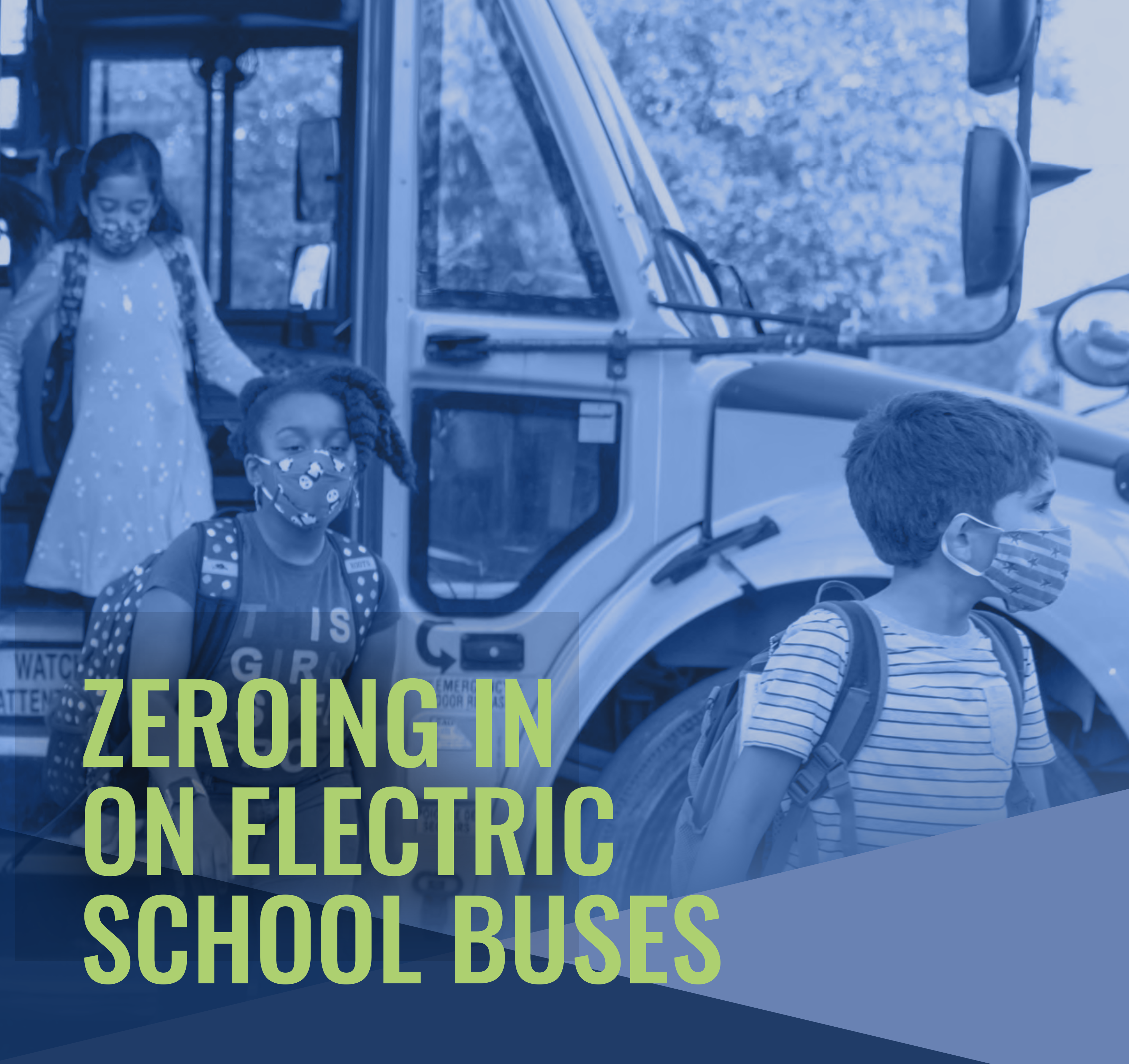

ZEROING IN ON ELECTRIC SCHOOL BUSES

THE ADVANCED TECHNOLOGY SCHOOL BUS INDEX: A U.S. ESB INVENTORY REPORT

December 2021

A CALSTART Report
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CALSTART

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List of Acronyms

ARP	American Rescue Plan
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CEC	California Energy Commission
DERA	Diesel Emissions Reductions Act
EnergIIZE	Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles
EPA	U.S. Environmental Protection Agency
ESB	Electric School Bus
FCEV	Fuel Cell Electric Vehicle
HVIP	California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
NACAA	National Association of Clean Air Agencies
NAPT	National Association of Pupil Transportation
NYTVIP	New York Truck Voucher Incentive Program
PGE	Portland General Electric
RAQC	Regional Air Quality Council
RSBPP	Rural School Bus Pilot Project
TaaS	Transportation-as-a-Service
V2G	Vehicle-to-Grid
VW	Volkswagen
WRI	World Resources Institute
ZETI	Zero-Emission Technology Inventory

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Executive Summary

This report aims to provide an inventory of the number of electric school buses (ESBs) currently present within the United States. Data collected through September 2021 includes ESBs that are funded, ordered, delivered, and deployed. In total, there are 1,738 ESBs in the United States that fall within these categories. By tracking buses throughout the adoption process, this report intends to capture the growth in the ESB market over time.

As of September 2021, there are 1,738 electric school buses (ESBs) awarded, ordered, delivered, and deployed in the United States.

As more school districts consider ESB adoption, alternative models for ownership and deployment could be an important aspect of their decision process. The high up-front cost of ESBs and unique challenges to infrastructure may make alternative models more appealing to school districts that currently own and operate their school transportation. These models will also be important for ESB adoption by privately owned fleets, which comprise one third of the nation's school bus fleet (NSTA, 2013).

Looking at specific growth indicators, such as funding and policy, are also an important element to understand the future of the ESB market. Across the United States, programs like the Diesel Emissions Reduction Act (DERA) and funding from the Volkswagen (VW) Mitigation Settlement assist in the transition to ESBs. In addition, states like California have developed their own funding programs, which have provided significant incentives for school districts and accelerated the state's transition. California legislation has also focused heavily on reducing diesel emissions, further driving the transition. California currently leads the nation in ESB adoption with a total of 850 ESBs, creating a sizeable gap between Maryland, the next highest state with 331 ESBs.

Policy and funding will help school districts across the country transition to ESBs, including the Infrastructure Investment and Jobs Act's $5 billion in funding allocated for ESBs and alternative fuels.

Together, policy and funding will help school districts across the country transition to ESBs. With the signage of the Infrastructure Investment and Jobs Act on November 15, 2021, opportunities for dramatic ESB expansion are set to boost the ESB industry. The school bus provision of the bill, Title XI, Section 71101, allocates $5 billion to zero-emission school buses and alternative fuels (De La Garza, 2021; SBF, 2021).

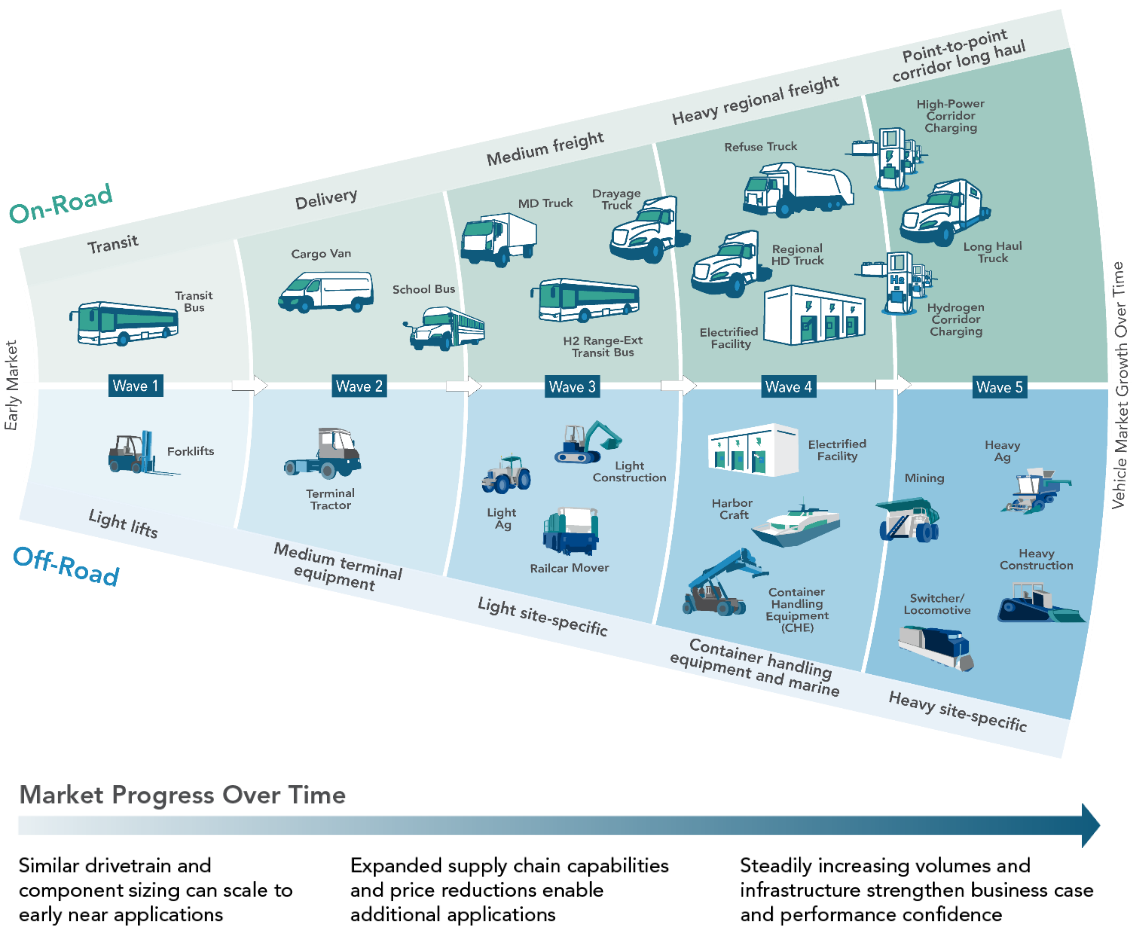
I. Introduction

This report is the first of its kind to track the deployment of electric school buses (ESBs) within the United States on a state-by-state basis. Currently, there are approximately 500,000 school buses transporting 26 million students every day in the United States; over 95% of those school buses run on diesel, which account for over five million tons of yearly greenhouse gas emissions (De La Garza, 2021). Less than 1% of the nation's school bus fleet is electric (Burgoyne-Allen, 2019). Since the ESB industry is still in its infancy, this report will be published annually to track the growth of the ESB market as it matures over time. The report will detail ESB adoption and provide industry context on the data collected and trajectory of the market, as well as highlight key factors impacting the ESB market, such as funding and policy, and barriers to adoption, including cost and education.

As government at the federal and state levels become more focused on meeting emissions reduction goals, the adoption of electric vehicles such as school buses will be important to address. School buses have been recognized as vehicles well suited for zero-emission technologies: ESBs have predictable routes to allow for scheduled charging and will bring more visibility to electric vehicles (Arora, 2021). ESBs will signal to the public that zero-emission technology is feasible, not only for personal use but for public use as well.

School buses have been identified as a crucial aspect of the Beachhead Strategy (**Figure 1** below). Developed in partnership between CALSTART and the California Air Resources Board (CARB), the Beachhead Strategy identifies commercial vehicle applications where zero-emission technologies are most likely to succeed—typically urban applications where vehicles operate along known routes of relatively short distances and can charge overnight at depots—and aims to secure an initial position within these markets to gain footholds for further market advancement (Welch, 2020). Electric transit buses were identified as the best first initial pathway to expand zero-emission technology, and now the transit industry has adopted over 3,500 full-size zero-emission buses. However, school buses were identified as an important pathway to expand heavy regional freight and point-to-point corridor long haul transportation, and ESBs have shown how zero-emission technology can meet real-world applications (Welch, 2020). For instance, ESBs have demonstrated that they can excel in a variety of environments, including extremely cold conditions in Alaska or extremely hot conditions in parts of California. This success is important, as the zero-emission technology for school buses is relatively new.

Figure 1. The Zero-Emission Beachhead (CARB, 2021a)



While ESBs may be more suitable for electrification than other vehicle sectors at this time, there are challenges to overcome for the market to advance. Currently, ESBs may still cost 300 percent more than an equivalent diesel-powered school bus, and although data suggests maintenance is much more affordable for ESBs, labor trained in electric drivetrains can be challenging to find in many areas of the country (Arora, 2021).

Continued funding support and advancement in policy will allow the ESB market to grow by giving time for ESB technology to mature and demand for ESBs to increase, consequently reducing the capital cost over time and allowing ESBs to reach cost parity[1] with their diesel counterpart. Federal funding opportunities such as those outlined in the **Infrastructure Investment and Jobs Act** will play a major role in growing the ESB market, but support at the state and local levels will need to continue to ensure growth for the foreseeable future.

[1] Cost parity occurs when a company achieves the same prices for their product or service with the market leader or competitor (Martin, 2019).

II. Report and Analysis

ESB Deployment

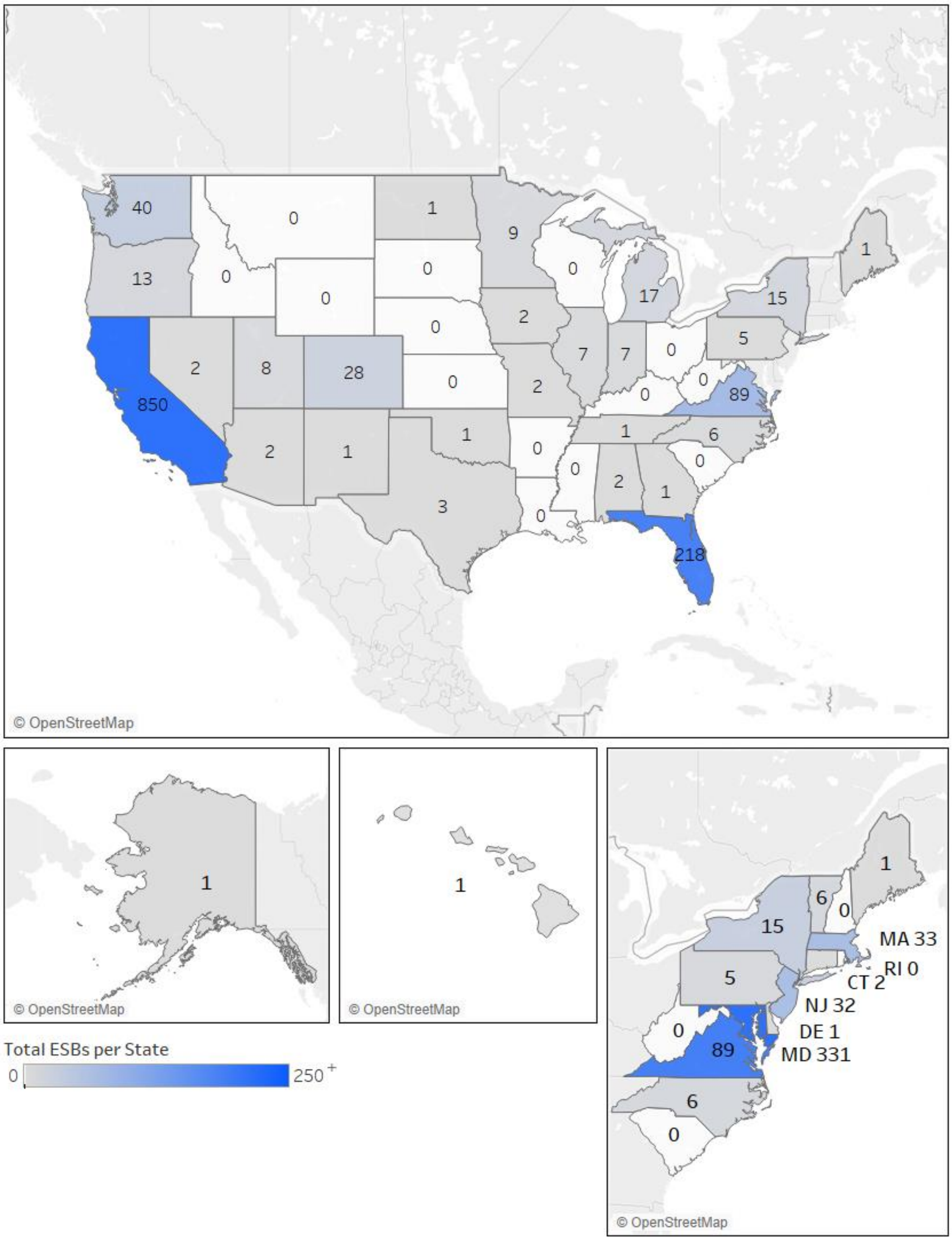
To obtain ESB adoption numbers within the United States, CALSTART generated a contact list from two sources: the CALSTART Midwest Volkswagen (VW) Appendix and the National Association of Clean Air Agencies (NACAA). Additionally, data was collected from articles, press releases, and direct communication with school districts and reviewed in collaboration with the World Resource Institute (WRI) Electric School Bus Initiative to ensure accuracy.

This report defines the adoption of ESBs as those that have been funded, ordered, delivered, or deployed. The stages of ESB adoption are defined as:

- **Funded:** Funding to support the procurement of the transit bus has been officially awarded.
- **Ordered:** The transit provider has officially placed an order for a zero-emission bus.
- **Delivered:** The zero-emission bus has been received by the transit provider and is being prepared to be placed into operational service.
- **Deployed:** The transit bus has been placed in operational service and is actively running in service.

Figure 2 shows that there are 1,738 ESBs that fall within these categories in the United States. These ESBs have been adopted across more than 300 school districts in 34 states.

Figure 2. Electric School Buses Currently Awarded, Ordered, Delivered, or Deployed within the United States (Updated September 2021)



As outlined in **Figure 3** below, the top five states with the most ESBs are as follows: California (850), Maryland (331), Florida (218), Virginia (89), and Washington (40). Within the top five states, California, Maryland, and Florida have over 80% of all ESBs adopted in the United States. In Florida and Maryland, the ESB data collection falls short of the deployment stage of adoption with most buses still in the awarded or on order phase. In Florida seven school districts have been awarded funds to cover a total of 218 ESBs; however, the state of Florida does not have any actively deployed ESBs at this time. In Maryland, 326 of the total 331 ESBs were awarded through a single contract with a third-party vendor to deploy ESBs within the Montgomery County Public Schools system. There are currently only six active ESBs in the state of Maryland operating in the counties of Howard, Frederick, Prince George's, and Montgomery. California has the overwhelming majority of ESBs within the United States with a total of 850 ESBs across 177 school districts and three third-party vendors.

Figure 3. Top Five States for Electric School Bus Adoption (Updated September 2021)

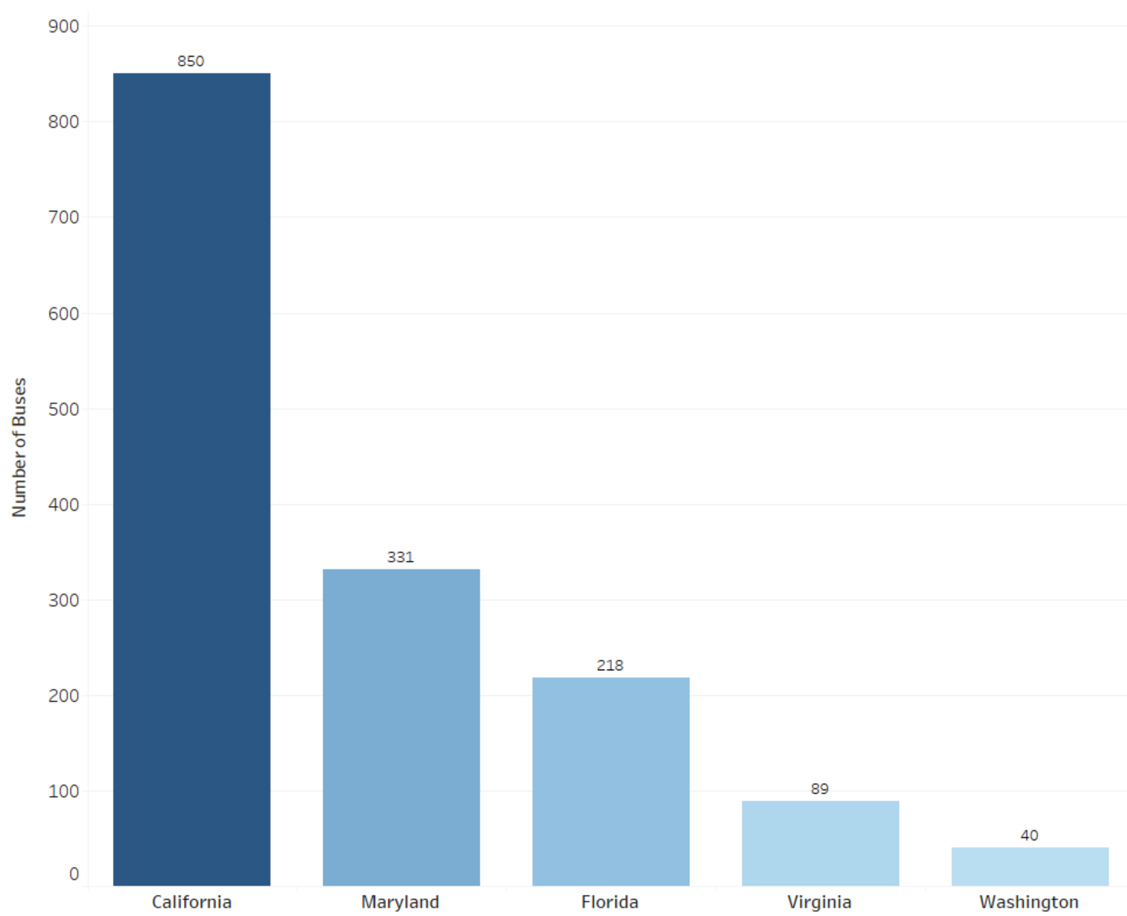
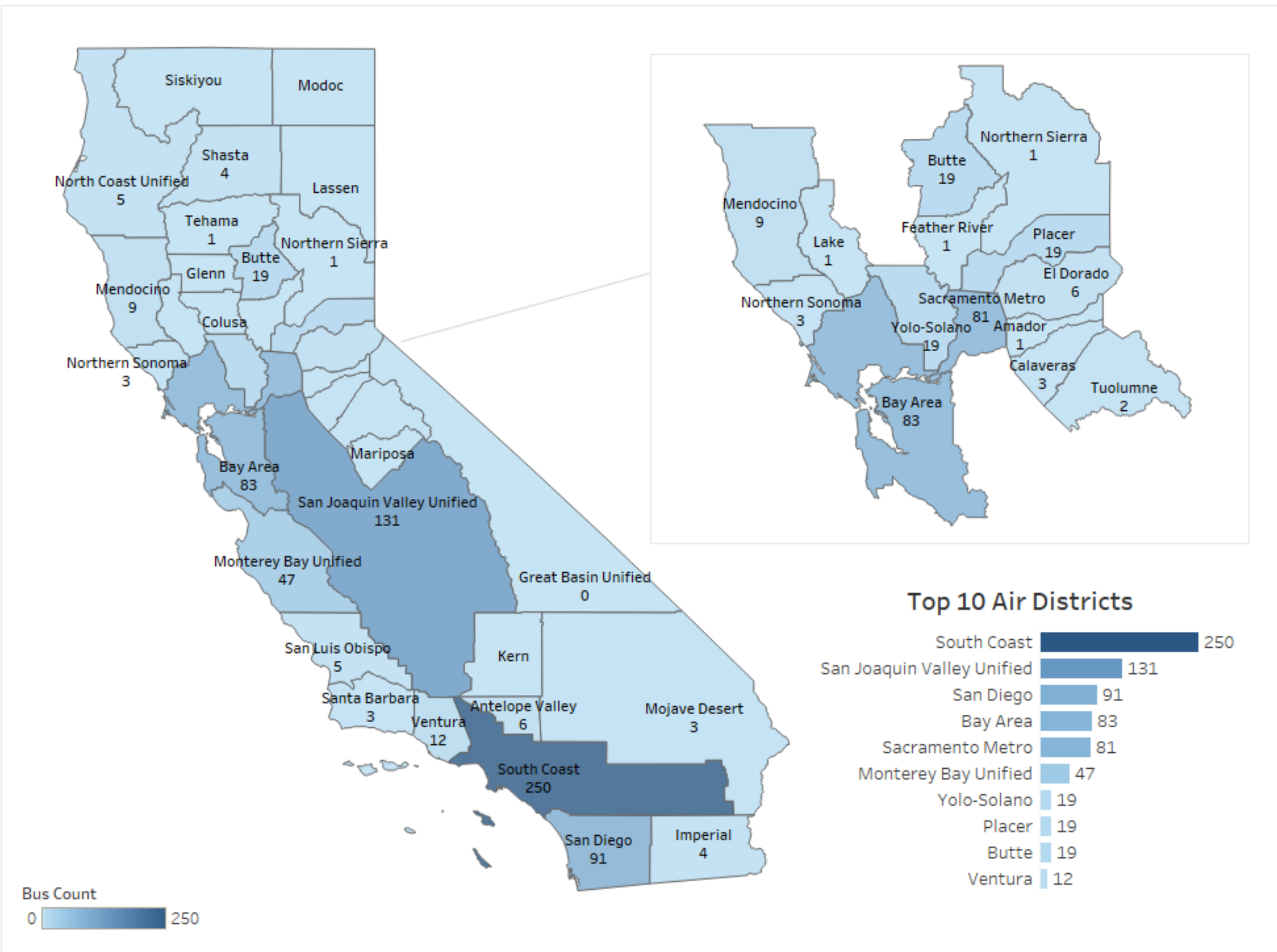


Figure 4 below shows the top 10 air districts with the most ESBs in California. The top five air districts are large air districts, with a consolidation of 636 ESBs. Larger air districts tend to receive more funding than their medium and small air district counterparts. According to the California Air Pollution Control Officers Association (CAPCOA), the sizing of air districts is based on historical funding allocated by the Carl Moyer Program (T. Le, personal communication, Oct. 20, 2021). Generally, funding through the Carl Moyer Program is based on population and pollution levels (CARB, 2016). Overall, four of the 10 air districts were medium size districts with a consolidation of 97 ESBs; one small air district had 19 ESBs. Section IV of this report details how funding plays a significant role in ESB adoption using California as an example state.

Figure 4. Top 10 California Air Quality Districts for Electric School Bus Adoption (Updated September 2021)



Note: School buses owned by transport companies (First Student, Inc., Michael's Transportation Services, Inc., Student Transportation of America) are excluded from the bus count mapping due to the lack of data for their operational area.

III. State of the Market

School Bus Types

There are four categories of school buses classified by Type A, Type B, Type C, and Type D. Each category of school bus is unique, as the type defines the size, passenger capacity, and shape of the bus (Arora, 2021). **Table 1** below highlights the differences between each school bus type. It should be noted that the Type B bus currently does not have an electric alternative.

Table 1. Comparison of Electric School Buses by Type

	Passenger Capacity	Bus Range	Manufacturers	Cost Estimate
Type A	16-20	100-150 miles	Lightning eMotors, Lion Electric, Micro Bird, Motiv Power Systems, Phoenix Motor Cars	$265,000- $450,000
Type B	20-30	NA	NA	NA
Type C	60-72	100-120 miles	Blue Bird, IC Bus, Lion Electric, Thomas Built	$300,000-$400,000
Type D	72-90	120-155 miles	Blue Bird, BYD, GreenPower Motor Company, Lion Electric	$345,000-$410,000

Type C bus models are the most prevalent ESB model; however, Type A school buses are becoming increasingly popular. Manufacturers are choosing to expand in the ESB market through the Type A bus due to its versatility and widespread use (Arora, 2021). For more information about the specifications of the available ESBs currently on the market, see Appendix A.

Deployment Models

With the higher up-front cost to purchase ESBs and challenges that come with installing and operating charging infrastructure, school districts are exploring their options for fleet electrification, and alternative models of ESB deployment are being introduced in the market. These alternative models to traditional ESB adoption give schools the opportunity to transition the burden of ownership and/or maintenance to a third party. According to the National Association of Pupil Transportation (NAPT), over one third of the nation's school bus fleet is already privately operated (NSTA, 2013). The other two thirds are operated by school districts themselves or students ride public transportation. These alternative models provide school districts who already outsource their transportation services and school districts considering outsourcing their transportation a pathway to ESB adoption, ultimately leading towards greater transition of the entire U.S. school bus fleet. **Table 2** depicts the variety of deployment models currently available.

Table 2. Deployment Models for Electric School Buses

Model	Vehicle Owner	Charger & Infrastructure Owner	Operations Responsibility
Traditional	School District	School District	School District
Lease	Third Party	School District	School District
Turnkey	Third Party	Third Party	School District
Transportation-as-a-Service (TaaS)	Third Party	Third Party	Third Party

- In the **traditional deployment model**, the school district owns the school bus, charger, and infrastructure, and manages operations. This deployment model is common and often found to be in use at school districts.
- The **lease deployment model** allows a third party to own the school bus and rent it to the school district, while the school district owns the charger and infrastructure and continues to manage the school bus operations.
- The **turnkey model** gives ownership of the school bus, charger, and infrastructure to a third party. The school district continues to manage operations.
- In **Transportation-as-a-Service (TaaS)**, a third party owns the school bus, charger, and infrastructure, and manages operations.

The benefit of using the turnkey or TaaS models is that the third party will cover the initial high cost of transitioning to an electric fleet. These deployment models can take on these costs by extending a contract over multiple years and taking advantage of incentives such as the vehicle-to-grid (V2G) capability of ESBs. V2G enables electricity to be sent back to the power grid from the battery of an electric vehicle; the energy then travels to the nearest location in need of power (Virta, n.d.). The owner receives credit from the utility company in exchange for providing energy to the grid. This revenue stream has allowed third-party companies to offset some of the ownership costs and, in some cases, has made these innovative deployment models possible at a budget-neutral cost to the school district. Due to V2G, ESBs have the capacity to provide resiliency to the electrical grid during blackouts, supplying energy to communities (Wiley, 2019).

IV. Funding and Policy

Funding Opportunities

Funding opportunities specifically designed for ESBs have been integral to the advancement of adoption across the United States. Investing in a school bus fleet is often a coordinated effort between local, state, and federal agencies (CARB, 2021b). Some funding programs discussed in this report will be state specific. These state specific funding programs can be used as models for other states to consider when adopting their own programs. As previously mentioned, there is a correlation between funding opportunities and ESB deployment. Recognizing this distinction as a mechanism helps explain how California became the leader in procuring ESBs.

Funding allows school bus fleets to ease the burden of the high up-front cost of procuring ESBs. For school districts with smaller budgets, committing to an ESB transition plan can be daunting. In short, having more funding opportunities available in the next few years will help accelerate the deployment of ESBs. This correlation has been evident in California, indicating why the state leads the nation in deploying ESBs. In 2021, California spent over $110 million to transition school bus fleets, with more funding to come (CARB, 2021b). **Table 3** provides some key funding programs operated by CARB and the California Energy Commission (CEC) that assist school districts in transitioning to ESBs. Many of these programs are designed by CARB to fulfill their plan to deploy 1,000 ESBs within California (CARB, 2021b).

Table 3. California Electric School Bus Funding Programs

Program	Program Owner	Year Program Started	Type of Funding	Total Funding To Date	Key Facts
Hybrid and Zero-Emission Truck and Bus Voucher Inventive Project (HVIP)	CARB	2010	Voucher	$88.8 million	• Supplies school bus fleets with vouchers to assist with the high cost of ESBs. • Will be allocating additional funding ($450 million) specifically for school bus fleets in small air districts.
Rural School Bus Pilot Project (RSBPP)	CARB	2016	Grant	$62 million	• Funded by CARB's Low Carbon Transportation Investments and Air Quality Improvement Program.
School Bus Replacement Program	CEC	2019	Grant	$75 million	• Provided over $75 million in funding for school bus replacement in disadvantaged and low-income communities, reaching various regions in California (Northern, Central, Southern, and Los Angeles County).
Clean Mobility Schools Pilot Project	CARB	2018	Grant	$24. 6 million	• Approved to help increase the visibility of zero-emission vehicles in the public eye. • Awarded three school districts grants amounting to $24.6 million in funds.
Community Air Protection Program	CARB	2017	Grant	$56.2 million	• Uses funds from the Cap-and-Trade auction to prioritize funding to reduce emissions in communities most impacted by air pollution. • Any school district seeking to replace diesel school buses is eligible for funding.
Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE)	CEC	2021	Grant	$50 million	• Helps communities meet infrastructure needs for battery-electric and hydrogen vehicle options. • Funds will be allocated to assist communities most impacted by pollution.

More states are following in California's footsteps by developing their own funding incentive programs. Below are a few examples of other funding programs across the United States:

- The **New York Truck Voucher Incentive Program (NYTVIP)**, created in 2013, provides vouchers to fleets based in New York to purchase zero-emission vehicles, plug-in hybrids, hybrid electrics, compressed natural gas, and propane alternatives. Voucher amounts are based on the difference in cost between the alternative vehicle and the conventional diesel vehicle (NYSERDA, n.d.i). NYTVIP has allocated $5.5 million to go toward ESBs (NYSERDA, n.d.ii).
- In 2018 the Regional Air Quality Council (RAQC) allocated funding to the **ALT Fuels Colorado program** to incentivize public, private, and nonprofit fleets to transition to fully electric or renewable natural gas vehicles. To date the program has funded over 800 alternative vehicles. Overall, the program has allocated over $21.5 million in funding and has approximately $3 million remaining (CAF, n.d.).
- In 2020 Portland General Electric (PGE) partnered with public school districts to help deploy ESBs in Oregon. The **PGE Electric School Bus Fund** uses funding from the Oregon Clean Fuels Program, where PGE will assist in covering the cost of ESBs and charging infrastructure. Per application the school district can secure up to $500,000 in funding. The program also covers funding for bus driver and technician training (PGE, n.d.)

On the national level there are several funding programs that support the deployment of ESBs. Below are funding programs available to and/or administrated by all states:

- The **VW Mitigation Settlement**[2] amounted to a $1.45 billion penalty for violations of the Clean Air Act (EPA, n.d.i). The settlement also required VW to create a $2.7 billion mitigation fund to support projects that focus on emission reductions (MDEQ, n.d.). Each state has been allocated funds for replacing eligible vehicles.[3] Washington, Virginia, and Florida are examples of states that have chosen to leverage their funds for ESBs. The funds from this settlement will bring 40 ESBs to Washington, 39 ESBs to Virginia, and 218 ESBs to Florida.
- The **Diesel Emissions Reductions Act (DERA)** funds grants and rebates for projects that focus on reducing emissions from diesel engines (EPA, n.d.ii). The Environmental Protection Agency (EPA) anticipates awarding $46 million in grant funding in 2021 (DieselNet, 2021). Eligible applicants include regional, state, local government, tribal agencies, nonprofits, and port authorities who plan on using funding to improve air quality. Since the creation of DERA in 2008, the EPA has provided over $300 million in grants and rebates (DieselNet, 2021).
- The **2021 American Rescue Plan (ARP)**, administered by the EPA, has dedicated $7 million for ESB rebates in disadvantaged communities (EPA, n.d.iii). Eligible school districts[4] and private

[2] To date, the VW Mitigation has helped secure funding for 72 ESBs within California (CARB, 2021b).

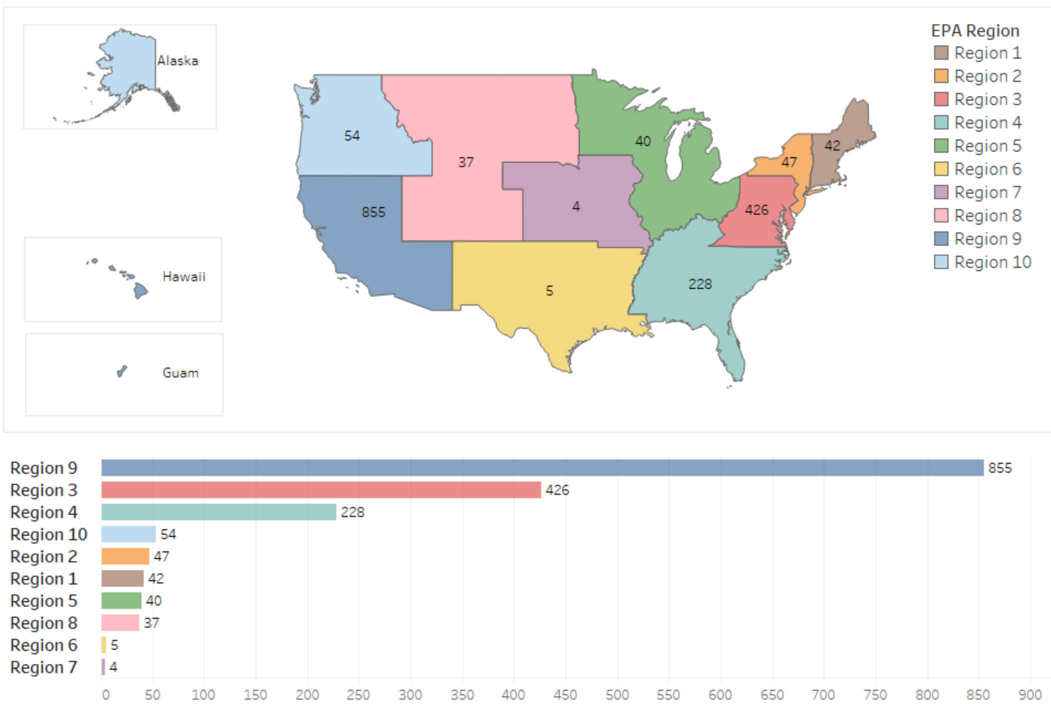
[3] Eligible vehicles include freight trucks, drayage trucks, school buses, shuttle buses, transit buses, freight switchers, ferries/tugs, ocean going vessels shore power, airport ground support equipment, and forklifts (CARB, 2021b).

[4] Districts on the ARP eligibility list have demonstrated that 30% or more students live in poverty, tribal schools, and private fleets that operate in school districts in the eligibility list (EPA, n.d.iii).

fleets that scrap the replaced diesel bus will receive a rebate of $300,000 per school bus.

Figure 5 below shows the deployment of ESBs by EPA region. Currently, the United States is divided into 10 different regions.[5] The regions allow the EPA to address environmental concerns for a specific area (EPA, n.d.iv). Focusing on a specific area gives the EPA more opportunities to partner with federal, state, local, and tribal partners to find solutions for local environmental problems (EPA, n.d.iv). Figure 5 shows the concentration of ESBs to be on the West and East coasts of the United States, with Region 9, Region 3, and Region 4 as the top three regions. The concentration of ESBs within those EPA regions reflects the areas of the United States whose funding opportunities have been dedicated to the deployment of ESBs.

Figure 5. Electric School Buses Adoption by EPA Region (Updated September 2021)



[5] For the complete list of regions and corresponding service areas, please go to the EPA's Regional and Geographic Offices page: https://www.epa.gov/aboutepa/regional-and-geographic-offices

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Available Type A Electric School Buses

Manufacturer	Lightning eMotors	Lion Electric	Micro Bird	Motiv Power Systems	Phoenix Motor Cars
Chassis	Ford E-450 Cutaway	Lion Electric	Ford E-450 Cutaway	Ford E-450 Cutaway	Ford E-450 Cutaway
GVWR	14,500 pounds	22,350 pounds	14,500 pounds	14,500 pounds	14,500 pounds
Battery Size	94 kWh or 125 kWh	84 kWh or 168 kWh	88 kWh	127 kWh	70 kWh, 105 kWh, 140 kWh
Charge System	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge	Level 2	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge
Level 2 Charge Time	5.5 hours or 7.5 hours	8.75 hours	7 hours	8 hours	Not Specified
DC Fast Charge Time	1.5 hours or 2 hours	3.5 hours	NA	Not Specified	Not Specified

Available Type C Electric School Buses

Manufacturer	Blue Bird	IC Bus	Lion Electric	Thomas Built
Chassis	Blue Bird	IC Bus	Lion Electric	Thomas Built
GVWR	33,000 pounds	33,000 pounds	33,000 pounds	33,000 pounds
Battery Size	155 kWh	105 kWh, 210 kWh, 315 kWh	126 kWh, 125 kWh, 210 kWh	226 kWh
Charge System	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge
Level 2 Charge Time	8 hours	Not Specified	6.5 to 11 hours	Not Specified
DC Fast Charge Time	3 hours	Not Specified	2.5 to 4.25 hours	3 hours

Available Type D Electric School Buses

Manufacturer	Blue Bird	BYD	GreenPower Motor Company	Lion Electric
Chassis	Blue Bird	BYD	GreenPower Motor Company	Lion Electric
GVWR	36,000 pounds	39,153 pounds	42,990 pounds	36,000 pounds
Battery Size	155 kWh	274 kWh, 300 kWh	194 kWh	126 kWh, 168 kWh, 210 kWh
Charge System	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge	Level 2 and DC Fast Charge
Level 2 Charge Time	8 hours	Not Specified	10.5 hours	6.5 to 11 hours
DC Fast Charge Time	3 hours	Not Specified	3.25 hours	2.5 to 4.25 hours