GENERATE:
INTELLIGENCE

ACCELERATING ELECTRIFICATION OF SCHOOL BUS FLEETS

2024

School districts eager to transition their fleets to electric school buses must navigate a thicket of financial and operational concerns that fall well outside the usual purview of school administrators and other traditional fleet maintenance operators. Sizable upfront costs, technical and bureaucratic hurdles, and a bevy of market uncertainties all complicate the path forward to a greener, cheaper, and healthier EV bus fleet. Overcoming the triple barriers of cost, complexity, and uncertainty requires business model innovation and adoption. Fortunately, the innovation already exists, and it's becoming widely accessible to school districts. As the stakes for large scale electrification loom ever higher, the fleet electrification-as-a-service (FaaS) model is simplifying and accelerating the electrification process for essential audiences – public schools and the children and families they serve.

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Executive Summary

Across the US, school districts are choosing to electrify their school bus fleets. The change is driven by the benefits electric buses provide to students' health and local air quality, the potential for cost savings, substantial available federal grant funding, and mounting pressure school districts face to decarbonize their operations.

School buses are also prime candidates for electrification: bus routes are predictable and almost always fall within the range offered by EVs available today, most existing bus yards have ample space for charging infrastructure, unused energy from electric school buses can be monetized by being fed back to the grid which boosts overall grid reliability, and the funding available to help subsidize electric school buses is a result of a growing public demand for them.

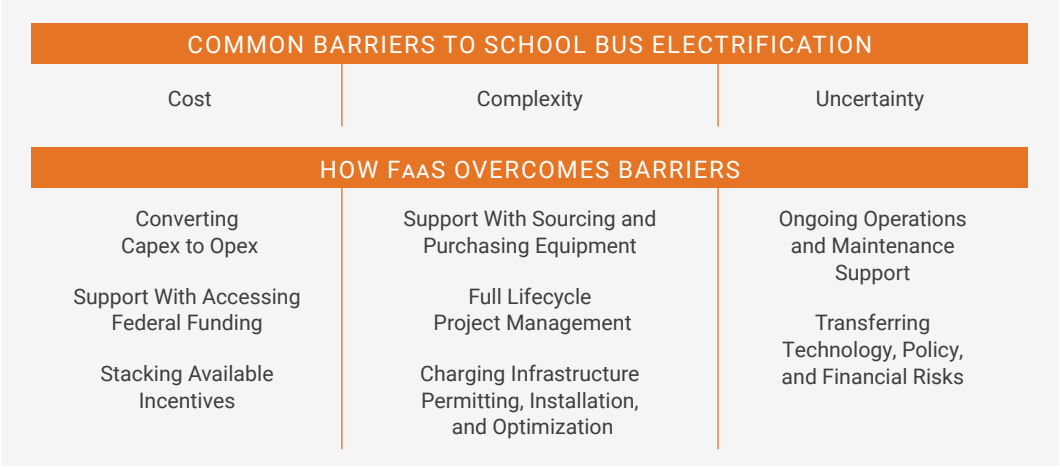
Yet persistent challenges are impeding electric school bus adoption at scale. Districts transitioning to electric buses face three barriers to adoption: cost, complexity, and uncertainty.

For many public school districts across the US that are resource-constrained, the significant upfront capital requirements make electric school buses impossible to purchase. Navigating the multifaceted federal, state, and local incentives to make the economics of the buses advantageous is complicated. New infrastructure that combines a need for different buses and a charging infrastructure adds operation and maintenance complexities that districts do not have the experience to address. Intricacies involved in the transition and lingering concerns about issues such as EV range remain deterrents to electrifying school bus fleets.

Despite these challenges, the public demand from parents, teachers, students, and the community to address air quality, noise, and climate issues is – understandably – unrelenting, putting districts in a difficult position.

With the right strategy and partners, however, school systems can overcome these hurdles. Working with fleet electrification-as-a-service (FaaS) providers helps school districts navigate policy and regulatory processes and access available grant funding while alleviating the sticker shock of capital expenditures and minimizing the anxieties associated with securing and managing charging infrastructure.

With over 13,000 school districts across the country serving nearly 50 million students with almost 500,000 school buses, the market is established and addressable. The question is, how quickly can we convert to a solution that is good for the students, the communities, the districts, and the planet? Embracing the FaaS model will accelerate the transition.



Electric School Bus Benefits and Market Drivers

Between the sizable health, environmental, and financial benefits that electric school buses deliver and the significant market drivers spurring – and in some cases, mandating – electrification, school districts have no shortage of reasons to electrify their bus fleets.

Benefits:

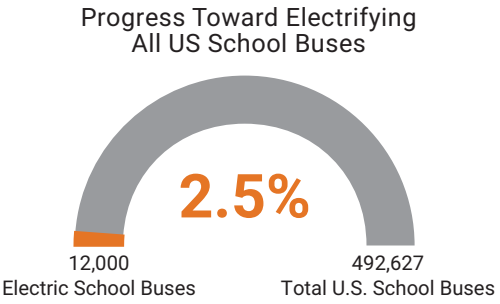
- Improved air quality and reduced noise pollution for students and bus drivers
- Reduced greenhouse gas emissions
- More resilient electricity grid
- Cost savings

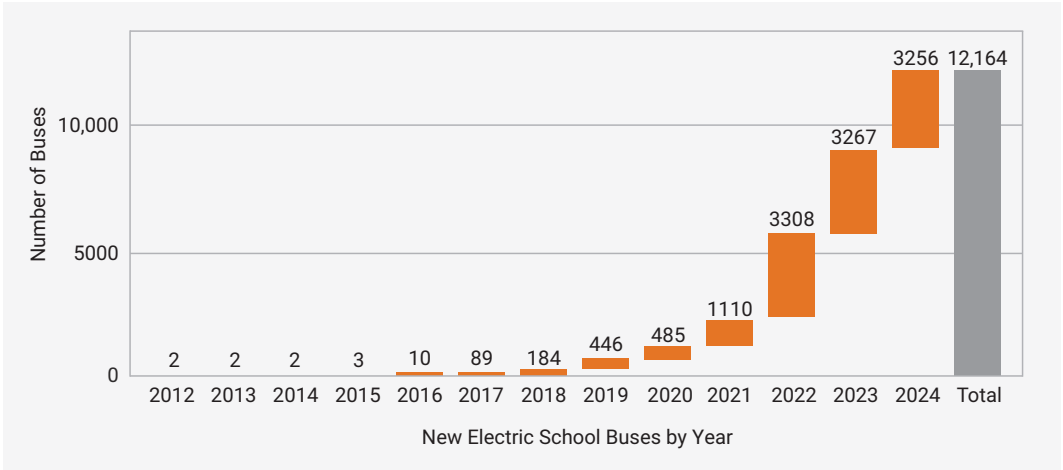
Market Drivers:

- Parent and community advocacy
- Policy requirements and mandates
- Available federal grant funding

School districts are recognizing these benefits and drivers, and school bus electrification is gaining momentum. Over 12,000 electric school buses currently operate across the country, with over 80% of them introduced in the last two years. Still, this share represents only 2.5% of total US school buses. Most school districts, therefore, still require bus fleet electrification solutions.

Figure 1: Number of Electric School Buses and Share of Total US School Buses





Source: WRI's Electric School Bus Initiative, as of May 31, 2024

Why Electrify?

Student Health Outcomes

Among the top drivers to electrify school bus fleets is the body of evidence showing e-buses provide a cleaner and quieter environment for schools' primary stakeholders – their students. Diesel-powered school buses, which currently account for 95% of school buses on the road, emit carcinogenic toxins, which studies show result in harmful air pollution affecting children's lung function and, in turn, their education.[1] A longstanding study found the level of diesel exhaust inside school buses to be as much as 23 to 46 times the level deemed a significant cancer risk by federal law.[2]

Electric buses are linked to cleaner air, lower asthma rates, and less noise pollution. One study found significant improvements in students' respiratory health and aerobic capacity scores after retrofitting school buses.[3] Elementary students, who are more vulnerable to air pollution, received double the benefits. Given that about 4.5 million children in the US currently suffer from asthma, these results illustrate the wide-reaching benefits of school bus electrification.[4] The study also linked retrofitted school buses with improved cognitive performance, particularly for English test scores. A 2024 study calculated the monetary value of the reduced mortality and childhood asthma rates enabled by electric school buses. It found that replacing a diesel-powered school bus with an electric one yields over $40,000 in health benefits across the bus's lifetime; in dense urban areas, the benefits can balloon to over $200,000 across each bus's lifetime.[5]

Parent and Community Advocacy

Parents, teachers, students, and other community advocates recognize these benefits, and their grassroots campaigns are serving as a major driver of school bus electrification. WRI's Electric School Bus Initiative tracks advocacy organizations and spotlights school districts that have successfully transitioned their fleets as the result of advocacy efforts.[6] One such effort led to Austin's Independent School District setting a district-level goal to electrify its entire school bus fleet, prompted in part by a letter from a collection of community groups, parents, and elected officials. "Getting to school shouldn't include a daily dose of toxic pollution or increase the chances that people will get sick," they wrote.[7] Another parent advocate, Areli Sanchez, began championing school bus electrification after her daughter's asthma caused her to repeatedly miss class and even required a hospital stay. "When she would come home from school or be on the bus, she got headaches and sick to her stomach. She said, 'Mami, I don't feel well, I feel dizzy,'" Sanchez told the AP.[8] These grassroots advocacy efforts are taking hold across the US to help galvanize the transition to electric school buses.

[1] American Journal of Respiratory and Critical Care Medicine, 2015. Adopting Clean Fuels and Technologies on School Buses.
[2] NRDC, 2001. No Breathing in the Aisles.
[3] Brookings, 2019. Fixing School Buses is an Effective (and Cheap) Way to Improve Students' Health and Academic Performance.
[4] NIH, 2023. Epidemiology of Current Asthma in Children Under 18.
[5] PNAS, 2024. Adopting Electric School Buses in the United States: Health and Climate Benefits.
[6] WRI, 2022. Electric School Bus Initiative.
[7] KVUE, 2022. Austin Leaders Push for Electric Buses in Austin ISD.
[8] AP, 2024. Tired of Diesel Fumes, These Moms Are Pushing for Electric School Buses.

Decarbonization Progress

School districts are also electrifying their fleets to decarbonize their operations and meet net-zero goals. Electric school buses offer significant reductions in greenhouse gas emissions compared to their diesel counterparts, even when accounting for the emissions derived from electricity generation. Current projections indicate that transitioning all the diesel-powered school buses in the US to electric models would reduce about 8 million metric tons of CO2 annually – equivalent to the annual energy use of one million homes.[9] And as clean energy sources continue to contribute a larger share of the electricity on the grid, these emissions reduction figures will increase.

Grid Resiliency

Electric school buses also serve as important resources for the power grid. The nature of school bus operations eliminates many of the common anxieties around EV charging and range – fleet managers know when and where the buses will run and how much charge they will require, with many school buses only performing predictable routes in the morning and afternoon. The predictability of their charging patterns makes buses well-suited for demand response and the bi-directional charging enabled by behind the meter vehicle-to-building (V2B) technology, which is available now, and vehicle-to-grid (V2G) technology, which is in its early stages. In some cases buses can avoid tapping the grid during peak demand hours by charging their batteries when electricity is less expensive, such as overnight. They can then push unused capacity back to the grid during the energy-intensive daytime hours when many buses sit dormant – making them important assets for meeting peak load. Some utilities offer financial incentives for avoiding peak demand hours – creating an opportunity for school districts to recoup some of their operating costs just by avoiding connection with the grid during rush hours.

Policy Compliance and Funding

In addition to the health and environmental benefits that electrified fleets offer, the availability of grant programs and tax incentives for electric school buses is also driving adoption. Notably, the EPA's Clean School Bus Program will provide $5 billion between 2022 and 2026. The program is catalyzing the school bus electrification market. To date, the program has allocated $3 billion in funding to over 1,000 schools, covering approximately 8,500 school bus replacements – a significant portion of the estimated 50,000 diesel buses that can be replaced with electric models annually. The program consists of three funding opportunities with different eligibility and award structures: the Clean Heavy-Duty Vehicles (CHDV) Grant Program, the Clean School Bus Rebate Program and the Clean School Bus Grant Program. Two additional federal funding programs – the 2024 Tribal and Territory DERA Grant and DOE's Renew America's Schools Program – and two Inflation Reduction Act (IRA) tax credits – the Qualified Commercial Clean Vehicle tax credit (Section 45W) and the Alternative Fuel Vehicle Refueling Property tax credit (Section 30C) – are also available.

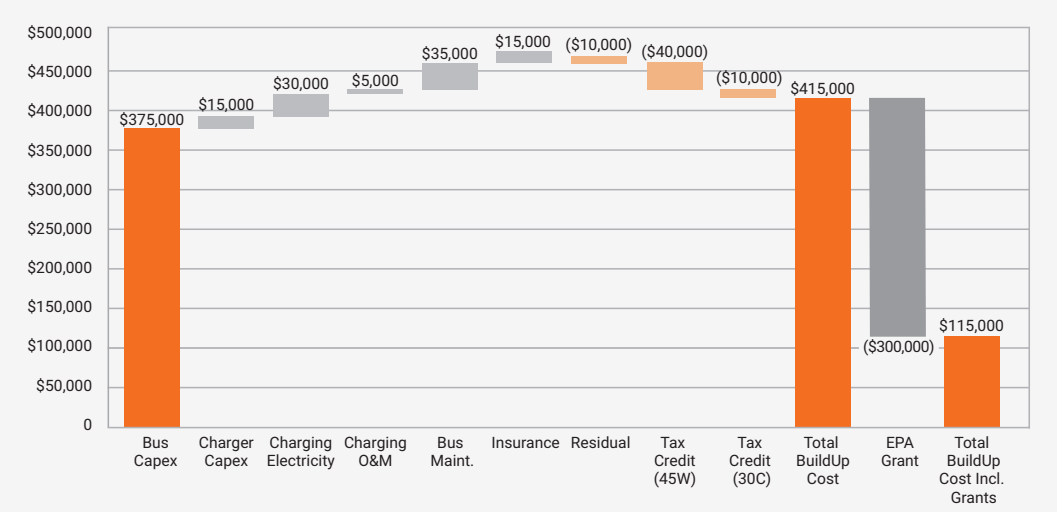
[9] Environment America Research & Policy Center, 2022. Electric School Buses and the Grid.

A patchwork of grants and rebates from state governments are also incentivizing the transition to electric buses. For example, the state of New York's Clean Water, Clean Air, and Green Jobs Environmental Bond Act (Bond Act) includes $500 million in funding to support school bus electrification, with the first $100 million available as of fall 2023, while Michigan's 2024 budget included $125 million in funding for electric school buses. In some cases, these funding programs are accompanied by more formal state- and local-level decarbonization requirements or climate action plans. Michigan's funding is a component of the state's MI Healthy Climate Plan. At least nine states currently have mandates around school bus electrification, led by Connecticut, Delaware, Maine, Maryland, and New York, or active or proposed legislation. For example, New York passed a provision mandating all in-state school bus purchases be electric by 2027 and all school buses in operation be electric by 2035, and California introduced a bill – which has been approved by Governor Newsom – requiring all new school bus purchases and contracts be zero-emission vehicles by 2035.

Cost Savings and Evolving Ownership Costs

Finally, the potential for real cost savings is poised to serve as an important tipping point in favor of school bus electrification. While cost remains an impediment to e-bus fleet adoption, the availability of grant funding, particularly EPA funding, is rewriting the script for comparing total costs of ownership (TCO) and bottom-line savings between electric school buses and their diesel counterparts. Generate tracks the evolving ownership costs for electric school buses as part of our proprietary research on this topic. As shown in Figure 2 below, Generate estimates the total lifetime cost of an electric school bus to be approximately $115,000. This estimate is the sum of all the associated costs, including capital expenditures of about $390,000 for the school bus and L2 charger. Generate's model then layers in school districts' opportunities to access funding and reclaim value, including – significantly – $300,000 in EPA grant funding.

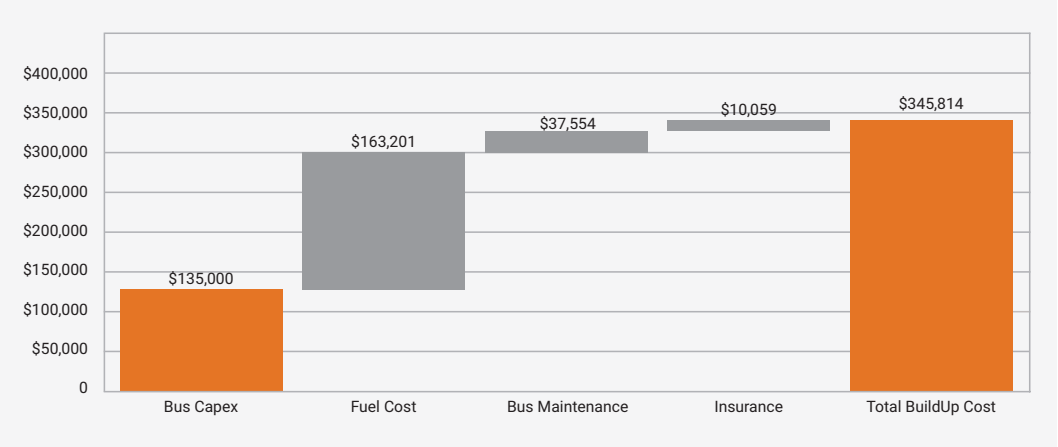
Figure 2: Average Total Cost of Electric School Bus Ownership, June 2024



Source: Generate Capital (These costs account for both current pricing standards and forecasted inflation rates.)

Generate estimates the TCO of diesel buses to be $345,000. As Figure 3 below demonstrates, fuel costs – and the high inflation rates that accompany them – account for a large percentage of this buildup cost. These TCOs imply significant cost savings for school districts that make the transition with the available funding assistance. When accounting for additionalities such as value of health and climate benefits, the costs of e-buses become even more compelling.

Figure 3: Average Total Cost of Diesel Bus Ownership, June 2024



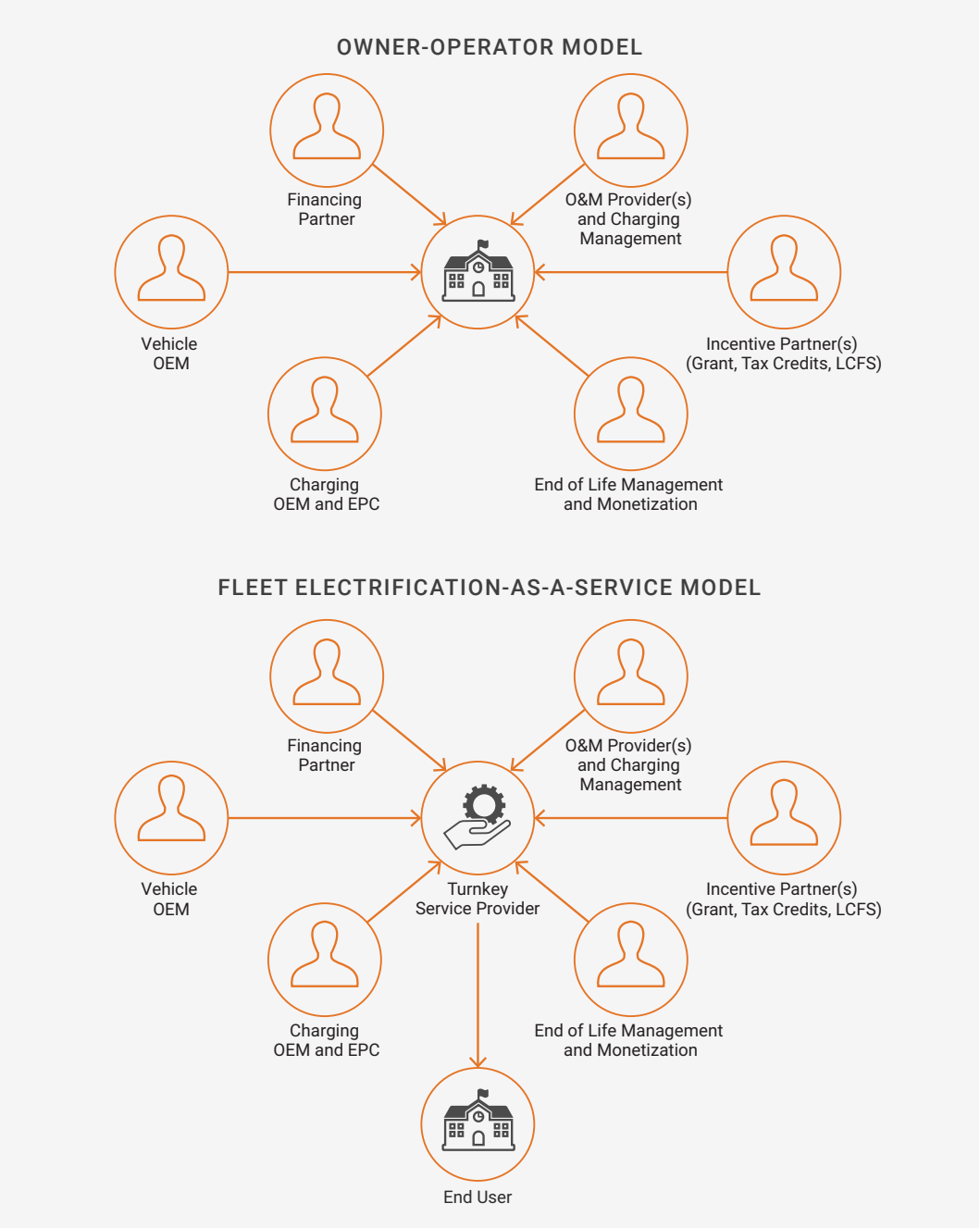
Source: Generate Capital (These costs account for both current pricing standards and forecasted inflation rates.)

These TCO models reveal that electric school buses can already serve as cheaper alternatives to diesel-powered fleets – though this hinges on a school district successfully accessing EPA grant funding – and they also point to the evolving nature of electric school bus ownership costs. While diesel bus costs are expected to remain steady, the price of electric fleets is expected to decrease sharply in the next several years. The current high volume of federal grant funding is intended to serve as a near-term stopgap ahead of the impending, and enduring, market-based approach. The near-term grant funding enables the electric school bus industry to scale. Reaching scale will in turn help drive down costs. In fact, Generate forecasts that by 2030, capital expenditures for electric school buses will decrease and the likely price range of V2G benefits will account for a value similar to the existing 45W tax credit, making electric fleets cost competitive with diesel ones – without government funding – in a few years' time.

The Owner-Operator Model vs Fleet Electrification-As-A-Service

For all these reasons, many school districts are looking to electrify their fleets. But under the prevailing owner-operator model, the process involved is often prohibitive. School districts must work out how to identify and apply for available funding, how to purchase the buses – including paying the upfront costs – how to purchase the chargers, where to install the chargers, how to set a charging schedule, how to handle ongoing operations and maintenance for the fleet and chargers, and more. They are also responsible for fleet optimization – making sure the buses and chargers are not just working, but also saving them money over time.

Figure 4: Comparison of the Owner-Operator and FaaS Models



By contrast, the fleet electrification-as-a-service (FaaS) model is a holistic approach that packages EV adoption, transition, and optimization services. Under the FaaS model, a financing and operating partner helps minimize financial, technology, and personnel burdens from school districts by managing many of the most challenging and resource-intensive components of electric school bus projects – from identifying and applying for grant funding on behalf of school districts, to buying the buses, to managing charging infrastructure permitting, installation, and interconnection, to optimizing smart charging, to helping train and upskill school district employees. In so doing, the FaaS model addresses each of the major barriers to school bus fleet electrification, making it a "one-stop shop" approach.

Along with helping school districts decarbonize, the FaaS model yields a myriad of other benefits and a virtuous cycle in the electrification movement. FaaS business models can help underwrite complex value streams such as low carbon fuel standards (LCFS), V2G, and the residual value of EVs, unlocking higher-return infrastructure investment opportunities that may not typically be available with strong-credit municipality, university, school, and hospital (MUSH) customers. By bundling solutions for school districts at scale through multi-year contracts, the FaaS model enables project-financeable assets that can unlock higher-return infrastructure investment opportunities and thus attract more investor capital to the important project of school bus electrification and increased willingness to pay from fleet customers. In other words, FaaS begets more fleet electrification. These business models can facilitate the widespread adoption of EVs, allow fleet managers to incrementally decarbonize their fleets, and create opportunities to integrate and invest in other complementary offerings like vehicle charging.

Costs: Moving From Capex to Opex

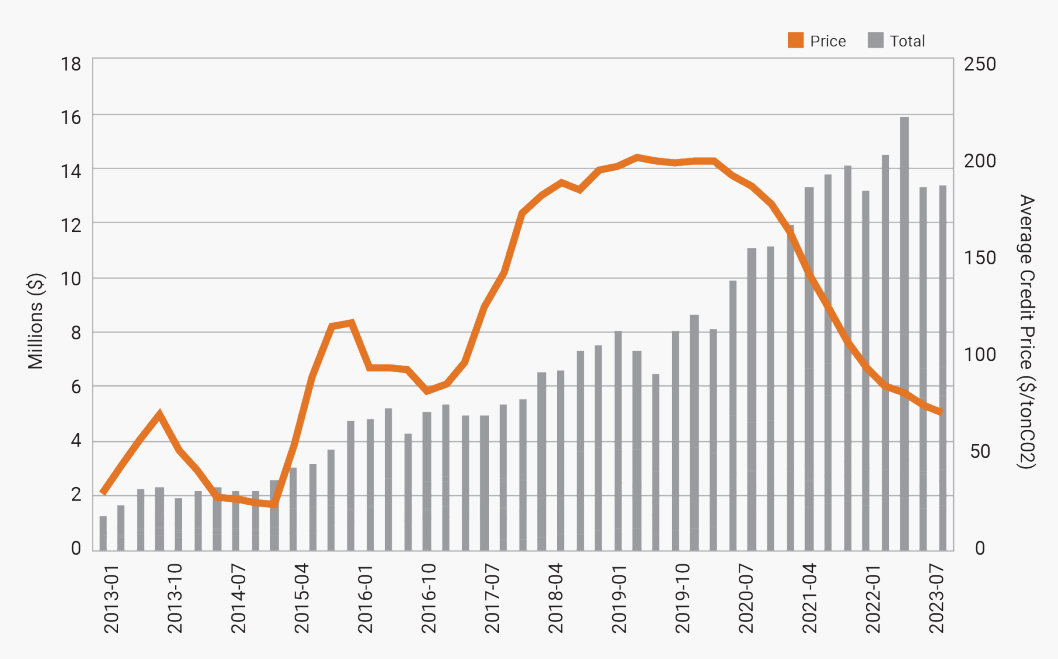
Despite electric school buses being cost competitive with diesel buses over the long term, the associated upfront costs deter many potential adopters. Cost was the top barrier cited by US school districts surveyed by Generate in 2023. An electric school bus costs $375,000 on average, compared to the $135,000 price tags for diesel buses, and L2 chargers average $15,000. While significant funding is available to offset the capital premium, accessing it is dependent on a school district successfully navigating the often arduous process of finding and applying for funds and keeping up with the due diligence involved.

In addition to the federal funding pathways described previously, the US Department of Transportation lists 80 federal programs that can fund EV infrastructure, including $5 billion available through the National Electric Vehicle Infrastructure (NEVI) Formula Program and $2.5 billion via the Discretionary Grant Program for Charging and Fueling Infrastructure.[10] Depending on their location and fleet make-up, additional available resources include California's LCFS credits or V2G revenues – these approaches require a sophisticated financing and underwriting strategy: over the last decade LCFS credits prices have ranged $24/tonCO2 to over $200/tonCO2.

The FaaS model addresses these cost barriers by allowing school districts to convert e-school bus costs from capex to opex while also providing significant support with accessing available funding. Through the FaaS model, electrification and financing partners distribute upfront and ongoing costs into a fixed monthly price, allowing school districts to avoid prohibitively high ticket prices. Once upfront capital is reduced, the costs of electric fleets become more comparable – and even favorable – to their diesel alternatives on a TCO basis today. Crucially, FaaS financing partners also stack the federal, state, and local incentives and funding sources available to school districts, driving down the annual budget outlay costs and making electric fleets a cheaper alternative to diesel buses.

[10] US Department of Transportation, 2024. Federal Funding Programs.

Figure 5: Total CA LCFS Credits by Fuel Type and Price



Source: Orennia

Complexity: From Convoluted to Simple

The difficulty of navigating the elaborate web of funding sources underscores the next major barrier to school bus electrification: complexity. The many intricacies and considerable knowledge base required to execute the fleet transition also pose significant obstacles to school districts. For instance, electrifying bus fleets requires the installation of charging equipment and specialized knowledge of utility interconnection and utility demand charges. In recent years, even the choice of charging equipment has been fraught with risk as momentum in the US swung between an alphabet soup of EV charging standards such as NACS, CCS, and CHAdeMO. After charging equipment is installed, fleet managers must optimize operational efficiency through smart charging – charging during off-peak electricity hours – as well as effectively predict and manage electricity costs, which will depend on a variety of factors such as the school district's size, density, and surrounding climate. The stakes are high for each of these complexities, as any operations and maintenance missteps could result in children not having a ride to school in the morning.

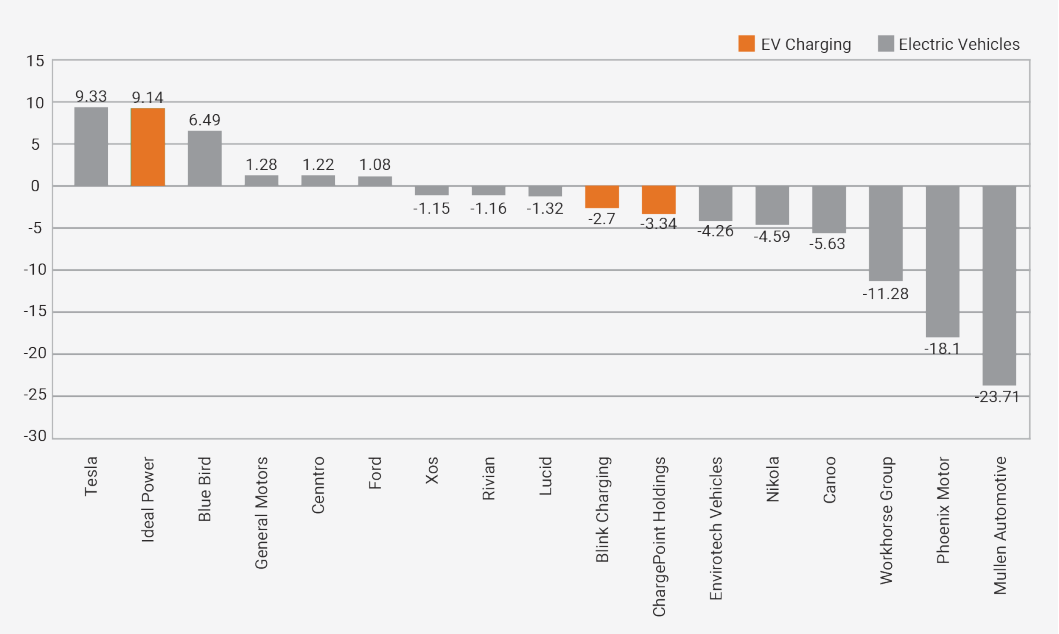
In contrast to the owner-operator model, a core component of the FaaS model is its focus on complexity management. FaaS partners can manage many of the intricacies of fleet transition and optimization on behalf of school districts, including helping school districts design, deliver, and optimize the charging infrastructure solutions needed to connect electric school bus fleets to the electricity grid and enable their smart charging. These services underscore the value of a partner that understands the power market in addition to the mobility market, given the two markets' intricate and interconnected nature.

Uncertainty: From Risky to Managed

The risks associated with fleet electrification pose significant barriers to entry for school districts, as fleet electrification requires navigating the technology, policy, and financial uncertainties associated with emerging markets. In late 2022, the New York State Energy Research and Development Authority (NYSERDA) conducted a survey of 138 school districts that highlighted several anxieties from potential customers.[11] Respondents expressed concern about EV range during extreme cold and across hilly terrain and schools' ability to provide reliable power onsite. Additional technology uncertainties include forecasting and managing batteries' charging capacities over their lifetimes and budgeting for bus repairs and parts replacement. The evolving policy landscape also emerged as a key concern for school districts. EV regulations and incentives continue to be introduced and challenged, making school districts wary of accessing funding.

Compounding school districts' uncertainties and anxieties, the broader EV market has faced considerable volatility. The Altman Z-score is a combination of financial metrics that has been found to correlate with a publicly traded manufacturing company's likelihood of bankruptcy. A score below 1.8 means a company may be headed for bankruptcy, while companies with scores above 3 are on sounder financial footing. As Figure 6 shows, certain segments of the fleet electrification market are not faring well on this framework. While electric school bus manufacturers are shown to be on steady footing – at 6.49, school bus manufacturer Blue Bird is comfortably above the Altman Z-score level – many charging infrastructure providers currently fall well below the threshold deemed economically healthy. For school districts pursuing fleet electrification, these uncertainties can raise questions. For instance, school districts run the risk of owning "stranded assets" if they buy technology from a company that later goes out of business, leaving them without warranties and O&M support.

Figure 6: Altman Z-Scores



Source: Bloomberg. Note: Altman Z-Score calculated on Bloomberg Terminal on June 25 using AZS function. The company selection is based on the BloombergNEF 1H 2024 Electrified Transport Market Outlook main list of equities, filtered for companies that had an estimated primary subsector of either EVs or EV Charging, that were US domiciled and with a market cap of greater than $20M. GM and Ford added for contextual purposes even though EVs make up a smaller share of their total revenue.

[11] NYSERDA, 2023. New York State Electric School Bus Roadmap.

Here again, the FaaS model can alleviate school districts' concerns. Inherent in the FaaS model is the transfer of fleet electrification risks from schools to their financing and operating partners. FaaS partners take on fleet electrification's technology, policy, and financial uncertainties. FaaS partners can also steer schools to stable technology partners with high Altman Z-scores and longstanding safety and reliability records, like Blue Bird. By managing the vehicle and charging infrastructure acquisition processes, optimization processes, and the grant application processes, FaaS partners alleviate the burdens of transition on school administrators and maintenance staff.

Conclusion

School districts eager to transition their fleets to electric school buses must navigate a thicket of financial and operational concerns that fall well outside the usual purview of school administrators and other traditional fleet maintenance operators. Sizable upfront costs, technical and bureaucratic hurdles, and a bevy of market uncertainties all complicate the path forward to a greener, cheaper, and healthier EV bus fleet. Overcoming the triple barriers of cost, complexity, and uncertainty requires business model innovation and adoption. Fortunately, the innovation already exists, and it's becoming widely accessible to school districts. As the stakes for large scale electrification loom ever higher, the FaaS model is simplifying and accelerating the electrification process for essential audiences – public schools and the children and families they serve.