CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

School Bus Replacement Program/Clean Transportation Program

FINAL PROJECT REPORT

Lynwood Unified School District Electric Bus and Infrastructure

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Dandre Brim
Primary Authors

Lynwood Unified School District
11321 Bullis Rd
Lynwood, CA 90262
(310) 886-1600
Lynwood Unified School District, available at www.mylusd.org

Agreement Number: ARV-19-020

Ian Baird
Commission Agreement Manager

Elizabeth John
Branch Manager
COMMERCIAL INDUSTRIAL ZERO-EMISSION TECHNOLOGIES AND INFRASTRUCTURE

Hannon Rasool
Deputy Director
FUELS AND TRANSPORTATION

Drew Bohan
Executive Director

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 non-road 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 June 3, 2019, and the agreement was executed as ARV-19-020 on November 10, 2019.

ABSTRACT

Lynwood Unified School district submitted an application to receive grant funding under the California Energy Commission Solicitation GFO-17-607 to replace three old diesel school buses. Lynwood Unified School District was awarded funding for three vehicle-to-grid ready electric school buses and the supporting electric vehicle charging infrastructure. Lynwood Unified School District purchased three electric school buses and installed three chargers through the California Energy Commission. The buses were placed into service during the fall of 2021 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 0.425 short tons of Oxides of Nitrogen, 0.014 short tons of Particulate Matter 2.5, 0.044 short tons of Hydrocarbons, 0.112 short tons of Carbon Monoxide, and 53.1 short tons of Carbon Dioxide and that the electric school buses had an annual cost savings of $44,252.

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 Lynwood Unified School District has always been student health and educational success. Lynwood Unified 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 installation included coordinating with the local utility company, producing engineering and design drawings by subcontractors, purchasing charging equipment, and constructing the charging station. The electric vehicle charging infrastructure is located and maintained at Lynwood Unified School District Service Center, 11300 Wright Road, Lynwood, CA 90262, Los Angeles County.

The second stage dealt with the procurement of electric school buses. Lynwood Unified School District applied for and was awarded grant funding for the purchase of three new electric school buses. Lynwood Unified School District selected a school bus manufacturer, placed a purchase order for bus procurement, and placed the buses into service during the Fall of 2021.

The third stage required Lynwood Unified 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.

Lynwood Unified 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. Lynwood Unified 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; and 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, Type C, Type D, 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 were 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 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 objective of the agreement 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

Lynwood Unified School District was awarded $1,168,881 to replace three old diesel school buses with three all-electric school buses, as well as purchase and install the associated charging infrastructure. The district selected Type C with chairlifts, based on the following needs:

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

Lynwood Unified School District is responsible for transporting 240 children per year, with an average route distance of 15 miles. Lynwood Unified School district has a fleet composed of 14 school buses featuring a total of five electric buses, five diesel buses and four gasoline buses.

Lynwood Unified School District decided to procure electric school buses from Lion because of the availability of buses, options to curtail bus needs to our bus operations, cost and the unibody cab construction. The Type C buses had the following upgrades: wheelchair lifts, air conditioning, stiffer bus platform, and radio and p/a system. These upgrades were necessary due to support our Special Education Department and weather conditions supporting comfortable transportation during hot weather. The total cost for the new electric school bus was $329,627 with a total cost of $988,881 for all three buses. Of that total, 100 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: Lynwood Unified School District Electric School Bus

Source: Lynwood Unified School District

The replaced diesel buses must be scrapped and removed from service within 12 months of 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 May 1, 2025, all three buses have been scrapped.

Figure 2: Example of Acceptable Method to Dismantle Vehicle Chassis

Source: Lynwood Unified 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 Lynwood Unified School District to install three Blink Level 2 Energy Star chargers. The infrastructure was completed June 30, 2024, and began operating October 1, 2024.

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 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 capacities 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 electric vehicle supply equipment 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

The district encountered several issues and delays in acquiring electric vehicle chargers. When the electric buses were delivered, the district did not have dedicated charging infrastructure constructed. The district desired to install BTC chargers to match the existing charging infrastructure previously constructed at the transportation site. However, BTC chargers were not available due to increased demand and supply shortages. After several months of trying to obtain quotes from Electric Vehicle Supply Equipment firms, the district was able to procure Blink Level 2 chargers. Before the Blink stations were installed, the district was able to place the three new electric buses into service by using the two existing BTC chargers at the transportation site. The addition of three new buses placed a heavy demand on the existing charging stations, however, the BTC chargers were able to meet the demand load of all electric buses in the fleet.

The district was able to begin the electrical infrastructure installation for three new charging stations with the support of district electricians. This was achieved by identifying existing electrical services within the electric bus yard. This identification of preexisting services meant not having to install new electric service which had a projected 2-year planning and installation timeline. Once received, district electricians were able to install the three new Blink charging stations, and they have been operating fully and able to meet the demand of the three electric buses.

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 of 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.

District mechanics received training using the Lion buses to understand the basics of the electrical systems, including the operational battery system supporting the power train, and the accessories battery separate system. Additionally, district mechanics received classroom training to understand emergency procedures and disconnect process for the battery systems in the bus as well as recommend maintenance.

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 three buses funded by the School Bus Replacement Program.

Lynwood Unified School District

When placed into service over a 12-month period, Lynwood Unified School District's three buses traveled a total of 23,593. The replaced diesel fuel bus had a miles-per-diesel-gallon average of 5. The miles traveled over the reporting period equate to a total reduction of 4,719 gallons of diesel. This reduction in total gallons of diesel equates to a reduction of 0.425 short tons of Oxides of Nitrogen, 0.014 short tons of Particulate Matter 2.5, 0.044 short tons of Hydrocarbons, 0.112 short tons of Carbon Monoxide, and 53.1 short tons of Carbon Dioxide

The average cost of a gallon of diesel fuel was $5.95 during the reporting period. This equals a diesel cost savings of $28,078 dollars. The total replaced diesel maintenance cost of the scrapped bus was $21,600 dollars. Over the 12-month period, the new electric school bus used 23,593 kWh. The total cost for this electricity usage was $5,426 dollars. Total maintenance cost for the new electric school bus amounted to $0. During this 12-month period alone, Lynwood Unified School District was able to save $44,252 with the new electric school bus.

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.

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 district's time and money, but it is also helping reduce the total amount of emissions released into the environment. Lynwood Unified School District is dedicated to contributing to California's overall goals of decreasing greenhouse gas emissions and improving overall air quality. Lynwood Unified School District's next steps are to continue to use our electric bus fleet of five buses to support our daily pupil transportation and expand in using the electric buses for short range field trips. Additionally, our expectation for future use of electric buses will be the improved long-range travel distance per upgraded battery charge and fast charging EV stations. Lynwood Unified School District will continue to work with Lion buses in resolving operational issues with electric bus dependability. Lynwood Unified School District will continue seeking grants that support electric or alternative fuel buses and replace our older buses that depend on fossil fuels.

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 responsibility 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.

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California that aims to cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

NITROGEN OXIDES (OXIDES OF NITROGEN, NOx)—A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO2 is a criteria air pollutant and may result in numerous adverse health effects.

PARTICULATE MATTER (PM)—Unburned fuel particles that form smoke or soot and stick to lung tissue when inhaled. A chief component of exhaust emissions from heavy-duty diesel engines.

SHORT TON—An imperial unit of mass equal to 2,000 pounds.