More Funding Is Needed to Stimulate the Adoption of Battery Electric School Buses in the United States and Stabilize the School Bus Industry

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JANUARY 2021

Purpose

This white paper has been prepared to introduce readers to the battery electric school bus market. It also expands on the challenges faced when it comes to jump-starting the electrification of the industry given the current funding climate.

Pages 3–4 are an organized overview of bulleted points that summarize the overall theme of the following six pages worth of detail.

Contents

Overview of Why and How to Jump-start the Electrification of School Bus Fleets

Support for the school bus industry should be a government priority. Here is why:

- The yellow school bus is the largest form of mass transit in America and outnumbers all others by more than two and a half times combined
- The school bus industry provides millions of jobs each year
- More than 26 million students depend on the school bus to get to and from school each day
- School buses provide a convenience to families while saving them time and money
- School buses reduce traffic by keeping more than 17 million cars off the roads each year
- Kids are about 70 times more likely to get to school safely if they take the school bus instead of traveling by car
- School buses maximize the likelihood that school children will arrive at school safely, on time, and ready to learn

Replace all older diesel school buses (model year 19xx—2006):

- There are ~160,000 older diesel school buses currently operating in the United States, manufactured before the EPA diesel emissions standards took effect in 2007
- These buses produce more than 90% more harmful emissions than school buses made today
- Rapidly replacing this aging population of heavily polluting diesel school buses should be a top priority of federal, state, and local governments
    - o Why?
        - Diesel exhaust has been linked to several serious health risks, including increased rates of respiratory illnesses and cancer
        - Older, more polluting school buses can lead to significant health risks for students who typically ride these buses from 30 minutes to two hours a day
        - In addition to affecting the health of the children who ride them, emissions from older school buses are detrimental to the health and environments of whole communities

Replace with zero-emission technology:

- Stricter diesel emission standards set to take effect from 2022 through 2029 in several states will effectively eliminate even the cleanest diesel technologies
- Many states have also set aggressive sales targets for battery electric vehicles (EVs), and some will require 50% of all school buses sold to be electric by 2030

- School bus manufacturers have adapted to these regulations and mandates by adopting battery electric technology and adding it to their suite of products
- Electric school buses are the best option to replace the above-mentioned population of diesel school buses and are undoubtedly the future of school transportation
    - Why?
        - Electric school buses drastically reduce greenhouse gases, have zero tailpipe emissions, and the air quality inside the bus is six times better than a diesel bus
        - Electricity is less expensive than diesel, and prices are more stable over time
        - Electric school buses are quiet, allowing for better communication between drivers and students and reducing noise pollution in neighborhoods
        - Electric school buses are 60% less expensive to operate and maintain, which means schools can invest more in students, teachers, and learning opportunities

Federal funding needed to bridge the gap:

- As an emerging technology, a battery electric school bus in today's market is at least three times more expensive than a diesel bus
- As a result, federal focus and investment are needed to jump-start school bus electrification
- The school bus industry would like to see federal support similar to the focus and funding given to the transit bus industry through the Federal Transit Administration
    - Example: The federal government provided $10M in 2020 for school bus replacements of all fuel types, while providing $130M in 2020 for the acquisition of electric transit buses
- Proposed federal programs like the "Clean School Bus Act" or existing ones like the EPA's "DERA School Bus Rebates" could be scaled up to accomplish this
- Federal investment in school bus electrification would produce a host of benefits by providing much needed funding for school districts, improving public health, and creating new manufacturing jobs
- Increased volumes and production would result in an accelerated reduction of costs, allowing for a price parity between electric and diesel school buses to be reached sooner than expected

Overview closing thoughts:

- When given the facts, strong support for the school bus industry and school bus electrification should be a politically attractive stance, regardless of party affiliation
- The school bus industry is largely funded at state and local levels, while federal funding is virtually nonexistent
- States and schools are facing budget shortfalls that could be alleviated by a federal program allocating significant and recurrent funding for school transportation
- School bus electrification not only yields both environmental and health benefits but is also a shining example of American resilience and innovation

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Thomas Built Buses e-Mobility Team – January 2021

Executive summary — More equitable federal focus and support are needed for the school bus industry vs. other forms of mass transit

The yellow school bus is the largest form of mass transit in America and outnumbers all others by more than two and a half times combined (transit/coach bus, rail, and airline transportation). It is also the safest form of transportation on the road today and a key pillar of our educational system. In fact, more than 500,000 school buses transport more than 26 million kids to and from school each day. That accounts for more than half of all K–12 students in America, and those children are 70 times safer riding on a yellow school bus versus in a car. Additionally, operating school buses across America replaces the equivalent of 17 million cars on daily commutes and maximizes the likelihood children will arrive at school safely, on time, and ready to learn.[i]

Maintaining a highly efficient and robust yellow school bus industry in the United States should be a top priority of federal, state, and local governments. Not only is it the safest and most effective way to transport children to and from school, but also the industry itself provides millions of jobs in America each year. Despite this, school transportation remains mostly funded by state and local governments, while federal support is almost nonexistent. Additionally, there is no standard formula for school transportation funding, and the mechanisms/amounts provided vary greatly from state to state. With funding often stagnant and subject to legislative appropriations, districts have to offset costs by reducing service, delaying upgrades, or other means. In the face of financial challenges, school transportation is often a common and shortsighted target for budget cuts. These cuts negatively affect communities by inevitably yielding greater traffic congestion and poorer air quality. Meaningful federal investment and standardized funding mechanisms/amounts should be established in collaboration with the school bus industry to ensure this critical cog in the wheel of American society remains solvent and is adequately supported as a key component of both education and mass transit in America.[ii]

Federal funding to stimulate school bus electrification is needed

Current registration data reflects there are close to 160,000 pre-2007 diesel school buses still in operation today. To understand how dirty older diesel buses are, consider the various emission standards diesel engines have had to meet in terms of nitrogen oxide (NOx) over the years. In 1984, the standard for NOx was 10.7 grams per horsepower hour. In 1998, it reduced to 4.0, and finally, in 2007, the standard successfully achieved was 0.2. That means diesel engine manufacturers achieved a 98% reduction in NOx emissions in under 25 years. Equally impressive reductions have been made with other pollutants, like particulate matter (PM), but the unavoidable truth is internal combustion engines will always produce harmful emissions. Emission reduction mandates set to take effect from 2024 to 2029 will effectively phase out even the cleanest diesel engines produced today. Many states are also mandating EV sales targets of zero-emission buses to be between 30% and 50% of all bus sales by 2030.[iii]

Recognizing that, ever-adapting school bus manufacturers have updated their product offerings to include zero-emission battery electric school buses. A battery electric school bus in today's market is at least three times more expensive than a diesel bus. The price of battery electric technology will reduce over time but is currently at a level where funding assistance is needed for schools to afford the higher upfront investment costs.

A significant amount of federal investment, focus, and leadership will be required to jump-start school bus electrification. Federal grants to school districts for electric bus purchases and related charging infrastructure would produce a host of benefits by providing much-needed funding to school districts, improving public health, and creating new manufacturing jobs. It would also result in the cost per bus declining substantially as production and volumes scale up, allowing for a price parity between electric and diesel buses to be reached sooner than expected. This could realistically be achieved by scaling up proposed federal programs like the "Clean School Bus Act" or existing ones like the EPA's "DERA School Bus Rebates" to replace, for example, 50,000 pre-2007 diesel school buses, or about 10% of the national fleet.[iv]

Use cases for electric school buses

It's often been stated the yellow school bus is the perfect use case for an electric vehicle. They cover short distances on daily runs and follow set, predictable routes. The duty cycle of a school bus inherently requires frequent stops and extended periods of idling. These route characteristics reduce fuel-efficiency and compound emissions in conventional gasoline or diesel vehicles. Conversely, electric vehicles are most efficient on these routes and can recapture some of the energy they expend through regenerative braking to recharge their batteries and extend their range.

A large number of school buses are off the streets, sitting in a depot for much of the day, giving them plenty of time to recharge their batteries. Other school buses are highly utilized during the day, often dispatched on multiple routes. During school days, they transport children safely to school in the morning and back home in the afternoon. Idle hours in the day create the potential for school buses to become energy storage resources on wheels. Many school buses are idled at the conclusion of each academic year and remain parked during the summer months. Long idle times make electric school buses an attractive candidate for providing vehicle-to-grid (V2G) services, such as storing energy and discharging it back to the grid during peak demand periods or demand response events.

Vehicle-to-grid (V2G) technology is an emerging form of managed charging that enables bidirectional flows of energy between electric vehicles and the grid. Energy stored in a vehicle's battery can be discharged back to the electric grid during peak demand periods or demand response events. This two-way power flow has the potential to transform electric vehicles into virtual power plants that can help regulate frequency and provide an additional source of revenue for EV owners. This technology also allows electric school buses to serve as mobile electricity storage devices and makes their grid services advantageous during emergencies. A fleet of electric school buses with V2G capabilities, for example, could be deployed to critical locations during red flag warnings before transmission lines are powered down, and electric buses could quickly restore power to critical infrastructure in communities that experience blackouts due to fire or storm damage to transmission lines. Given school buses are also mostly available to serve as energy storage assets during the middle of the day and the summer months, they pair well with solar electricity generation.[vi]

In addition to the attractive duty cycle and future V2G capabilities, electric school buses also benefit our most important future citizens, schoolchildren, who will have an emissions-free ride and bus stop in the future.

Electric school bus manufacturers overview

All major school bus manufacturers already have electric vehicles in the market or have announced future plans. Below are overviews of manufacturers who currently offer electric school buses and/or electrified chassis for school bus manufacturers:

Thomas Built Buses, with more than 1,500 employees based in High Point, North Carolina, is a division of Daimler Trucks North America. Its electric school bus uses a chassis supplied by Freightliner Custom Chassis

Corporation and an electric powertrain supplied by Proterra. Thomas Built Buses makes the **Saf-T-Liner® C2 Jouley™** electric school bus.

> **Freightliner Custom Chassis Corporation,** located in Gaffney, South Carolina, is a division of Daimler Trucks North America. Freightliner Custom Chassis Corporation manufactures nearly two-thirds of all diesel walk-in van chassis, more than half Class A diesel motorhome chassis, and more than a quarter of conventional school bus chassis in partnership with Thomas Built Buses.
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> **Proterra** is a dedicated electric transit bus and powertrain producer headquartered in Burlingame, California, with manufacturing in Los Angeles, California, and Greenville, South Carolina. Proterra has sold more than 950 electric transit buses that have accumulated more than 13 million miles of service.

Blue Bird, based in Fort Valley, Georgia, has more than 1,500 employees and partners with Indiana-based Cummins for its electric bus powertrains. It makes electric versions of its Vision, All American, and Micro Bird school buses.

IC Bus, headquartered in Lisle, Illinois, is a wholly owned subsidiary of Navistar International. IC Bus has more than 1,500 employees, and its manufacturing base is in Tulsa, Oklahoma. IC Bus makes the chargE, developed in partnership with Traton Group.

Lion Electric Company, founded in 2011 as Lion Bus (Autobus Lion), is headquartered in Saint-Jérôme, Quebec. Lion primarily produces yellow school buses, specializing in battery electric powertrains.

GreenPower Motor Company, headquartered in Vancouver, British Columbia, with primary manufacturing and fleet operations in Porterville, California, fabricates multiple models of high-floor and low-floor vehicles, including transit buses, school buses, shuttles, and a double-decker. GreenPower employs a clean-sheet design to manufacture all-electric buses that are purpose-built to be battery-powered and zero-emission.

Motiv Power Systems, based in Foster City, California, is the leading provider of all-electric medium-duty chassis for buses and trucks. Motiv builds chassis for Type A electric school buses in partnership with manufacturers like eQVM, Collins, and Trans Tech. Motiv also offers a Type C electric school bus.

Economics

The purchase price of an electric school bus is significantly higher than a diesel school bus. As expected with new technologies, the introduction price will start high and come down over time as the supply chain becomes price competitive and production volume increases. It is unclear if or when parity with a diesel-powered school bus will be reached. Similar to the passenger car industry, which has not reached parity with gas vehicles even after a decade of existence (but is growing close), incentives are required to accelerate the adoption of electric vehicles. Once a vehicle is purchased and in operation, the running and maintenance costs are expected to be significantly lower than its internal combustion engine counterparts. Not only is electricity (as a fuel) less costly per mile, but a significant reduction of moving parts in a battery electric school bus leads to an expectation of lower maintenance and repair costs. Reduced maintenance, repair, and fuel costs over the lifetime of a school bus result in a favorable total cost of ownership (TCO).

Electric school buses also require charging infrastructure at the school or yard of the school bus contractor. The costs for smaller projects charging infrastructure are five digits and quickly go into six-digit figures for medium-sized projects. In many cases, the cost of charging infrastructure has proven to be a barrier when it comes to school bus fleets moving forward to electrify their fleet. Incentives are required to alleviate current cost burdens of purchasing and installing charging infrastructure for electric vehicles.

Infrastructure

As mentioned above, charging infrastructure can be a significant cost to the fleet operator. The grid connection, trenching, construction of the site, switchgear, and chargers themselves can add up to a significant expense. The day-to-day cost of using electricity as a fuel is significantly less expensive than diesel or gasoline, in most cases, and is significantly improved when utility companies offer rate programs structured to support commercial EV charging.

Grid connection and electricity costs can be mitigated only by close collaboration with utilities and their regulatory bodies. Since utilities have heavily regulated rate structures, they can only offer specially crafted programs for school districts and school bus contractors if they are granted the right to do so by their regulatory agency. As an example, some utility programs have offered large rebates on grid connections, transformer upgrades, charger reimbursements, and time-of-use (TOU) rate programs that lower commercial electrical rates. Not all utility companies offer these types of rate structure programs. Collaboration and engagement with multiple stakeholders will help develop and deploy attractive programs that promote deployment of electric school buses.

AC Charging vs. DC Fast Charging – Electric vehicles can be charged (fueled) using two types of chargers: Alternating Current (AC) and Direct Current (DC). When it comes to AC charging electric vehicles, power from the grid is always AC, and batteries only accept DC; hence a converter is built inside the bus. It's called the "onboard charger," though it really is a converter. It converts power from AC to DC and then feeds it into the battery of the bus. This is the most common charging method for electric vehicles today, and most chargers use AC power.

For DC Fast Charging, an AC to DC converter is inside the charger itself. That means it can feed power directly to the battery of the bus and does not need the onboard charger to convert it. DC chargers are bigger, faster, and an exciting breakthrough when it comes to EVs. As a result, they are also more costly than AC chargers. Incentives from both the government and utility providers will need to play a large role in helping schools afford the acquisition and installation of DC chargers and DC charging infrastructure.

The role of incentives

Electrification of the school bus industry does not come without significant investment. In order to reach meaningful adoption levels, these investments have to make sense from a customer point of view. Incentives help in various ways to bridge the gap until EV technology will be economical without the existence of financial support. Incentives will also accelerate the volume ramp-up of battery electric vehicles and ultimately accelerate the timing to price parity vs. the internal combustion engine. There are broadly three categories of incentives that help the adoption of battery electric commercial vehicles:

1. **School Bus Purchase Incentives** – At state and federal levels, there are a few financial incentives available for the purchase of a new electric school bus. Incentive programs have a wide variety of limiting requirements, like only being able to receive funds if the district or contractor has diesel buses older than a certain model year to scrap and replace. While an excellent target, requirements like these can limit the number of fleets eligible for incentive dollars, and operators that have modernized their fleets with newer clean-diesel technology may not have a bus old enough to qualify. The documentation and application requirements for these programs can be paper-intense and discourage fleets from applying. Incentive programs that are simple to apply for and manage are more attractive to fleets.

    - **VW funding** – More electric school bus-specific funding opportunities are needed. A majority of the VW-funded opportunities have been open to multiple vehicle/fuel types and treated like

competition. This makes it difficult to secure specific funding for electric school buses. VW funds have been left up to states to administer, and most have been very slow at spending/investing the funds allotted to them. After three years, an estimated 80% of funds remain unspent.[vii]

- **Federal funding** – In the grand scheme of things, federal funding for school buses is almost nonexistent. Considering school buses are the largest form of mass transit in the U.S. and the safest way to transport children, the lack of federal funding is surprising. School districts are cash-strapped, and cutting funding leads to greater traffic congestion and more dangerous commutes. A recurring federal funding program for school bus replacements to supplement existing state and local funding structures would help alleviate this issue. A good example to follow would be federal funding for transit buses.

2. **Infrastructure Incentives** – Operating electric vehicles requires the installation of new EV chargers and often infrastructure to provide ample power for the fleet. Many school bus depots were built decades ago and lack electrical power feeds to support EV needs. Infrastructure investments are significant and can interrupt the normal business at a depot. A variety of organizations, including utility companies, have programs to support the installation of infrastructure through special programs and financial support. Incentives from and collaborations with utility companies can significantly accelerate the installation projects and therefore put electric school buses into operation.

3. **Operation Incentives** – The owning and operation of charging infrastructure has the potential to generate revenue in states where Low Carbon Fuel Standard credits are available. Electric school buses have substantial power draws on the grid when they are charging at full speed. Utility companies penalize those power draws often through demand charges as part of their regulated rate structure pricing. More favorable rate structure plans from utilities will result in lower operating costs, making EV school buses more attractive for operators.

Expected customer demand

Less than 1% of school buses are currently electric. While many school districts are experimenting with electric buses, most of these are running pilot projects with orders for just a handful. One major exception is in Virginia, where Dominion Energy has committed to the largest electric school bus program to date in cooperation with school districts. Dominion plans to have 50 electric school buses in service in 2021, replace most of Virginia's 1,500 school buses with electric buses by 2025, and electrify 100% of the bus fleet by 2030. The utility will pay the incremental cost of electric buses and install charging infrastructure in exchange for having access to the electricity storage capacity of buses as a grid asset when they are not in use transporting children.

The Dominion electric school bus program in Virginia shows that electric school bus technology is ready to scale. Many electric school bus efforts, however, have stalled in their pilot stages due to a lack of federal assistance. Without congressional support to accelerate progress, it will take far too long to achieve the economic, health, and climate benefits that electric school buses can provide.[viii]

Regulation

On a state and federal level, a number of policies and regulations are being investigated or proposed. The reduction of emissions from mobile sources and higher efficiency of electric motors are the main drivers for policymakers to take action. Close collaboration with manufacturers is necessary, as new regulations are being developed to ensure a safe and feasible transition to electric school buses.

A rushed introduction of mandates and regulations can lead to unwanted negative outcomes:

- **Safety** – School bus manufacturers work diligently to ensure the safety of their products as a top priority. This includes the safety of the batteries, high-voltage components, and proper impact tests. A premature mandate that is not aligned with the available volumes in the market will result in third-party retrofitting of vehicles that are potentially not up to common safety standards.
- **Reliability** – Uptime is a key factor for fleet operators in the transportation industry to run their business effectively. Therefore, the reliability growth (RG) testing of components and entire vehicles is common practice for school bus manufacturers. RG testing requires a high number of test miles and time. Premature mandates would compromise the time that school bus manufacturers are allotted for their reliability testing standards.
- **Service Infrastructure** – Service and Maintenance providers need to be trained and qualified to perform maintenance and repairs on electric vehicles. Proper tools and personal protective equipment required to perform work on high-voltage components is an additional investment by operators. The training and rollout will take time. However, without the proper availability of qualified service centers, electric school buses will not receive needed service and maintenance in time and will be out of operation.

Key takeaways/immediate asks:

1. More federal funds needed for school bus replacements
2. Ongoing federal program(s) for school bus electrification are needed, similar to what we see on the transit side through the Federal Transit Administration (FTA)
3. Federal, state, and local governments need to recognize the importance of the school transportation industry, and it needs to be adequately funded as a result
4. Our citizens understand and build groundswell support for cleaner vehicles that transport schoolchildren in our local communities
5. States need to dedicate a percentage of VW funds to school bus electrification (electric school buses and charging infrastructure)

Conclusion

Battery electric school buses will revolutionize the school transportation industry. The efficient electric powertrain will ensure lower operating costs and zero emissions from the “tailpipe.” Production volumes will be low in the beginning and ramp up as battery prices drop and availability increases. Incentives will help the economics of battery electric transportation. Policymakers should work with schools and manufacturers to align funding programs that make sense and will be effective in replacing the massive population of older, dirty diesel school buses still in operation today. A battery electric school bus for our schoolchildren makes sense and appeals to many.

Overall, there are persuasive public health and climate-related reasons to transition to electric school buses and provide children with healthier, cleaner school transportation. Reductions in maintenance and fuel costs, potential cost offsets from vehicle-to-grid technology, and a variety of possible funding arrangements make the upfront costs a surmountable obstacle. Given the urgency and substantial efforts needed to meet existing climate change and air quality goals and the emergence of viable electric bus technology, scaling federal programs and planning for a broader transition should begin as soon as possible.

Sources

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