CALIFORNIA ENERGY COMMISSION

California Energy Commission

School Bus Replacement Program/Clean Transportation Program

FINAL PROJECT REPORT

Lake Tahoe Unified 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.
- 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 (Committee on Budget and Fiscal Review, 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-19-059 on October 16, 2019.

Abstract

Lake Tahoe Unified School District (LTUSD) submitted an application to receive grant funding under the California Energy Commission (CEC) Solicitation GFO-17-607 to replace one old diesel school bus. Lake Tahoe Unified School District was awarded funding for one vehicle-to-grid ready electric school bus and the supporting electric vehicle charging infrastructure. Lake Tahoe Unified School District purchased one electric school bus and installed one charger through the CEC. The bus was placed into service December 23, 2020 and districts were offered workforce training to help support the successful deployment of the new electric fleet. The old, diesel-powered bus was also dismantled and removed from service. This project found that the electric school bus reduced emissions by 0.257 short tons of NOx (oxides of nitrogen), 0.014 short tons of $PM_{2.5}$, 0.024 short tons of HC, 0.059 short tons of CO and 22.5 short tons of CO_2 and that the electric school bus had a cost savings during the reporting period of $2,888.67.

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 LTUSD has always been student health and educational success. LTUSD 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 in South Lake Tahoe, CA, El Dorado County.

The second stage dealt with the procurement of electric school buses LTUSD applied for and was awarded grant funding for the purchase of one new electric school buses. LTUSD selected a school bus manufacturer, placed a purchase order for bus procurement, and placed the buses into service December 23, 2020.

The third stage required LTUSD to scrap the old diesel school bus within 12 months from the delivery of the new electric school bus. This disposal is to ensure that the old diesel school bus do not continue to produce emissions.

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

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

CHAPTER 1: Introduction

Background

Senate Bill 110 (Committee on Budget and Fiscal Review, 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 scrapping 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 schools the necessary charging infrastructure 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.

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, which did not include an awarded Type B bus.

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 supports the state's overall energy goals such as the Low Carbon Fuel Standard (LCFS) target

[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.

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

LTUSD was awarded $ 331,389.00 to replace one old diesel school bus with one all-electric school buses, as well as purchase and install the associated charging infrastructure. The district selected Type A Microbird, with wheelchair lift, based on the following needs:

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

LTUSD is responsible for transporting 1331 children per year, with an average route distance of 176,220 miles. LTUSD has a fleet composed of 28 buses featuring a total of 8 electric school buses, 20 diesel buses, 0 CNG buses.

LTUSD decided to procure an electric school bus from A-Z Buses because they were a local vendor. The Type A bus had the following upgrades: Wheelchair lift. These upgrades were necessary due to wheelchair bound students being transported to school. The total cost for the new electric school bus was $274,417.23. Of that total, $269,488.38 was covered by the CEC. Figure 1 below shows one of the district's new electric school buses funded by the CEC.

Figure 1: LTUSD Electric School Bus 12

Source: LTUSD

The replaced diesel bus 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 December 9, 2021, one of LTUSD buses have been scrapped.

Figure 2: LTUSD Dismantled Vehicle Chassis

Source: LTUSD

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 LTUSD to install one 50KW Slim 480VAC CCS1/Empty RFID. The infrastructure was completed in 2020 and began operating December 23, 2020.

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[4] 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 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 experienced obstacles with their bus as well as delays with infrastructure. The delays in infrastructure installation were primarily due to local regulations for allowable timeframes for groundwork. In South Lake Tahoe, groundwork can only take place during drier months, specifically May through October. These restrictions caused a delay in permanent infrastructure installation as the district had a contract with Liberty Utilities to install the infrastructure, but could not begin work due to local regulations. The delay in installation of infrastructure caused delays in data collection, as the temporary chargers were unable to access the data metrics required for the grant.

There were also obstacles with their Type A Micro Bird bus, which were put into service in December 2020. As an early adopter, the district face problems with the transmission as well as electric fan and coolant pump failures. The repairs were all covered under warranty; however the bus had to be sent to A-Z multiple times for transmission repairs.

[4] Level 2 Chargers operate between 208 and 240 Volts with output of anywhere between 3 kW and 19 kW of alternating current power.

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.

A-Z provided three hours of onsite training consisting of a walkaround of the unit and basic components for three on site mechanics.

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 bus funded by the CEC. Listed below are the specific data points for the one bus funded by the School Bus Replacement Program.

LTUSD Bus 12

When placed into service over a 12-month period, LTUSD's Bus 12, shown in Figure 3, traveled 12,014 miles. The replaced diesel fuel bus had a miles-per-diesel-gallon average of 6. The miles traveled over the reporting period equate to a total reduction of 2,002 gallons of diesel. This reduction in total gallons of diesel equates to a reduction of 0.257 short tons of NOx (oxides of nitrogen), 0.014 short tons of $PM_{2.5}$, 0.024 short tons of HC, 0.059 short tons of CO and 22.5 short tons of CO_2.

The average cost of a gallon of diesel fuel was $3.23 during the reporting period. This equals a diesel cost savings of $6,457.53. The total replaced diesel maintenance cost of the scrapped bus was $1,550. Over the 12-month period, the new electric school bus used 26,418 kWh. The total cost for this electricity usage was $3,918.86. Total maintenance cost for the new electric school bus amounted to $ 1,200.00. During this 12-month period alone, LTUSD was able to save $2,888.67.

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 12

Source: LTUSD

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. LTUSD is dedicated to contributing to California's overall goals of decreasing greenhouse gas emissions and improving overall air quality. LTUSD's next step is to increase the district's number of EV buses through the North Coast Unified Air Quality Management District grant (total of 4 buses) and California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) grant (total of 10 buses). LTUSD has applied to the Energize Infrastructure grant, and have destroyed 5 diesel buses to date with an additional 10 to be destroyed through the HVIP grant.

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 seven major areas of responsibilities are:

1. Planning and Policy Development
2. Renewable Energy Growth
3. Energy Efficiency
4. Energy Innovation
5. Cleaner Transportation
6. Responsible Electricity Infrastructure
7. Emergency Response

CARBON DIOXIDE (CO2) - A colorless, odorless, non-poisonous gas that is a normal part of the air. Carbon dioxide is exhaled by humans and animals and is absorbed by green growing things and by the sea. CO2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent). The major source of CO2 emissions is fossil fuel combustion. CO2 emissions are also a product of forest clearing, biomass burning, and non-energy production processes such as cement production. Atmospheric concentrations of CO2 have been increasing at a rate of about 0.5% per year and are now about 30% above preindustrial levels. (EPA)

CARBON MONOXIDE (CO) - A colorless, odorless, highly poisonous gas made up of carbon and oxygen molecules formed by the incomplete combustion of carbon or carbonaceous material, including gasoline. It is a major air pollutant on the basis of weight.

HYDROCARBONS - Compounds containing various combinations of hydrogen and carbon atoms. They may be emitted into the air by natural sources (e.g., trees) and as a result of fossil and vegetative fuel combustion, fuel volatilization and solvent use. Hydrocarbons are a major contributor to smog.

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 aim 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.