approved a $1 million contract with Cerritos Community College to develop and implement the "Electric School Bus Training Project." Cerritos Community College developed the curriculum with the Southern California Regional Transit Training Consortium and college faculty throughout the state. Faculty from the colleges provided training in the school bus regions through a hybrid of in-person and online training.

The training project included automotive instructor led training to maintenance and service technicians for 96 hours. It also included 12 hours of school bus operator training. The training content consisted of:

- Electric Vehicle School Bus and Charging Infrastructure Familiarization.
- Circuit Diagnostic With Digital Volt Ohm Meter.
- Computerized Engine Management Systems.
- Complexity of the Harness and Computer Functions in the Modern Chassis.
- Programmable Logic Controller Input/Output Systems Diagnostics.
- Network Systems Electronics Diagnosis and Repair
- Electric Bus Driver Training Familiarization.

Redwood City School District did not participate in the CEC workforce training program, but will utilize the program if awarded future electric school buses.

Workforce training is an important consideration when incorporating zero-emission school buses into a fleet. As with most new technologies, there is a learning curve and operational adjustments the fleet must make to maximize the benefits of the technology. Compared to conventional-fueled school buses, there are differences in zero-emission school bus maintenance and operation. For example, zero-emission school buses have fewer moving parts, do not have an exhaust system, or require oil changes, and the braking systems of these buses last longer. For these reasons, along with many more, electric school buses have proven to be a cost-effective solution.

CHAPTER 4:
Data Collection

12-Month Data Collection

A requirement of the School Bus Replacement Program was to collect 12 months of data and metrics on the usage of the new buses. These data points will be used to determine the financial, environmental, and health benefits of replacement school buses funded by the CEC. Listed below are the specific data points for the seven buses funded by the School Bus Replacement Program.

The following is the list of school buses:

School District	Bus Number	Bus Type
Redwood City School District	#35	2022 Blue Bird T3RE
Redwood City School District	#36	2022 Micro Bird G5
Redwood City School District	#37	2022 Micro Bird G5
Redwood City School District	#38	2022 Micro Bird G5
Redwood City School District	#39	2022 Micro Bird G5
Redwood City School District	#40	2022 Micro Bird G5
Redwood City School District	#41	2022 Micro Bird G5, with lift

Redwood City School District Seven Electric Buses

When placed into service over a 12-month period spanning from July 2022 through June 2023, Redwood City School District's seven buses traveled 44,973 miles, an average of 6,425 per bus. The replaced diesel fuel bus had a miles-per-diesel-gallon average of 9.0. The miles traveled over the reporting period equate to a total reduction of 4,997 gallons of diesel. This reduction in total gallons of diesel equates to a lifetime reduction of 572.15 short tons of GHGs, 1179.45 pounds of NOx (oxides of nitrogen) and 8.2 lbs. of $PM_{2.5.}$

The average cost of a gallon of diesel fuel was $5.66 during the reporting period. This equals a diesel cost savings of $27,186.68. The total replaced diesel maintenance cost of the scrapped bus was $39,014.08. Over the 12-month period, the new electric school bus used 59,956 kWh. The total cost for this electricity usage was $12,717.00. Net fuel cost savings during the 12-month reporting period was $14,469.68. Total maintenance cost for the new electric school bus amounted to $17,220; however, all repairs for the electric school buses have been covered under warranty. The $17,220 is only expenses related to preventive maintenance in the buses every 45 days per state regulation. During this 12-month period alone, Redwood City School District is not able to accurately report on maintenance cost savings due to the new buses being under warranty while the replaced diesel buses were not. More information will need to be collected once warranties end to report on differences in maintenance costs. Due to the number and severity of issues with the electric school buses during the reporting

period, Redwood City School District likely would have spent more on electric bus maintenance if repairs were not covered under warranty. The District expects that maintenance issues will become less frequent and hopes that costs will not be more than what was required for the diesel fleet. Similarly, the EVSE infrastructure required several repairs which have also been covered under warranty and the premium maintenance plan the District purchased. With the diesel fleet, the District did not own, operate, and maintain any type of fueling infrastructure.

The CEC's School Bus Replacement Program will help reduce tailpipe emissions of smog-forming nitrogen oxides by 98,000 lbs. and toxic diesel soot by more than 2,500 lbs. Minimizing exposure to hazardous emissions reduces the risk to adolescent bus riders of developing respiratory diseases such as asthma and helps the state achieve emissions reductions goals.

Figure 3: Electric Replacement Bus Number 35

Source: Redwood City School District

Figure 4: Electric Replacement Bus Number 37

Source: Redwood City School District

Figure 5: Electric Vehicle Supply Equipment

Source: Redwood City School District

CHAPTER 5:
Conclusion

The School Bus Replacement Program was vital to the long-term success of transporting students to and from school. Not only is the program saving districts time and money, it is also helping reduce the total amount of emissions released into the environment. Redwood City School District is dedicated to contributing to California's overall goals of decreasing greenhouse gas emissions and improving overall air quality. Redwood City School District's next steps are to continue using the electric buses on school routes, share lessons learned with other school districts seeking to electrify their school bus fleets, continue working with A-Z Bus Sales, BTCPower and EVGateway on operational issues and improvements, and eventually transition the remaining school bus fleet for an all-electric future.

GLOSSARY

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 five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

KILOWATT (kW) — One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon, a typical home — with central air conditioning and other equipment in use — might have a demand of 4 kW each hour.

KILOWATT-HOUR (kWh) — The most commonly used unit of measure telling the amount of electricity consumed over time, means 1 kilowatt of electricity supplied for 1 hour. In 1989, a typical California household consumed 534 kWh in an average month.