# CHARGING FORWARD

## New York's Costly Rush to Electrify School Buses

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A new law requires New York State's school bus fleet be entirely zero-emission by 2035. But the higher price of electric school buses relative to diesel buses, the cost of necessary new infrastructure to support electric buses, and the limited funding available for the transition make it unlikely that the state can achieve full electrification by that deadline.

Replacing all of the state's diesel-fuel school buses with electric buses will cost between $8 and $15.25 billion more than the cost of replacing them with new diesel buses. Of that amount, less than $800 million - less than 10 percent of the transition cost - may be available from a combination of state and federal sources to help school districts and private fleet operators make the transition.

The extra cost of electric buses, their limited range compared to diesel buses, and their more rapid battery depletion in cold weather and hilly terrain will create substantial challenges for local school districts.

Given the state's goal of achieving cleaner school buses, most of the benefits that electric buses would bring can be achieved more cost-effectively by purchasing newer diesel models, retrofitting bus equipment or using alternative fuels.

### INTRODUCTION

In her January 2022 State of the State agenda, New York Governor Kathy Hochul established a goal of making all new school bus


purchases zero-emission vehicles by 2027, with all school buses being zero emission by 2035.[i] The stated purpose was to "improve air quality for New York State's children while also working toward [the state's] Climate Act goals."[ii] The proposal became a statutory mandate in April when it was enacted as part of the state's 2023 budget.

Hochul announced on January 5th, 2022 that the state would provide aid for installing electric bus infrastructure, including the purchase and lease of buses and their charging equipment. Funding for this transition will come from the American Rescue Plan, the Diesel Emissions Reduction Act, the Infrastructure, Investment and Jobs Act, the Inflation Reduction Act, the Volkswagen Clean Air Act Settlement, and the New York Truck Voucher Incentive Program (NYTVIP).[iii] An additional $500 million would be available from New York's proposed Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022, if approved on November 8th. All of these funds are distributed through annual competitive programs, and in certain cases cannot be combined.

With more than 50,000 school buses,[iv] New York has ten percent of the national fleet.[v]

With purchase prices of $150,000 to $275,000 more than diesel buses, plus infrastructure upgrade costs of $10,000 to $30,000 per bus, the upfront cost to electrify New York's entire school bus fleet will be between $8 billion and $15.25 billion more than replacing them all with new diesel buses. At that price even the combined outside funding sources — which add up to less than $800 million — won't go far toward helping New York school districts pay for the switch to zero-emission buses.

## A COSTLY TRANSITION

Currently, 95 percent of the nation's school buses run on diesel.[vi] Only 5,000 out of the estimated 500,000 buses are electric, as of November 2021. Electric school buses have upfront costs more than double that of diesel buses. The electric buses cost around $300,000 to $400,000[vii] with similarly sized diesel buses going for around $125,000 to $150,000.[viii]

The price of electric buses is projected to decrease over time as higher demand promotes innovation and more fully developed supply chains.[ix] But this suggests that the first school districts to acquire electric buses will be at an economic disadvantage, as they will purchase the least-advanced models at the highest prices. School districts would be wise to wait until electric bus technology is more advanced.

The anticipated future lower cost of electric school buses also depends on a projected decline in battery costs and the achievement of efficiencies of scale in component markets and manufacturing.[x] But the CEO of electric vehicle automaker Rivian recently noted that, "all the world's [battery] cell production combined represents well under 10 percent of what we will need in ten years . . . meaning 90 to 95 percent of the battery supply chain does not exist."[xi] Given the increased demand for critical materials for batteries for both electric vehicles and electricity storage, the limited mining of battery minerals worldwide, and China's current domination of refining of these critical materials, the future cost of batteries is highly unpredictable.

An advantage of electric buses is that their maintenance costs may be less than or equal to the lifetime cost of diesel buses. Because electric school buses have fewer moving parts than diesel buses, they are expected to need less maintenance over their operating lives.[xii] Electric buses do not require oil and brake fluid changes, engine tune-ups, spark plugs, drive belts, or fuel filter replacements. In addition, systems such as regenerative braking technology enhance energy efficiency and decrease the wear on brakes and tires, further reducing maintenance costs.

Electric buses are in some cases also cheaper to power than diesel buses. The state of Vermont places charging costs at around $0.14 to $0.22 per mile when vehicles are plugged in at non-peak times.[xiii] One study that assumed diesel fuel costs of $0.36 per mile ($2.50 per gallon in these calculations) yielded projected annual fuel cost savings of around $1,700 to $2,600, for a bus traveling 12,000 miles.[xiv] At the current average price of roughly $5 per gallon, those fuel savings would be as much as $5,000 per year. Of course, this calculation will vary based on the changes in both diesel fuel costs and the costs of the source of electricity, which can be highly variable.

Other factors, however, complicate the lifetime cost calculation. Batteries for electric school buses are more expensive to replace than engines and require more frequent replacement. They are expected to lose 30 percent of their range after 10 years and to need replacement every 12 to 15 years.[xv] Diesel bus engines are typically replaced every 12 to 20 years.[xvi] And while diesel engine costs range from $4,500 to $13,500,[xvii] lithium-ion batteries can run as high as $50,000, if replacement costs are not covered under warranty.[xviii]

Terrain and climate also help determine the operating cost of an electric bus.[xix] Inconsistent vehicle range and variability in cold weather create potential additional expenses and decreased performance.[xx] While lithium-ion batteries hold their charge in the cold and are not damaged by freezing temperatures, less energy can be pulled from the battery, decreasing the range up to 30 percent.[xxi] This could be a problem particularly in New York's North Country.

Heating, ventilation and air conditioning on a bus create more load on the battery, causing driving range to drop, as shown in an Alternative Fuels Data Center study.[xxii] The study used a transit bus rather than a school bus, but both are medium-heavy duty, zero-emission vehicles. Studies carried out by other transit agencies in colder climates found heating and cooling consume as much as 50 percent of total battery power usage.[xxiii]

***Even using the most generous estimates, the federal and state assistance would pay for only around 5,000 electric buses, or about 10 percent of the state's total school bus fleet.***

To power more than 50,000 electric school buses in the state,[xxiv] will require a massive charging and energy storage infrastructure. Existing bus storage facilities will need to be expanded and rehabbed — or new ones will need to be built — to accommodate adequate charging operations. This can be costly and time-consuming, with each electric bus requiring up to $10,000 to $30,000 in additional infrastructure.[xxv]

Infrastructure requirements are substantial and go beyond the bus and charger.[xxvi] It is not only the electrical capacity of the site that matters, but the capacity of the local electric utility. Some municipal utilities may not have the necessary transmission capacity and will need to upgrade. Overall, installing the proper infrastructure can take years.[xxvii]

Electric buses also require four to eight hours to recharge, depending on the bus model and its usage; some fast-charging models may require less than two hours.[xxviii] En route charging — charging somewhere other than at the bus storage facility — is generally more expensive than depot charging.[xxix] Unless school districts are given flat rates for electricity, charging during peak times — or any time between 6 am and 10 pm — incurs extra costs not typically factored into calculations of reduced fuel costs.[xxx] Recharging buses midday - which could be needed to run after-school routes - could add about $3,000 per year in peak demand costs, offsetting much of the annual fuel savings.[xxxi]

Electric grid capacity considerations further complicate the issue of bus charging. Full deployment of electric school buses will greatly hike demand on the grid, with an impact that remains unclear.

Overall, purchasing and operating a single electric school bus for 10 to 12 years costs roughly $506,010[xxxii] — a conservative, low-end, estimate. The lifetime cost of a diesel bus is approximately $324,500,[xxxiii] assuming higher bus price estimates and engine replacement.

The higher costs of electric school buses are projected to be offset by the reduced environmental costs from their use. Unfortunately, there is no standard formula for assessing environmental costs. A Nepalese case study attempted to account for the benefit of reduced environmental damage, by calculating a "lifecycle cost" that considers both the cost paid to purchase and operate buses, and the estimated cost of environmental damage from carbon dioxide ($CO_2$) emissions. It found that the life cycle cost of an electric bus over 10 years was $166,387.25 USD.[xxxiv] The life cycle cost of a diesel bus over a 10-year period was estimated at $159,866.57 USD.[xxxv] That said, when the usage of an electric bus exceeded 10.7 years, then the environmental cost of diesel buses ($6,520.68 USD) made the electric buses cheaper in comparison.[xxxvi]

The calculation for environmental costs in that study focused primarily on the cost of CO2 per ton, which was set at $4 per ton.[xxxvii] Substituting a higher cost of CO2 damage — the U.S. government currently sets it at $51 per ton — yields a greater environmental cost of diesel buses and enhances the comparative value of electric buses. Unfortunately, there is no widespread agreement on how to estimate the social cost of CO2.

Crucially, however, this does not make zero-emission buses any more affordable — or more operationally effective in unfavorable conditions - for school districts. They do not directly capture the value of CO2 emissions reductions, no matter how that value is calculated.

## THE CHALLENGE OF MEETING THE STATE'S 2035 DEADLINE

Funding allocated to pay the considerably higher cost of electric buses is a fraction of what is required to make the state's school bus fleet zero emission by 2035. That makes the timeline a daunting challenge for school districts.

### Funding Challenges

Of the federal funding set aside for clean school buses in the Infrastructure, Investment and Jobs Act, only $2.5 billion of the full $5 billion is to be used solely for electric school buses.[xxxviii] The other $2.5 billion is split between electric buses and other types of clean school buses, including hydrogen fuel-cell buses or buses that utilize clean fuels in diesel engines. These sums are the totals to be allocated nationally over a 5-year period. For each fiscal year from 2022 to 2026, there is only $500 million for clean and zero emission school buses, and $500 million for solely zero emission school buses. Grants are to be awarded on a competitive basis for clean or zero-emission school buses.[xxxix]

The goal of the federal funding is nationwide deployment, and each state would receive about $10 million in funding annually if divided equally among the states. With electric school buses costing at least an estimated $150,000 more than their diesel counterparts, that would help each state purchase about 67 school buses per year. That would allow New York to purchase around 335 buses before 2027, converting less than one percent of the New York fleet. If the state managed to gain a share of funding equal to its proportion of the U.S. population, it could get as much as $30 million per year - or $150 million over five years - enough to buy perhaps 1,000 buses by 2027 (based solely on the premium over diesel bus costs, because schools will eventually have to replace their buses anyway). This equals two percent of the state's needs.

The Inflation Reduction Act sets aside $1 billion over 10 years[xl] to fund heavy-duty electric vehicle replacement – including other vehicles besides school buses – throughout the country. Eligible recipients of funding include states, municipalities, Native American tribes, and nonprofit school transportation associations.[xli] With a diverse and broad group of recipients eligible to receive the annually distributed $100 million, New York will reap nominal benefits from this source of funding for heavy-duty electric vehicles. If the entire amount went to school buses, it would buy about 667 electric school buses nationwide. If New York got a population-proportionate share, it would get $60 million over the next decade, enough to purchase up to 400 buses.

Other federal funding comes from the Volkswagen Clean Air Act Settlement, which stems from VW's sale of diesel motor vehicles with "defeat devices,"[xlii] (computer software designed to cheat on federal emissions tests).[xliii] The settlement required Volkswagen to fund a $2.7 billion mitigation trust fund, with an additional $225 million added to the fund after a supplementary settlement.[xliv] Out of the $48.3 million in funding set aside for New York, approximately $6 million is dedicated to electric school buses,[xlv] enough to purchase around 40 buses.

Through the Diesel Emissions Reduction Act (DERA) the EPA offers rebates in addition to grants to reduce harmful emissions from older, dirtier diesel vehicles.[xlvi] In addition to electric buses, DERA funds retrofits for buses using alternative fuels such as propane, natural gas, clean diesel, or gasoline. Since the DERA program was started in 2012, there have been 2,000 bus replacements, or about 200 per year, or an average of four per state annually. Assuming that New York received rebates for four electric buses per year until 2035, that would come to approximately $15.6 million.

The EPA also offers separate rebates for electric school bus replacements through the American Rescue Plan of 2021 (ARP). $7 million is set aside for eligible school districts to replace their current fleet with electric school buses, with a $300,000 rebate per bus. This allotment of funding will cover around 23 buses nationwide.[xlvii] As that would cover potentially the full amount of an electric bus, it would free up the school's normal bus funding to purchase other buses, so roughly speaking it might double the number of buses schools can afford. At 46 buses nationwide, this is still less than one bus per state. New York's population proportionate share is $420,000, or less than three buses.

While schools and other bus fleet operators can apply to both the DERA and ARP programs, they cannot combine the funds towards one bus purchase. Each pot of money must be applied to a different bus purchase.[xlviii]

Finally, $500 million is set aside in New York's Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022 (EBA) for the costs associated with purchasing and converting to a zero-emission bus fleet.[xlix] That half-billion will become available if the bond referendum is approved by voters on November 8, 2022. A few guidelines in the EBA describe how these funds are to be allocated throughout the state. These include ensuring that 40 percent of the funds in the EBA be used to benefit disadvantaged communities and that such communities receive at least 35 percent of the benefits of the funds. Considering again just the premium over diesel buses, these funds would purchase up to 3,333 electric buses.

Table 1 compiles these estimated numbers and shows how limited the funding is, with the rest falling on fleet operators (school districts and private transit firms, who will necessarily pass the costs on to school districts).

In sum, even using the most generous estimates, the federal and state assistance sources outlined above would pay for only around 5,000 electric buses, or about 10 percent of the state's total school bus fleet. The rest of the cost will fall on school districts, either directly (for those that operate their own bus fleets) or indirectly (for those who contract with private school bus operators).

Issues with the flexibility of funding are a concern. For instance, funding from the New York Truck Voucher Incentive Program (NY-TVIP) cannot be combined with funds from the US EPA's Diesel Emissions Reduction Act

School Bus Rebate Program or from the New York State Energy Research and Development Authority (NYSERDA) Clean Green School funding.[l] NYSERDA's Clean Green Schools Initiative is broadly used for projects revolving around clean heating or cooling and capital projects which move toward decarbonization. NYTVIP funding also cannot be used for more than five buses within a given school district, and no more than 20 buses within New York City.[li] No more than two school buses will be funded for a given private school, and no more than 12 school buses will be funded for a single contractor that is upstate-based and under exclusive contract with four school districts. Any electric school bus replacement must be within 0.5 miles of a disadvantaged community.[lii]

***Issues Stemming from Current Production Levels***

Securing the funds to purchase electric buses is just one step in the process school districts must go through to meet the 2035 mandate. The acquisition process poses further challenges. "Committing" is an umbrella term that summarizes the four key steps in acquiring an electric school bus: awarding of funding; ordering; delivery; and operation.[liii] The World Resource Institute (WRI) notes that school districts and fleet operators across the U.S. have committed to 12,275 school buses, but only five percent of these buses are currently delivered or operational.[liv] According to the WRI, once funds have been awarded, it takes up to another 16 months for an electric school bus to be delivered.

**Table 1: Electric Bus Transition Funding**

| **Total Transition Cost** | **$8 — 15.25 billion** |
|---|---|
| American Rescue Plan | ($420 thousand) |
| Diesel Emissions Reduction Act | ($15.6 million) |
| Investment, Infrastructure and Jobs Act | ($150 million) |
| Inflation Reduction Act | ($60 million) |
| Volkswagen Clean Air Act Settlement | ($6 million) |
| New York Truck Voucher Incentive Program | ($58.3 million) |
| Clean Water, Clean Air and Green Jobs Environmental Bond Act of 2022 | ($500 million) |
| **Remaining Cost for Fleet Operators** | **$7.2 — 14.46 billion** |

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Production levels will have to increase substantially to meet demand not only from New York but from California — the leader in school bus electrification — and other states that are moving in the same direction. But the supply chain constraints referenced above may limit how rapidly manufacturers can ramp up production.

### IMPACT ON SCHOOL ACTIVITIES, EDUCATIONAL EXPERIENCE AND STUDENT HEALTH

Further complications are evident when listening to education leaders and school officials. These individuals warn that the implementation of this plan will be both financially and logistically challenging.[lv] Districts will have to install charging stations, overhaul electrical infrastructure and reconfigure bus routes to support new electric fleets.[lvi] The Association of School Business Officials is lobbying for more funding and more flexibility in the mandate.[lvii]

Because of schools' budget constraints, increasing the amount spent on transportation could also harm academic achievement. Schools may have less to spend on teachers and academic programming.[lviii]

School districts would also have to plan field trips and extracurricular activities around bus range and the availability of charging stations, which is not the case when using diesel buses.[lix] Limited range will be a problem particularly for schools located in rural districts, potentially putting some field trips out of reach, thus limiting students' educational opportunities.

Electric buses are tied to lower levels of asthma and pneumonia, particularly in elementary-aged children as they are exposed to lower levels of nitrogen oxide emissions and particulate matter than from buses using diesel fuel.[lx]

However, the main method of reducing negative health effects stemming from diesel school buses is to replace older models with newer buses that have emission controls and idle reduction technologies.[lxi] The buses that are identified as being most imperative to replace are those built between 1998 and 2010.[lxii] The EPA also recommends the use of cleaner fuels such as biodiesel or compressed natural gas which work to reduce emissions from school buses.[lxiii] Cleaner biodiesel fuel is quickly becoming more readily available.

While electric school buses are cleaner than modern diesel bus retrofits, the cost of retrofitting a bus is much lower than replacing that vehicle with an electric model, and both retrofitting and shifting to cleaner fuels can be done in a shorter timeframe.

Moreover, funding for retrofitting buses already exists through the federal Diesel Emissions Reduction Act (DERA) and through the Congestion Mitigation and Air Quality Improvement Program (CMAQ).[lxiv]

These more cost-effective shifts bring positive changes in student health and academic performance, as shown by a study from the state of Georgia. The installation of emission reduction retrofit devices, reduction of bus idling, and increased use of ultra-low sulfur diesel were used together to produce noticeable benefits. These benefits included significant positive effects on students' aerobic capacity, respiratory health, and English test scores.[lxv]

In Georgia, the total amount spent on engine retrofits was $12.6 million at an average cost of roughly $8,110 per bus.[lxvi] Retrofitting 10 percent of the bus fleet cost the average district around $90,000, while replacing 10 percent of a fleet with new diesel or hybrid buses would cost anywhere from $1.4 million to $4 million.[lxvii]

Assuming all 50,000 New York school buses were retrofitted (although many, of course, will be replaced as they wear out), they could be upgraded for under $500 million — the amount set aside in the Environmental Bond Act — rather than the billions required for electrification.

## RECOMMENDATIONS

### *Allow for newer or retrofitted diesel buses*

Newer diesel buses burn more cleanly and produce less particulate matter than older diesel buses. Significant improvements in student health can be achieved at much lower cost through this approach. And as fleet operators find their buses coming to the end of their operational lives, they can be expected, and if necessary required, to buy the cleanest diesel buses available.

Funding in New York State specifically allocated for electric school buses should be used alternatively for retrofitting. There is $6 million dedicated to funding electric school buses in New York State alone through NY-TVIP and $500 million available if the Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022 passes. When using figures from a study of Georgia's retrofits, there is enough funding for over 60,000 retrofits in the state. That is more than enough funding to retrofit every bus in the state with additional funds left over.

### *Consider the use of renewable hydrocarbon biofuels*[lxviii]

Biofuels are produced from biomass sources through a variety of biological, thermal, and chemical processes. These fuels are chemically identical to petroleum gasoline, diesel or jet fuels. They also meet the same ASTM International fuel quality standards as the petroleum fuels that they replace, meaning that they can be used in existing engines and infrastructure. While production is limited currently to a capacity of over 590 million gallons per year, it is expected to rise soon to 2 billion gallons.[lxix] Commercial facilities are increasingly focused on renewable diesel production, and these production plants may stand alone or be co-located at petroleum refineries. Flexibility to consider other technologies could also allow for hydrogen fuel cells to be implemented into existing compressed natural gas fleets

### *Push for funding to be diverted to the DERA and CMAQ*

Funding set aside for electric bus initiatives will have a minuscule effect on the state's air quality and reduction in fossil fuel emissions. But if the $500 million of funding distributed annually from the $2.5 billion set aside for electric school buses in the Infrastructure, Investment and Jobs Act were to be diverted to DERA ($46 million)[lxx] and Congestion Mitigation and Air Quality Improvement Program (CMAQ) ($11.2 million)[lxxi] the effect of the programs would greatly increase. Combined, these programs have retrofitted only 2,072 buses since 2009.[lxxii] With proper placement of funding, these programs could be highly effective in reducing negative environmental and health impacts of school buses in the United States without imposing unneeded and unfunded mandates on school districts.

### *Extend the Deadline*

If the zero-emission bus mandate is kept in place, the deadline should be extended so that no fleet operator has to replace their current buses before the end of their normal operational life. Because diesel buses last up to 20 years, any recently purchased buses will have to be replaced prematurely, imposing extra costs on fleet operators, including school districts. And the later in time zero-emission buses can be purchased, the more affordable they are likely to be.

**CONCLUSION**

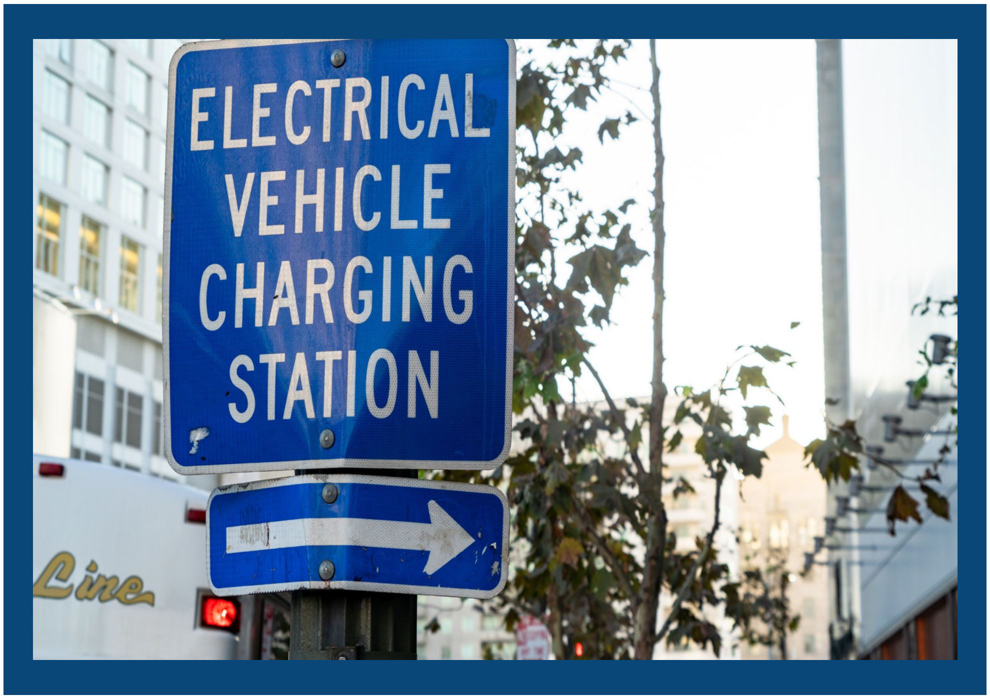
Electric school buses are substantially more expensive to purchase than diesel school buses. Although they are cheaper to maintain, the upfront costs pose a barrier to school districts trying to comply with the state mandate. Future lower prices for electric school buses depend on uncertain projections of lower battery costs.

Electric buses themselves are problematic as their range is substantially shorter than their fuel-using counterparts, and they experience shorter ranges from heating and cooling the vehicles. Local terrain and weather also negatively impact battery range. The batteries on electric buses deplete over time, and they are considerably more expensive to replace than typical diesel engines.

Charging during peak times of the day may increase the cost of charging and decrease estimated fuel savings if school districts are not awarded flat rates for electricity. Additionally, the capacity of the electric grid to handle the surge in demand from full school bus fleet electrification is unclear.

The substantial delay between the awarding of funding, the ordering of the vehicles, and their actual delivery complicates the goal of achieving a zero-emission school bus fleet by 2035. Funding itself is a major concern as the federal and state aid sources identified to date fall well short of the cost of replacing 50,000 school buses in 13 years. Even the federal and state funding sources that are available carry restrictions that limit their likely utility to school districts.

The estimated net cost of replacing the state's entire school bus fleet with electric battery buses is $8 to $15.25 billion, 16 to 30 times the $500 million cost of retrofitting the current



fleet. Even with generous funding and conservative cost estimates, each electric school bus will cost $150,000 to $275,000 more than a diesel bus, with an additional $10,000 to $30,000 in infrastructure costs per bus.

Ultimately, there are more cost-effective solutions to making New York's school bus fleet more environmentally friendly, such as using biofuels or diverting funding to historically successful and established programs.

Of course, some school districts are choosing on their own to transition to electric buses, and this discussion is no critique of that. Allowing each district to make its own decisions on the relative costs and benefits is the most appropriate public policy model to follow, as local school officials are electorally accountable to their constituents.

But while electric school buses can improve the health of students, the negative health impacts of diesel buses are more cost-effectively mitigated by purchasing newer models or retrofitting older buses with more advanced technology.

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## ENDNOTES

[i] Hochul, Kathy. 2022. "New York State of the State: A New Era for New York." https://www.governor.ny.gov/sites/default/files/2022-01/2022StateoftheStateBook.pdf.
[ii] Ibid.
[iii] De La Garza, Alejandro. 2021. "US School Buses May Never be the Same Thanks to Biden's Infrastructure Plan." Time Magazine. November 15. https://time.com/6117544/electric-school-buses/.
[iv] New York State Department of Motor Vehicles. n.d. "School Bus Safety." https://dmv.ny.gov/more-info/school-bus-safety.
[v] Lewis, Michelle. 2020. "New York's Vehicle-to-Grid E-School Bus Pilot Program is a Success." Electrek, December 14. https://electrek.co/2020/12/14/new-york-vehicle-to-grid-school-bus-pilot-program-success/.
[vi] De La Garza, Alejandro. 2021. "US School Buses May Never be the Same Thanks to Biden's Infrastructure Plan." Time Magazine. November 15. https://time.com/6117544/electric-school-buses/.
[vii] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[viii] Wachunas, Joseph. 2022. "The Big Deal About NYC's First Electric School Buses Being Diesel Repowers." School Transportation News. January 7. https://stnonline.com/blogs/the-big-deal-about-nycs-first-electric-school-buses-being-diesel-repowers/.
[ix] Rijal, Sushil, Sabin Paudyal, and Sudeep Thapa. 2019. "Life Cycle Costing Comparison of Diesel Bus vs Electric Bus in the Context of Nepal." KEC Conference. http://kec.edu.np/wp-content/uploads/2020/01/Paper_5.pdf#:~:text=The%20life%20cycle%20cost%20of%20Diesel%20Bus%20is,have%20lower%20lifetime%20cost%20by%20NPR%200.4%20million.
[x] World Resources Insitute. 2022. "The Real Cost of Electric School Buses (Is Lower Than You Think)." CleanTechnica. February 2. https://cleantechnica.com/2022/02/02/the-real-cost-of-electric-school-buses-is-lower-than-you-think/.
[xi] McClain, Sean, and Scott Patterson. 2022. "Rivian CEO Warns of Looming Electric-Vehicle Battery Shortage." The Wall Street Journal. April 18. https://www.wsj.com/articles/rivian-ceo-warns-of-looming-electric-vehicle-battery-shortage-11650276000.
[xii] eTransEnergy. n.d. "Electric School Bus Fleet." https://www.etransenergy.com/thought-leadership/electric-school-bus-fleet#:~:text=For%20school%20districts%2C%20electrification%20means%20their%20fleet%20will,and%20decreases%20the%20wear%20on%20brakes%20and%20tires.
[xiii] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[xiv] Ibid.
[xv] Ibid.
[xvi] School Transportation News. 2019. "Choosing School Bus Engines to Reduce Budget & Maintenance Headaches." February 1. https://stnonline.com/partner-updates/choosing-school-bus-engines-to-reduce-budget-maintenance-headaches/.
[xvii] Knight, Elaine. 2021. "How Much Does a Bus Engine Cost?" Justdownsize, December 6. https://justdownsize.com/how-much-does-a-bus-engine-cost/.
[xviii] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[xix] Matthews, Kevin. n.d. "Total Cost of Ownership: Determining if Electric Buses are Right for Your District." FirstStudent. https://firststudentinc.com/resources/articles/total-cost-of-ownership-determining-if-electric-buses-are-right-for-your-district/.
[xx] New York State Energy Research and Development Authority, New York Public Transportation Authority, and New York State Department of Transportation. 2022. "Deploying Battery Electric Buses at Scale: A Toolkit for New York." June 14. https://perkinswillinc.sharepoint.com/sites/msteams_387c65/Shared%20Documents/General/Electrification%20Toolkit/NYSERDA-BEBToolkit-TABLOID%2020220531.pdf.
[xxi] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[xxii] United States Department of Energy Alternative

Fuels Data Center. n.d. "Flipping the Switch on Electric School Buses: Vehicle Requirements: Module 2 (Text Version)." https://afdc.energy.gov/vehicles/electric_school_buses_p3_m2.html.
[xxiii] Ibid.
[xxiv] Lewis, Michelle. 2020. "New York's Vehicle-to-Grid E-School Bus Pilot Program is a Success." Electrek. December 14. https://electrek.co/2020/12/14/new-york-vehicle-to-grid-school-bus-pilot-program-success/.
[xxv] Ibid.
[xxvi] Matthews, Kevin. n.d. "Total Cost of Ownership: Determining if Electric Buses are Right for Your District." FirstStudent. https://firststudentinc.com/resources/articles/total-cost-of-ownership-determining-if-electric-buses-are-right-for-your-district/.
[xxvii] Ibid.
[xxviii] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[xxix] New York State Energy Research and Development Authority, New York Public Transportation Authority, and New York State Department of Transportation. 2022. "Deploying Battery Electric Buses at Scale: A Toolkit for New York." June 14. https://perkinswillinc.sharepoint.com/sites/msteams_387c65/Shared%20Documents/General/Electrification%20Toolkit/NYSERDA-BEBToolkit-TABLOID%2020220531.pdf.
[xxx] Vermont Department of Environmental Conservation. 2019. "Electric School Bus and Transit Pilot Program." August 12. https://dec.vermont.gov/sites/dec/files/aqc/mobile-sources/documents/eBus_Pilot_FAQ_20190812.pdf.
[xxxi] Ibid.
[xxxii] School Transportation News. 2019. "Choosing School Bus Engines to Reduce Budget & Maintenance Headaches." February 1. https://stnonline.com/partner-updates/choosing-school-bus-engines-to-reduce-budget-maintenance-headaches/; United States Department of Energy Alternative Fuels Data Center. n.d. "Vehicle Cost Calculator." )https://afdc.energy.gov/calc/.
[xxxiii] New York State Energy Research and Development Authority. n.d. "NYTVIP Eligible Vehicle List." https://www.nyserda.ny.gov/All-Programs/Truck-Voucher-Program/How-the-Program-Works/Eligible-Vehicles; Thomas Built Buses. 2019. "The Definitive Guide to Saving Money on Fuel Costs for Your Fleet, April 23. https://thomasbuiltbuses.com/resources/articles/determining-fuel-costs/.
[xxxiv] Rijal, Sushil, Sabin Paudyal, and Sudeep Thapa. 2019. "Life Cycle Costing Comparison of Diesel Bus vs Electric Bus in the Context of Nepal." KEC Conference. http://kec.edu.np/wp-content/uploads/2020/01/Paper_5.pdf#:~:text=The%20life%20cycle%20cost%20of%20Diesel%20Bus%20is,have%20lower%20lifetime%20cost%20by%20NPR%200.4%20million.
[xxxv] Ibid.
[xxxvi] Ibid.
[xxxvii] Ibid.
[xxxviii] United States Congress. 2021. "H.R.3684 - Infrastructure Investment and Jobs Act of 2021." https://www.congress.gov/bill/117th-congress/house-bill/3684/text.
[xxxix] Ibid.
[xl] United States Congress. 2022. "H.R.5376 - Inflation Reduction Act of 2022." p. 659-660. https://www.congress.gov/bill/117th-congress/house-bill/5376/text.
[xli] Id. at 662.
[xlii] United States Environmental Protection Agency. 2022. "Volkswagen Clean Air Act Civil Settlement." August 31. https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement
[xliii] United States Congress. 2022. "H.R.5376 - Inflation Reduction Act of 2022." https://www.congress.gov/bill/117th-congress/house-bill/5376/text.
[xliv] Ibid.
[xlv] New York State Energy Research and Development Authority. 2022. "New York Truck Voucher Incentive Program Implementation Manual." April 11. https://portal.nyserda.ny.gov/servlet/servlet.FileDownload?file=00P8z000000nuMvEAI.
[xlvi] United States Environmental Protection Agency. 2021. "DERA and ARP School Bus Rebates Webinar" October 6. https://www.epa.gov/system/files/documents/2021-10/2021-arp-dera-rebates-webinar-2021-10-06_0.pdf.
[xlvii] Ibid.
[xlviii] Ibid.
[xlix] New York State Senate. 2022. "Implementation of the Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022." April 22. https://www.nysenate.gov/legislation/laws/ENV/A58.

[l] Ibid.
[li] Ibid.
[lii] Ibid.
[liii] Freehafer, Lydia, and Leah Lazer. 2021. "The State of Electric School Bus Adoption in the US", September 10. World Resources Insitute. https://www.wri.org/insights/where-electric-school-buses-us.
[liv] Lewis, Michelle Lewis. 2022. "Here's Where US Electric School Bus Adoption Currently Stands." Electrek. June 22. https://electrek.co/2022/06/22/us-electric-school-bus-adoption/.
[lv] Silberstein, Rachel. 2022. "New York Schools Have Five Years to Begin Electric Bus Conversion."Times Union.April 13. https://www.timesunion.com/news/article/New-York-schools-have-five-years-to-begin-17072485.php.
[lvi] Ibid.
[lvii] Ibid.
[lviii] Ibid.
[lix] School Transportation News. 2019. "Choosing School Bus Engines to Reduce Budget & Maintenance Headaches." February 1. https://stnonline.com/partner-updates/choosing-school-bus-engines-to-reduce-budget-maintenance-headaches/.
[lx] Austin, Wes, Garth Heutel, and Daniel Kreisman. 2019. "School Bus Emissions, Student Health, and Academic Performance." Economics of Education Review 70:109-126. https://doi.org/10.1016/j.econedurev.2019.03.002.
[lxi] United States Environmental Protection Agency. 2022. "Making School Buses Cleaner." August 29. https://www.epa.gov/dera/making-school-buses-cleaner.
[lxii] Ibid.
[lxiii] Ibid.
[lxiv] Austin, Wes, Garth Heutel, and Daniel Kreisman. 2019. "School Bus Emissions, Student Health, and Academic Performance." Economics of Education Review 70:109-126. https://doi.org/10.1016/j.econedurev.2019.03.002.
[lxv] Ibid.
[lxvi] Ibid.
[lxvii] Ibid.
[lxviii] United States Department of Energy Alternative Fuels Data Center. n.d. "Renewable Hydrocarbon Biofuels." https://afdc.energy.gov/fuels/emerging_hydrocarbon.html
[lxix] Ibid.
[lxx] United States Environmental Protection Agency. 2022. "National Grants: Diesel Emissions Reduction Act (DERA)." April 25. https://www.epa.gov/dera/national.
[lxxi] Austin, Wes, Garth Heutel, and Daniel Kreisman. 2019. "School Bus Emissions, Student Health, and Academic Performance." Economics of Education Review 70:109-126. https://doi.org/10.1016/j.econedurev.2019.03.002.
[lxxii] Ibid.

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