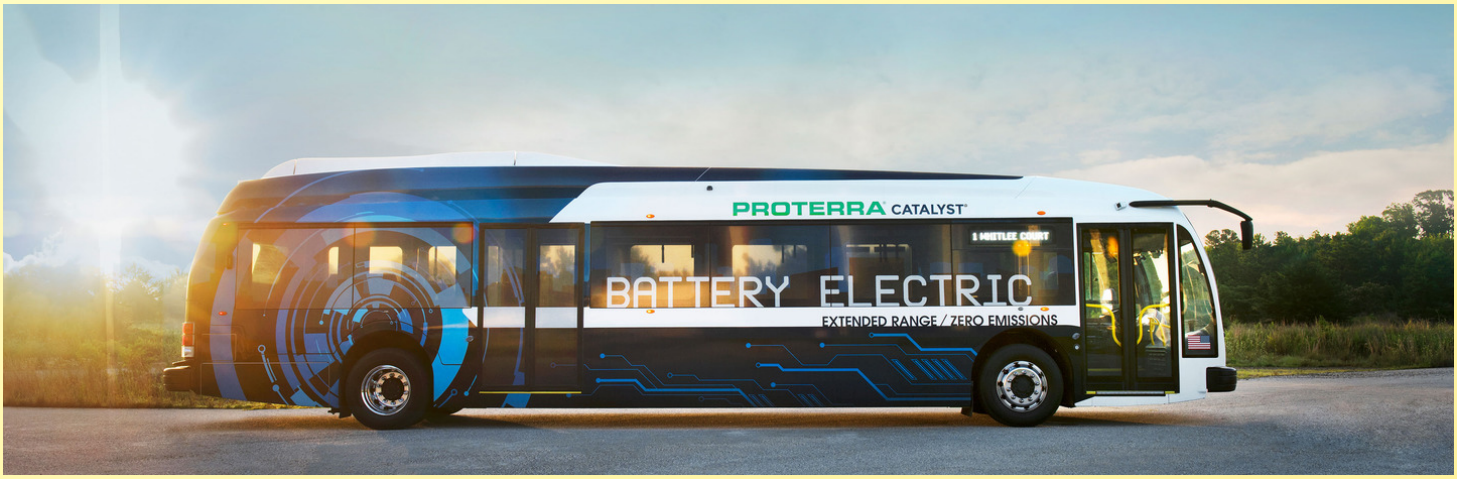


Paying for Electric Buses

Financing Tools for Cities and Agencies to Ditch Diesel

U.S. PIRG Education Fund

ELECTRIC BUSES HEALTHY KIDS

ENVIRONMENT AMERICA RESEARCH & POLICY CENTER

Paying for Electric Buses

Financing Tools for Cities and Agencies to Ditch Diesel

Matt Casale and Brendan Mahoney

U.S. PIRG Education Fund

Fall 2018

Acknowledgements

The authors wish to thank Morgan Ellis, Associate Director Clean Transportation for All Campaign, Sierra Club; John Clements, Former Transportation Director, Kings Canyon Unified School District; Sandy Pooler, Tim Shannon, Director of Transportation, Twin Rivers Unified School District; and Alana Miller, Tony Dutzik, and Elizabeth Ridlington, Frontier Group, for their review of drafts of this document, as well as their insights and suggestions.

The authors bear responsibility for any factual errors. Policy recommendations are those of U.S. PIRG Education Fund. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

With public debate around important issues often dominated by special interests pursuing their own narrow agendas, U.S. PIRG Education Fund offers an independent voice that works on behalf of the public interest. U.S. PIRG Education Fund, a 501(c)(3) organization, works to protect consumers and promote good government. We investigate problems, craft solutions, educate the public, and offer meaningful opportunities for civic participation. For more information about U.S. PIRG Education Fund or for additional copies of this report, please visit www.uspirgedfund.org.

Cover Photos: Transit Bus: 40’ Catalyst Bus, Proterra; School Bus Charging, MotivPower; Watch for Children: Airman First Class Kathleen D. Bryant.

Table of Contents

Executive Summary

Most of America's school and transit buses run on diesel, a highly-polluting fuel, but there is a better option. All-electric buses are here, and they're cleaner, healthier and save money for transit agencies, school districts and bus contractors to run in the long-term.

Diesel is internationally recognized as a dangerous carcinogen, and diesel exhaust contributes to several respiratory illnesses, including asthma.[1] Children are particularly susceptible to the negative health effects of diesel exhaust because their lungs are still developing. Transportation is also the largest source of greenhouse gas emissions in the country, with heavy-duty vehicles including buses playing a major role in the problem.[2]

Yet every day, our citizens, including commuters and school children, are forced to breath these toxic fumes. **Switching to electric buses with zero tailpipe emissions significantly reduces exposure to the localized pollutants. Electric buses are also much cleaner than their diesel or natural gas counterparts**. Replacing all of America's dirty diesel buses, both transit and school buses, with clean electric buses would avoid an average of 7.3 million tons of greenhouse gas emissions annually.[3]

In addition to the public health and environmental benefits, school districts and transit agencies also see cost savings due to the reduced fuel and maintenance costs of electric buses. While electric transit buses costs around $200,000 more than diesel buses, **lifetime fuel and maintenance savings of electric transit buses are around $400,000.**[4] And while electric school buses cost around $120,000 more than diesel school buses, **lifetime fuel and maintenance savings of electric school buses are around $170,000.**[5]

Electric buses are available and able to handle many bus routes in the United States. In 2017, 568 electric transit buses were on the road in the U.S., servicing some of the largest public transit agencies in the country.[6] That number continues to grow. Electric school buses are available as well. California's fleet has grown to over 150 and electric school buses are on the road in Massachusetts, New York, and Minnesota.[7] Several of the major school bus manufacturers already have electric bus models ready, and others have announced models that will be available in 2019.[8]

To clean our air and protect our health, cities, transit agencies and school districts should commit to transitioning to 100% all electric buses by 2030, and immediately begin to implement a plan to phase out the purchase of new diesel buses. As more and more places make these commitments, the electric bus market will only continue to grow and become more competitive. The technology will continue to advance, and prices will continue to come down.

Still, the upfront purchase price of electric buses is often cited as a hurdle to a swift transition. Although electric buses can save money over their lifetime, they currently cost more to buy than diesel buses do. **However, a review of available financing and funding choices reveals that American cities and school districts have a plethora options to make the transition to electric buses feasible.**

Transit agencies and school districts may be able to use traditional funding and financing mechanisms to pay for electric buses, such as **municipal bonds** and **local option transportation taxes**. **Municipal bonds** can used by municipalities, transit agencies, or school districts to pay for large capital transit and school projects.

Agencies and school districts can also use **vehicle-to-grid technology** to offset the costs of electric buses. This is particularly valuable for school buses. When equipped with vehicle-to-grid technology, electric buses can use their batteries for energy storage, providing a service to the grid by reserving and selling electricity back at times of high demand.

Additionally, bus operators can seek out the multitude of grant and incentive programs available for the purchase of electric buses, as well as partner with utilities for beneficial rate programs or infrastructure investments. For instance: In Massachusetts, Pioneer Valley Transit Authority and Martha's Vineyard Transit Authority are both using Volkswagen settlement funds to purchase electric buses. Twin Rivers Unified School District in California secured a $1 million investment in charging infrastructure from the local utility. Chicago, through the federally funded Drive Clean Chicago program, has made $10 million available for the purchase of electric buses and trucks.

It is time for both transit agencies and school districts to make the switch to electric buses. Electric buses are better for our health, for our planet, and they provide operators with year to year and lifetime financial benefits. Transit agencies and school districts that want to make the switch to electric buses have a plethora of options to help overcome the initial purchase price, it is time that they use them.

To accelerate the adoption of electric buses, we recommend that:

- Cities, transit agencies, and school districts **commit to transitioning to 100% all-electric buses by 2030**, with a plan to phase out the purchase of new diesel buses immediately.
- Cities, transit agencies, and school districts use traditional financing methods like **municipal bonds** and **local option transportation taxes** to finance the purchase of new electric buses.
- Cities, transit agencies, and school districts partner with local utilities to obtain **beneficial rate structures** to help save on charging costs and work with utilities to secure **charging infrastructure investments**.
- Cities, transit agencies, and school districts take advantage of **existing federal, regional, state, and local grant and incentive programs** to lower the initial purchase price of electric buses.
- States increase funding available for the purchase of electric buses through **new grant and incentive programs**, like CARB's grant and incentive programs, and explore using a cap-and-trade policy to generate revenue for clean transportation.

Introduction

Electric buses are here and, when compared with diesel or natural gas counterparts, they are cleaner, they are healthier, and they save operators money on annual fuel and maintenance costs. They are also quieter and nicer to drive. But most importantly, they eliminate localized toxic pollutants and climate emissions that are making us sick. This is especially important for our children.

The public health and environmental benefits of electric buses are so great that some additional costs over what it would take to purchase new diesel buses represent worthwhile investments. To protect our health, our clean air, and to help mitigate the devastating effects of climate change, it is important that we make the switch to electric buses as fast as possible.

The list of reasons to make the switch to electric buses keeps growing longer, and interest is growing among school districts and transit agencies across the country.

Yet, the sticker price of electric buses remains the largest impediment. Electric buses, both transit and school buses, are more expensive to purchase than their diesel or natural gas counterparts. Many transit agencies and school districts want to take advantage of the benefits of electric buses but can't afford them. Cities and states should be doing everything they can to allow agencies to take advantage of all available options, as well as create new options that help accelerate the switch.

While new sources of funding are also needed, there are several financing, funding, and incentive options that make large scale electric bus purchases possible, often with little to no additional costs over what it would take to purchase new diesel buses.

In this report, we review the available options, including how transit agencies and school districts can raise the revenue necessary through issuing municipal bonds or using ballot initiatives. We also review the federal, regional, state, and local grant and incentive programs that are available to help offset some of the upfront costs of electric buses, including the Volkswagen settlement.

By strategically using these options, often in conjunction with one another, several school districts and transit agencies have launched successful electric bus programs, helping to make their communities healthier. This report should serve as a guide to other school districts and transit agencies on how to make the switch to electric buses financially feasible.

Electric Buses Are Here

Not that long ago, electric buses were something of a novelty, and not seen as ready for widespread use. But in the past few years, they have taken off. More and more major manufacturers are making electric buses, and the technological advancements have come a long way. In fact, a recent report from Bloomberg New Energy Finance estimated that electric buses will take over half the world fleet by 2025.[9] In Shenzhen, China, the city is already running an entire fleet of 16,000 electric buses.[10]

Electric Buses Are the Cleaner and Healthier Option

It has long been known that diesel fumes pose a threat to our environment and public health. Currently, 60% of America's transit buses and 95% of school buses run on diesel.[11] Diesel is internationally recognized as a dangerous carcinogen.[12] Every day, our citizens, from commuters to school children, are forced to breath these toxic fumes.

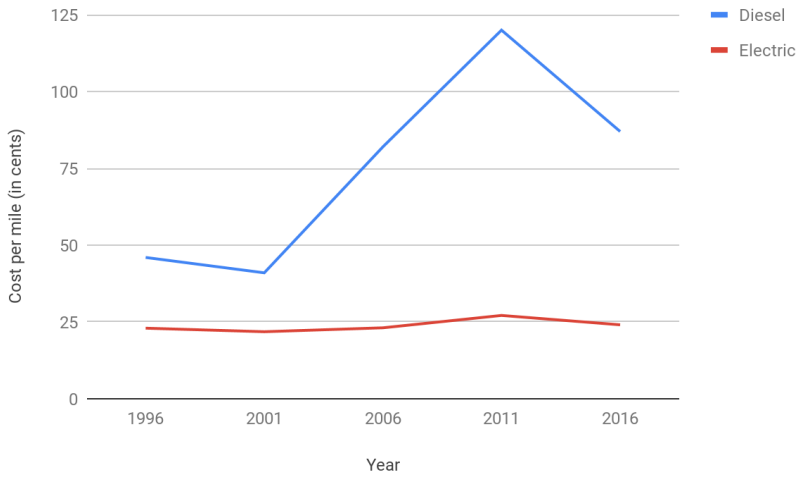
Transportation is also the largest source of greenhouse gas emissions in the country, with heavy-duty vehicles including buses playing a major role in the problem.[13]

The good news is that we now have the technology to provide clean and safe bussing across the country. Electric buses produce zero tailpipe emissions and have the potential to reduce the pollutants in our air that harm our climate and our health. Replacing all of America's dirty diesel buses, both transit and school buses, with clean electric buses would avoid an average of 7.3 million tons of greenhouse gas emissions annually.[14]

Electric Buses Have Lower Lifetime Costs

All-electric buses can save school districts and transit agencies money in annual operating costs from reduced fuel and maintenance costs, while also providing more predictability in costs each year since electricity prices are relatively stable compared to fuel prices, as demonstrated in Figure 1 below.

Figure 1 - Stability of Electricity vs. Diesel Prices[15]



Initial results from a six-vehicle electric school bus pilot program funded by the Clinton Global Initiative illustrate how schools can potentially save money with electric buses. Their analysis found that an electric bus saves nearly $2,000 a year in fuel and $4,400 a year in reduced maintenance costs.[16] The Chicago Transit Authority (which in 2014 became the first major transportation agency in the U.S. to run an electric bus) estimates that a single electric bus saves the city nearly $80,000 per year: $25,000 in fuel and $55,000 in avoided healthcare expenses resulting from cleaner air.[17]

These year to year savings mean that, in the long-run, electric buses are often cheaper than their diesel counterparts. While electric transit buses costs around $200,000 more than diesel buses, lifetime fuel and maintenance costs of diesel transit buses savings of electric buses are around $400,000.[18] And while electric school buses cost around $120,000 more than diesel school buses, lifetime fuel and maintenance savings of electric school buses are around $140,000.[19] As demonstrated in Figures 2 and 3, this means that the total lifecycle costs of electric buses are lower than those of diesel buses.

Figure 2 - Total Lifecycle Costs of Transit Buses[20]

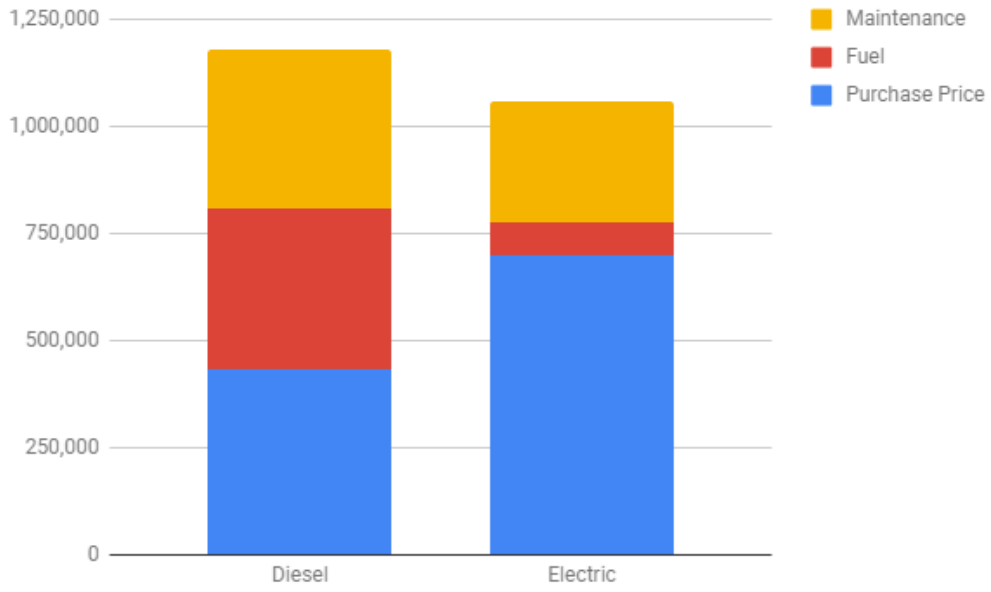
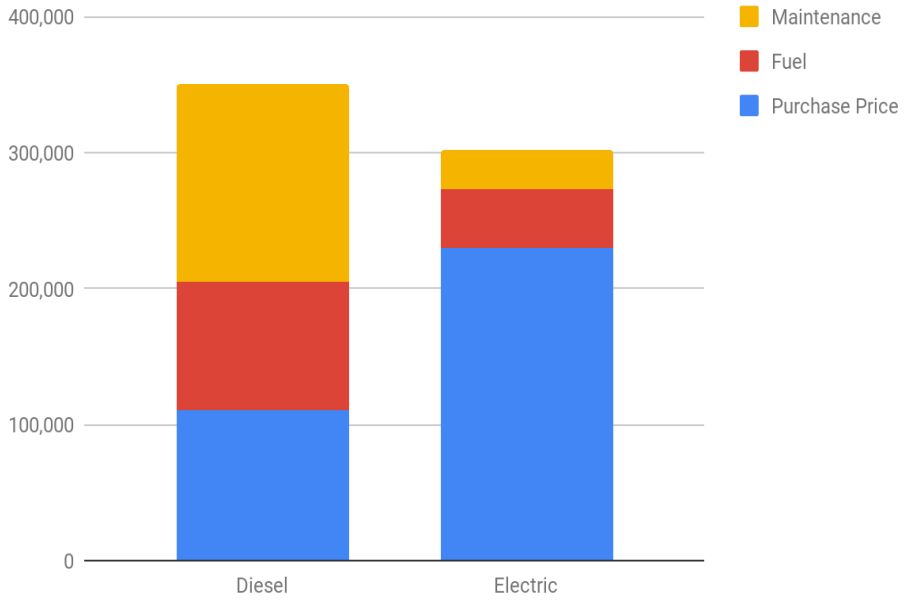


Figure 3 - Total Lifecycle Costs of School Buses[21]



The Electric Bus Market is Growing

Many companies have already tapped into the emerging electric bus market, providing models for both transit agencies and school districts.[22] Price differences between electric and diesel models continue to narrow as more transit agencies and manufacturers enter the electric bus market, technology improves and battery prices continue to decrease.[23]

Electric buses have seen dramatic growth in recent years. In 2009, there were only 17 electric transit buses servicing American cities. By 2017, that number grew to 568 and electric buses were servicing some of the largest public transit agencies in the country including in Los Angeles and Chicago.[24] Electric buses have consistently proven to be more fuel efficient and cost effective for mass transit. Transitioning to electric buses is also one of the most expedient ways for cities to curb their contribution to climate change and improve air quality for citizens.

The success of electric buses in public transit has carried over to the electric school bus market as well, leading to new innovations and price reductions. While early roll-outs of electric school bus programs faced logistical and mechanical challenges, increased interest in the market has spurred massive improvements in the reliability and resilience of electric school buses.

Paying for Electric Buses

Even as the benefits of electric buses become clearer, the price difference between electric and diesel models continues to be an obstacle to many transit agencies and school districts making the switch. However, a review of financing and funding options available reveals that American cities and school districts have a plethora funding options to make the transition to electric buses. Bus operators that pursue these options have an opportunity to protect the public health of commuters and school children, to reduce our nation's contribution to climate change, and can even save money in the process.

Purchase Prices of Electric Buses

Based solely on sticker price, electric buses are more expensive than diesel buses. An electric transit bus costs around $700,000, while a diesel transit bus costs around $500,000. [25] An electric school bus costs around $230,000, while a diesel school bus costs around $110,000. [26]

Although lower fuel and maintenance costs mean that electric buses save money over their lifetimes, the higher upfront cost still acts as a barrier to transit agencies and school districts that want to make the switch. Below are several options these agencies and districts may have that can help overcome the hurdle of the purchase price and begin to make the transition to electric buses. Many of the options presented below can be used in conjunction with one another to lower overall costs. When this is possible, the financials will work out even better in favor of the electric bus operator.

In cities and states where some of these options are not available, these should serve as models for programs that should be adopted to help accelerate the transition to electric buses.

Municipal Bonds

In many places, transit agencies and school districts do not need to pay out a lump sum to purchase these buses. Rather, governments can issue municipal bonds which allow outside investors to front the cost of electric buses. Governments then pay back the investors the principle plus interest over time.

Municipal bonds are a debt security issued by a state or local government, often used to fund public works projects. Outside investors buy shares of the bond from the issuing authority. The government then repays the investors the principal amount of the bond, plus interest, over time, often on a semiannual basis. The length of time the government will take to pay back the principle and interest is called the bond's maturation period. Municipal bonds are very attractive to investors because the bonds are exempt from federal and often state taxes.[27]

Despite the connotation of the word "municipal" with cities, many types of public entities can issue municipal bonds, including city and state governments as well as school districts.[28] The bond issuing process involves a

network of financial professionals and government officials. Different state and local governments have different rules regulating the methods by which municipal bonds can be issued.[29] Because the issuance of municipal bonds requires new taxes or budgetary restructuring, the legislative body often must approve the bond, but that is not always the case.[30] Sometimes, voters must directly approve the issuance of a new bond through a ballot measure.[31] Generally, the bonds are issued through a government's treasury which oversees the legal process of preparing the bond.[32]

Municipal Bonds Are Commonly Used for Public Transit and Education

Municipal bonds are often used by city governments to allocate funds to public transit projects. Likewise, municipal bonds are often used by school districts to pay for large capital projects, including the purchase of school buses.[33]

Municipal bonds are divided into two categories: revenue bonds and general obligation bonds.

- Revenue bonds secure the funds to repay the bond through a specific tax or revenue source. For example, Metropolitan Atlanta Rapid Transit System is funded by a revenue bond backed by the collection of a sales tax.[34] The Dallas Area Rapid Transit system has funded several improvements to its service through revenue bonds, including introducing seven electric buses to their fleet.[35]

- General obligation bonds are not backed by a specific revenue source, but rather a government's general funds.[36] For instance, the Bay Area Rapid Transit District in California has the authority to fund projects by issuing general obligation bonds, although it must first receive voter approval to do so.[37] Bonds issued directly by school districts to finance various projects are almost always general obligation bonds.[38]

Municipal Bonds Can Be Used to Purchase Electric Buses

The average sticker price of an electric transit bus is $700,000, which is around $200,000 more than a conventional diesel bus.[39] If a city were to issue a municipal bond for the purchase of a single electric transit bus costing $700,000 with a maturation period of 10 years and interest rate of 3.96% (the current average interest rate for municipal bonds),[40] the city would make annual payments on the bus of around $86,000 over the maturation period, totaling $860,000.[41] But this cost is mitigated by the lifetime savings of electric buses. Electric buses save transit agencies, on average, $41,000 per year on fuel and maintenance costs.[42] Over the lifetime of the bus, those savings amount to $410,000. Factoring in those savings, the net payment for an electric transit bus purchased using a bond would be $451,000. The cost of a diesel bus costing $500,000 purchased using the same bond would be $615,000. Meaning that over the lifetime of the bus, the electric bus will still save the agency over $164,000, compared to issuing bonds for diesel buses.

If a school district issued a bond for a purchase of an electric school bus costing $230,000[43] with a ten-year maturation period and 3.96% interest rate, the city would spend a total of around $283,000 on the bus.[44] With a lifetime savings of about $168,000 per electric school bus,[45] the net lifetime cost of an electric schools would be $114,000. A diesel school bus bought using the same bond would cost $135,350. Using this method, an electric school bus would

still save over $20,000 over the lifetime of the bus, compared to issuing bonds for diesel buses.

The financials for electric school buses are tighter than transit buses. While it is expected that this will continue to improve with more developed technology and decreasing battery prices, it is not impossible that there will some situations where an electric bus still costs more than a diesel bus. But as discussed above, there are many reasons to switch to electric buses even if they are more expensive than diesel buses. This is especially true for school buses, because children are far more susceptible to the negative health effects of diesel exposure.[46]

Case Study-Dallas Area Rapid Transit

Dallas Area Rapid Transit (DART) operates buses and a light rail system in downtown Dallas, TX. In 2016 they issued a bond for the purchase of electric buses. The general obligations bond has an interest rate of 5.0%, slightly higher than average for municipal bonds, and a maturation period of 20 years.[47] In July of 2018, the bond had raised the needed revenue and the agency unveiled seven new electric buses. The purchase of the buses was also supplemented by a grant from the Federal Transportation Administration. The funds raised covered the cost of the buses as well as two overhead charging stations for on-route charging. DART officials expect that the buses, manufactured by Proterra, will save the agency $2.1 million on fuel costs alone over the lifespan of the buses.[48] The buses join DART's light rail system as part of their fleet of zero-emissions vehicles.[49]

Local Option Transportation Taxes

A local option tax is a special-purpose tax implemented and levied at the city or county level. Local option taxes are often used as a means of raising funds for specific local or area projects, including transportation projects. There is a wide array of funding mixes across regions and municipalities based on the state and local regulations and authorities regarding the generation and use of revenue, but many states authorize local gas taxes, local vehicle license or registration taxes, and local option sales taxes for transportation.[50]

Local option transportation taxes work by increasing local gas, sales, vehicle registration, or other taxes by small amounts to pay for local transportation projects. In many states, these must be passed through ballot measure. The taxes are appealing because they are usually implemented for finite periods of time, for specific projects and expenditure plans, and offer more local control of transportation investment decisions.[51]

In 2017, nearly 90% of all transportation related ballot initiatives passed.[52] Voters in Lawrence Kansas passed a sales tax increase to fund their transportation agency, which has previously invested in hybrid electric buses.[53] In Manhattan, Kansas, a 0.2 increase to the sales tax adds $2 million to the transportation budget of the small town of 50,000.[54] In Greene County, Ohio, a 0.9 percent property tax levy brings in approximately $3.3 billion a year, with $1 million going to capital projects.[55] Other cities from Georgia, to Michigan and Colorado voted to approve similar investments in their public transportation.[56] When the decision is given directly to the voters, they overwhelmingly vote to invest in transit.

Case Study - Lake Tahoe School District

In 2018, the El Dorado County Board of Supervisors in California approved $1 million in funding to update buses in the county's school districts. One of these districts, Lake Tahoe Unified School District, received $600,000 in funding for the purchase of two electric school buses and charging equipment. The county was able to directly fund the purchase of the electric buses through a law passed in 2005. This law allows for the county government to raise vehicle registration fees in order to fund transportation projects.[57]

Vehicle-to-Grid Technology

Electric buses are powered by taking energy from the grid and storing it in large batteries. They use that stored energy to travel on their routes. New technology is becoming increasingly available that allows buses to send stored energy back to the grid. When equipped with vehicle-to-grid technology, electric buses can use their batteries for energy storage, providing a service to the grid by reserving and selling electricity back at times of high demand. This is particularly valuable for school buses, which typically charge overnight when electricity demand is lower; are parked during the middle of day and evening, when demand is highest; and often aren't in use during the summer when air conditioning use peaks. For example, if a school bus had extra juice after driving children home in the afternoon, it could connect to the grid and sell excess energy back to the grid during.

Vehicle-to-grid features could help school districts make the finances of electric buses pencil out more easily. A 2014 analysis from researchers at the University of Delaware estimated that a school bus could generate more than $15,000 from selling energy back to the grid, providing net benefits after five years of operation.[58] Early pilot projects with electric school buses in three school districts in California found each bus could generate more than $6,000 each year by sending extra electricity back to the grid during periods of high demand.[59]

Grant and Incentive Programs

Several federal, regional, and state grant and incentive programs already exist that can be used to help supplement other funding sources and offset some of the upfront costs of making the switch to electric buses. Cities and states should work to make these types of programs more accessible for transit agencies and school districts to use for the purchase of electric buses.

Volkswagen Settlement

After being caught violating clean air standards, courts in the U.S. and Europe ordered Volkswagen to pay $30.4 billion in fines.[60] In the US, nearly $3 billion of this money was used to create an Environmental Mitigation Trust Fund which allocates the settlement award to fund low or no emissions vehicle programs.[61] Every state has been granted a share of this settlement based on the number of offending vehicles sold in the state.[62] States are currently in the process of deciding how to spend the money. Some states, like New York, Minnesota, Georgia, and Massachusetts have already dedicated significant portions to be used towards the purchase of electric buses.[63]

Case Study - Martha's Vineyard Transit Authority

Martha's Vineyard, a small island community off the coast of Massachusetts, was the first transit agency in the state to commit to purchasing an all-electric fleet. In July of 2018, the island received six electric buses manufactured by the Chinese-based company BYD. The Vineyard Transit Authority purchased the buses with the help of a $1.2 million grant from the Federal Transit Administration as well as a $545,000 state grant.[64] In the summer of 2018, the Massachusetts Department of Environmental Protection announced that the island would receiving money from the state's VW settlement money allocation for the purchase of additional electric buses.

Federal Programs

The Federal Transportation Administration offers a number of grant programs, many of which have been used to purchase electric buses. In 2018, **The Low or No Emissions Grant** program awarded grants to over 50 state and local governments, totally $84.5 million. For the first time in the program's history, all awards were for the purchase electric buses and charging equipment.[65] This program along with the Department of Transportation's **Congestion Mitigation and Air Quality Improvement** and **State of Good Repair** programs are grants which state and local governments apply for on an annual basis. Awards for these programs are announced at the beginning of each fiscal year.[66]

Other federal grant programs include:

School Bus Rebate Program—This program is administered by the U.S. Environmental Protection Agency and is designed to help school districts reduce their diesel emissions. The program offers rebates to school districts who retrofit or update their buses to reduce the amount of diesel exhaust they emit. In 2017, 141 school districts across the country received rebates from the program totaling $8.78 million.[67] This program has been used extensively to transition buses from diesel to diesel-electric hybrids. However, some electric bus companies now specialize in fitting electric motors on older conventional bus frames.[68] For school districts looking to update their current fleet, rather than purchase all new electric buses, this program would be very appealing.

Urbanized Area Formula Funding Program— This program is specific to funding transportation projects in urban areas and is available to a variety of governing authorities, including city governments and transit agencies. The Federal Transportation Administration, which administers the program, provides prospective applicants with a list of eligible projects including rebuilding buses and updating a city's transportation management technologies. Cities could use this grant to retrofit older buses with zero-emission electric motors and purchase the needed charging equipment.[69] Through the Urbanized Area Formula Funding program, purchasing a bus with higher upfront costs but lower operating expenses may be a better value for agencies in the long run. Transit agencies in the U.S. can use federal money to pay for up to 80 percent of the purchase price of a bus (or other capital investment for transit).[70] This means the transit agency would only have to over a fraction of the cost the electric bus, and could supplement

awards from this program with other grants and incentives.

BUILD Discretionary Grant Program—In 2018, the Federal Transit Administration replaced the Transportation Investment Generating Economic Recovery (TIGER) grant program with the Better Utilizing Investments to Leverage Development (BUILD) grant program. Despite the name change, BUILD is similar to TIGER, providing competitive grants to local governments to update their transportation systems.[71]

Case Study - King County Metro

Through a combination of grant applications and direct advocacy with bus manufacturers, officials in King County, Washington have been championing the cause to get electric buses for their area's transit agency. In 2016, the county received a grant through the FTA's Low-No Emissions program to purchase three electric transit buses from Proterra.[72] Since then, the County has been continuing talks with the bus manufacturer to expand their fleet of electric buses and improve charging infrastructure, with plans to be fully electric by 2040. Before the deployment of their electric buses, the King County Metro's diesel buses accounted for 80% of the area's greenhouse gas emissions.[73] In the two years since the electric buses were deployed, they have avoided 1.1 million pounds of tailpipe emissions and saved the County $150,000 in fuel costs.[74]

Case Study - IndyGo

The Indianapolis Public Transit Corporation (IndyGo) is currently operating of one the largest electric bus fleets in the country with 21 electric buses. Rather than purchasing new electric buses, the agency refurbished existing conventional bus frames with electric motors and lightweight interiors. The agency reports that the operational costs of their electric buses are one-fourth that of their diesel buses. Their electric bus program was funded entirely by a TIGER grant through the federal Department of Transportation.[75]

State and Regional Programs

In addition to federal grant programs, many states and regional authorities offer programs designed to fund transportation reform and encourage transitions to alternative fuel sources

California has become a hub of new electric bus programs thanks in part to the state's robust grant programs for emissions reduction projects. The California Air Resources Board (CARB), a subsidiary of the California Environmental Protection Agency, aids the implementation of statewide clean air standards by funding innovative emissions reduction projects. CARB often collaborates with other state agencies and non-governmental organizations to secure funding for such projects. A particularly good example is CARBS' Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP). There are now over 1,100 fleets participating in the program, over 3,400 vehicles have been replaced.[76]

California has been able to fund many of these programs through a transportation cap-and-trade program.[77] In a cap-and-trade system, the government sets an emissions cap and issues a quantity of emission allowances consistent with that cap. Emitters must hold allowances for every ton of greenhouse gas they emit. Companies may buy and sell allowances, and this market establishes an emissions price. Companies that can reduce their emissions at a lower cost may sell any excess allowances for companies facing higher costs to buy.[78]

The California cap-and-trade rule applies to large electric power plants, large industrial plants, and fuel distributors (e.g., natural gas and petroleum).[79] The revenue from the program is invested in reducing air pollution, including through promoting zero-carbon transportation.[80]

In the Northeast and Mid-Atlantic states, the Regional Greenhouse Gas Initiative (RGGI) is a similar cap-and-trade program that has helped make significant progress towards reducing carbon emissions from the electricity sector. RGGI was the first market-based program in the U.S. to reduce greenhouse gas emissions from power plants that run on fossil fuels.[81] Auction proceeds are invested in energy efficiency programs.[82] Massachusetts has used some of the funds to fund electric bus pilot programs.[83]

The Georgetown Climate Center has been convening discussions amongst 12 states in the Northeast and Mid-Atlantic since 2010 to talk about regional cooperation on transportation pollution (the Transportation Climate Initiative, or TCI). Of those states, six have already committed to introduce some kind of "market-based policy" to reduce emissions from transportation across state lines. (RI, CT, NY, VT, DE, MA; plus DC).[84] One possibility is that a regional RGGI-like program will be set up to reduce transportation emissions and fund clean transportation investment, like the purchase of electric buses. Unlike RGGI, this program and the investment of revenue would specifically target transportation.

These programs provide promising models for to reduce emissions from the transportation sector, while also raising revenue that could be used to fund clean transportation investments, like the switch to electric buses. States and regions across the country should follow the lead of California and the Northeast and Mid-Atlantic states.

Case Study - Twin Rivers Unified School District

Twin Rivers, which services three large Sacramento suburbs, has been championing electric school buses for more than a decade. They currently operate 16 electric school buses across their district. They have paid little out of pocket for the buses, receiving funding from the California Air Resources Board, the California Energy Commission, and their local air quality district. They have also worked closely with Sacramento Municipal Utilities District (SMUD). SMUD has not only agreed to a rate structuring deal with the district but has also provided $1 million for the purchase of new charging equipment.[85]

Case Study – Massachusetts School Bus Pilot Program

The Massachusetts electric school bus pilot program provided valuable information about the potential of electric buses in rural, suburban, and urban areas as well as important considerations for communities considering making the switch to electric buses. The program, designed to test the viability of current electric technology in Massachusetts, was funded by the Regional Greenhouse Gas Initiative (RGGI) and administered by the Massachusetts Department of Energy Resources. After an evaluation by DOER and the Vermont Energy Investment Corporation, the program was considered a success, with many district officials and bus operators giving the buses positive reviews. The three electric buses deployed in the state reduced the amount of greenhouse gases and harmful pollutants by more than half compared to diesel buses. The program also highlighted the importance of charge management to ensuring the buses' energy efficiency and cost effectiveness, as well as the critical role of proper operating training.[86]

City Programs

There are also locally based programs designed to encourage sustainable development within individual cities. For example, Drive Clean Chicago has provided $10 million for the purchase of electric buses and trucks.[87] Drive Clean Chicago, which could be replicated in other cities, is funded by the federal Congestion Mitigation Air Quality Program.[88] Each program within Drive Clean Chicago has its own eligibility and application requirements. Drive Clean Chicago is administered by the Chicago Department of Transportation in partnership with CALSTART and the Chicago Area Clean Cities Coalition.[89]

There are also larger groups like the Clean Cities Coalition which is a locally organized program funded through the U.S. Department of Energy. Members of the Clean Cities Coalition are local governments that commit to various goals related to alternative fuel vehicles and energy saving strategies. These members are given access to planning resources and US Department of Energy grants, including programs through which diesel buses can be replaced.[90]

Leasing Options

There are also opportunities to work directly with private companies to make the switch to electric buses more affordable. Electric bus manufacturer Proterra offers a number of leasing options, including low cost financing as well as an operating lease. The operating lease allows cities to pay for the use of the bus over time with an option to purchase the bus at the end of the lease period.[91] Transit authorities can also partner with utility companies to create similar long-term payment plan options. Pay As You Save (PAYS) for Clean Transport is an innovative payment model where a utilities company would pay the upfront cost of the bus. The transit agency would then pay the company back over time with a fixed payment on their electric bill.[92]

Utility Investments and Incentives

Utilities have been playing a major role in supporting the transition to electric buses. By providing beneficial rate structures for electric bus charging, and supporting charging infrastructure, utilities can help speed the adoption of electric buses. Utilities can also benefit from electricity sales to electric bus fleets.

Utilities can help support electric buses by investing in infrastructure for bus charging in depots and on routes, by developing special rate structures to help make charging buses more economical, by helping to finance the upfront purchasing costs of electric buses, and by introducing smart charging systems to help maximize integration of renewable energy.[93] For example, in Oregon, Portland General Electric is partnering with the transit agency Tri-Met to enable Oregon's first all-electric bus route.[94] The utility will install and operate six electric bus charging stations and help Tri-Met purchase an additional electric bus.[95]

Case Study - White Plains, New York

White Plains School District in New York is a perfect example for what can be accomplished when active local leaders champion electric buses. The district's 125 buses are owned and operated by National Express, a private contractor. In early 2018, districts officials, concerned with the public health risks of diesel buses, began talks with representatives at National Express about the possibility to bring electric buses to their schools. National Express, in turn, worked directly with the electric school bus manufacturer eLion to bring five all-electric buses to White Plains. While the electric buses were more expensive than comparable diesel models, National Express did not increase their contract with the school.[96]

The bus contractor was able to offset the additional costs with the help of New York State's Truck Voucher Incentive Program and by partnering with Con Edison, the local utilities company. As part of the partnership with Con Edison, National Express allows the utilities company to use the school buses to store additional power from the grid during the summer month, when the buses are not in use. District leadership is optimistic about the future of electric buses in the area, with plans to be the first fully electric school bus fleet in the world. Additionally, this deal has spurred the electric bus market in New York, with eLion competitor Blue Bird staging electric bus demonstrations and offering competitive financing deals across the state.[97]

Case Study - Antelope Valley Transit Authority

The Antelope Valley Transit Authority (AVTA), which provides transit services throughout Northern Los Angeles County, California, used funds from a local grant program to purchase two electric buses in 2014 and plans to transition their entire fleet to electric buses by the end of 2018. In order to fund the full fleet conversion, they have received a $24.4 million grant from the California State Transportation Agency. The AVTA's goal of a fully operational fleet of 89 electric buses will require close cooperation with their local utilities district. Southern California Edison, the largest provider of electricity provider in southern California has been very supportive of the AVTA's electric bus project and has agreed to provide an affordable rate structure to the agency.[98]

Recommendations

It is time for both transit agencies and school districts to make the switch to electric buses. Electric buses are better for our health, for our planet, and they provide operators with year to year and lifetime financial benefits. While the difference in sticker price between an electric bus and a conventional diesel bus may make the electric bus look too expensive, it doesn't have to be. For transit agencies and school districts ready to make the switch, there are a several options available to help overcome the hurdle of the initial purchase price. Where these options are not already available, cities and states should work to implement funding programs to support the adoption of electric buses.

To accelerate the adoption of electric buses, we recommend that:

- Cities, transit agencies, and school districts **commit to transitioning to 100% all-electric buses by 2030**, with a plan to phase out the purchase of new diesel buses immediately.
- Cities, transit agencies, and school districts use traditional financing methods like **municipal bonds** and **local option transportation taxes** to finance the purchase of new electric buses.
- Cities, transit agencies, and school districts partner with local utilities to obtain **beneficial rate structures** to help save on charging costs and work with utilities to secure **charging infrastructure investments**.
- Cities, transit agencies, and school districts take advantage of **existing federal, regional, state, and local grant and incentive programs** to lower the initial purchase price of electric buses.
- States increase funding available for the purchase of electric buses through **new grant and incentive programs**, like CARB's grant and incentive programs, and explore using a cap-and-trade policy to generate revenue for clean transportation.

Methodology

Calculating purchase, financing, and operational costs for Diesel and Electric Transit Buses

According to New Flyer of American, the average cost of an electric transit bus is $700,000, while a comparable diesel model costs $500,000.[99] WM Financial reported that in August of 2018, the average interest rate on municipal bonds based on The Bond Buyer 20-Bond GO Index was 3.96%.[100] We chose a 10 year maturation period as that would allow cities to make payments over the lifetime of the bus.

To calculate the annual payments, we used the following formula: $P = \frac{r(PV)}{1-(1+r)^{-x}}$

$$P = \frac{0.0396(700{,}000)}{1-(1+0.0396)^{-10}}$$

$$P = 86,132$$

To calculate the total net cost per year we subtract the annual fuel and maintenance savings as compared to a diesel bus, then multiply the annual net cost by the maturation period to get the total net cost:

$$(86{,}132 - 41{,}000)(10) = 451{,}319$$

To find the cost of purchasing a diesel bus with a municipal bond, we used the same calculations substituting in the cost of a diesel bus:

$$P = \frac{0.0396(500{,}000)}{1-(1+0.0396)^{-10}}$$

$$P = 61,523$$

$$(61,523)(10) = 615,230$$

Subtracting the net cost of the diesel bus from the net cost of the electric bus, we find the overall cost or savings of the electric bus.

$$451{,}319 - 615{,}230 = -163{,}911$$

$$Total\ savings = 163{,}911$$

Cost difference between Diesel and Electric School Buses

We did these same calculations for electric school buses. The average cost of an electric school bus is $230,000 while a comparable diesel model costs $110,000.[101] We used the same interest rate of 3.96% and the same maturation period of 10 years.

Again, we use the following formula:

$$P = \frac{r(PV)}{1-(1+r)^{-n}}$$

$$P = \frac{(0.0396)(230{,}000)}{1-(1+0.0396)^{-10}}$$

$$P = 28{,}300$$

Again, we subtracted the annual fuel and maintenance savings from the annual bond payment then multiplied the net annual cost by the maturation period.

$$(28{,}300 - 16{,}834)(10) = 114{,}668$$

To find the cost of purchasing a diesel school bus with a municipal bond, we used the same calculations substituting in the cost of a diesel bus.

$$P = \frac{(0.0396)(110{,}000)}{1-(1+0.0396)^{-10}}$$

$$P = 13{,}535$$

To find the total cost, we multiply the annual payment by the maturation period.

$$(13{,}353)(10) = 135{,}350$$

To find the net cost or savings for the electric bus we subtract the cost of the diesel bus from that of the electric bus

$$114{,}668 - 135{,}350 = -20{,}882$$

$$Total\ Savings = 20{,}882$$

Notes

[1] World Health Organization (2012). *IARC: Diesel Engine Exhaust Carcinogenic*. Retrieved from: https://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf.

[2] Environmental Protection Agency. "Sources of Greenhouse Gas Emissions." Retrieved from: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[3] Argonne National Laboratory (2017). "Heavy-Duty Vehicle Emissions Calculator". Retrieved from https://afleet-web.es.anl.gov/hdv-emissions-calculator.

[4] California Air Resources Board (2017). *5th Innovative Clean Transit Workgroup Meeting*.

[5] Reynolds, Jim et al (2016). First Priority Green Fleet, *Benefits of Electric School Buses* (presentation).

[6] Hanlin, Jason et al (2018). "Battery Electric Buses: A State of the Practice", *Transit Cooperative Research Program*, National Academies Press. (Electric buses were ordered by transit agencies in Santa Barbara, California; Chattanooga, Tennessee; and Tempe, Arizona).
[7] Fred Lambert, "A fleet of all-electric school buses grows to 150 vehicles in California,"*Elektrek*, May 7, 2018, available at https://electrek.co/2018/05/07/all-electric-school-buses-fleet-california-2/.

[8] Vermont Energy Investment Corporation (2018). "Electric Bus Models Available for Purchase January 2018." Retrieved from: https://www.veic.org/Media/success-stories/types-of-electric-school-buses.pdf.

[9] Mark Chediak, "Electric Buses Will Take Over Half the World Fleet by 2025," *Bloomberg*, Feb. 1, 2018, available at https://www.bloomberg.com/news/articles/2018-02-01/electric-buses-will-take-over-half-the-world-by-2025.

[10] Linda Poon, "How China Took Charge of the Electric Bus Revolution," *City Lab*, May 8, 2018, available at https://www.citylab.com/transportation/2018/05/how-china-charged-into-the-electric-bus-revolution/559571/.

[11] Robert Pudlewski, "When Will AltFuels Replace Diesel, Gas Powered School Buses?" School Transportation News, 13 April 2017 archived at https://web.archive.org/web/20180217002454/http://stnonline.com/news/latest-news/item/8512-when-will-alt-fuels-replace-diesel-gas-powered-school-buses; Federal Transit Administration, U.S. Department of Transportation, National Transit Database – 2016, October 2017.

[12] World Health Organization (2012). *IARC: Diesel Engine Exhaust Carcinogenic*. Retrieved from: https://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf.

[13] Environmental Protection Agency. "Sources of Greenhouse Gas Emissions." Retrieved from: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[14] Argonne National Laboratory (2017). "Heavy-Duty Vehicle Emissions Calculator". Retrieved from https://afleet-web.es.anl.gov/hdv-emissions-calculator; For more on the public health and environmental benefits of electric

buses, as well as a more in depth review of current electric bus technology, see the U.S. PIRG report: "Electric Buses: Clean Transportation for Healthier Neighborhoods and Cleaner Air," available at https://uspirg.org/sites/pirg/files/reports/Electric%20Buses%20-%20National%20-%20May%202018%20web.pdf.

[15] U.S. Energy Administration Information (2018). Data on diesel, electricity, and other fuel costs over time available at: https://www.eia.gov/petroleum/; U.S. Dept. of Energy (2018). "Charging Electric Vehicles", *Alternative Fuels Data Center.* Retrieved from: https://www.afdc.energy.gov/fuels/electricity_charging_home.html.

[16] Clinton Global Initiative V2G EV School Bus Working Group, ZEV School Buses – They're Here and Possibly Free (presentation), 22 April 2016, available at https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf.

[17] Chicago Transit Authority, Electric Bus, accessed 6 February 2018, archived at https://web.archive.org/web/20180206213131/http://www.transitchicago.com/electricbus.

[18] California Air Resources Board (2017). *5th Innovative Clean Transit Workgroup Meeting*.

[19] Reynolds, Jim et al (2016). First Priority Green Fleet, *Benefits of Electric School Buses* (presentation).

[20] Clinton Global Initiative V2G EV School Bus Working Group, ZEV School Buses – They're Here and Possibly Free (presentation), 22 April 2016, available at https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf.

[21] Matthews, Kevin et al (2016). *ZEV School Buses: They're Here and Possibly Free*. Retrieved from: https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf.
[22] Vermont Energy Investment Corporation (2018). *Electric School Buses Available for Purchase.* Retrieved from: https://www.veic.org/Media/success-stories/types-of-electric-school-buses.pdf.

[23] Hanlin, Jason et al (2018). "Battery Electric Buses: A State of the Practice", *Transit Cooperative Research Program*, National Academies Press. (Electric buses were ordered by transit agencies in Santa Barbara, California; Chattanooga, Tennessee; and Tempe, Arizona).

[24] Ibid.

[25] New Flyer of America (2017). *Large Transit Bus System Electric Buying Spree.* Retrieved from: www.newflyer.com/2017/10/countrys-largesttransit-bus-system-electric-buying-spree.

[26] Matthews, Kevin et al (2016). *ZEV School Buses: They're Here and Possibly Free*. Retrieved from: https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf.

[27] Securities and Exchange Commission (2012). *Report on the Municipal Securities Market*. Retrieved from: https://www.sec.gov/news/studies/2012/munireport073112.pdf.

[28] MSRP (2018). *Six Things to Know When Issuing Municipal Bonds.* Retrieved from: http://msrb.org/msrb1/pdfs/MSRBSixThingstoKnow.pdf.

[29] Case examples: In Franklin County, OH, the county board can issue bonds by a simple majority vote on the board and does not need voter approval in most cases. In Montgomery County, MD, the county board oversees all public-school funding and must approve any municipal bonds issued to fund school related projects. In Baltimore City County, MD, all municipal bonds require voter approval. A longer list of case studies can be found in *Municipal Bonds Build America,* available at http://www.naco.org/sites/default/files/documents/NACo-Research_Policy_MuniBonds_2013.pdf.

[30] MSRP (2018). *Roles and Responsibilities: The Financing Team in an Initial Municipal Bond Offering.* Retrieved from: http://msrb.org/msrb1/pdfs/Financing-Team.pdf.

[31] Ibid.

[32] Ibid.

[33] My Texas Public School (2014). *Bonds 101: Questions and Answers.* Retrieved from: https://www.mytexaspublicschool.org/The-School-System/Funding/Bonds-101-Questions-and-Answers.aspx.

[34] *Five Most Active Municipal Bonds*. Retrieved from: http://www.municipalbonds.com/investing-strategies/five-most-active-municipal-bonds/.

[35] *Invest in Transportation.* Retrieved from: https://neighborly.com/invest-in/transportation.

[36] MSRP (2018). *About Municipal Securities.* Retrieved from: http://www.msrb.org/EducationCenter/Municipal-Market/About.aspx.

[37] Bay Area Rapid Transit (2017). *Be Climate Smart. Invest in BART Green Bonds*. Retrieved from: https://www.bart.gov/news/articles/2017/news20170501-1.

[38] See note 33.

[39] See Note 20.

[40] WM Financial Strategies (2018). *Rates Over Time-Interest Rate Trends.* Retrieved from: http://www.munibondadvisor.com/market.htm. Accessed September 6, 2018. Cities or agencies with better credit rating will receive lower interest rates, leading to more savings.

[41] Calculated with the following formula: $P=(r(PV))/(1-(1+r)^{-n})$; r=.0396, PV=700,000, n=10; This calculation assumes that the issuer is paying the principal and interest concurrently. If the principal and interest are paid separately, the following formula is used $A=P+(1+rt)$.

There may be additional transactional costs associated with issuing a bond. These can vary widely depending on the specific situation and will likely be minimal but have the potential to become significant. Marc Jaffe. "Doubly Bound: The Costs of Issuing Municipal Bonds." Retrieved from: https://haasinstitute.berkeley.edu/sites/default/files/haasinstituterefundamerica_doublybound_cost_of_issuingbonds_publish.pdf. The issuing authority should explore all costs associated with a bond.

[42] *Electric Bus.* Retrieved from: http://www.transitchicago.com/electricbus.

[43] Matthews, Kevin et al (2016). *ZEV School Buses: They're Here and Possibly Free*. Retrieved from: https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf.

[44] See methodology.

[45] Reynolds, Jim et al (2016). First Priority Green Fleet, *Benefits of Electric School Buses* (presentation). Including vehicle-to-grid revenue.

[46] Miller, Alana et al (2018). "Electric Buses: Clean Transportation for Healthier Neighborhoods and Cleaner Air", *U.S. PIRG Education Fund.* Retrieved from: https://uspirg.org/sites/pirg/files/reports/Electric%20Buses%20-%20National%20-%20May%202018%20web.pdf.

[47] *Dallas Texas Area Rapid Transit Prerefundeducation Refunding Senior Lien*. Retrieved from http://www.municipalbonds.com/bonds/issue/235241QN9/.

[48] Branham, Dana (2018). "DART's Fleet of Electric Buses Roll Out in Downtown Dallas, *Dallas News.* Retrieved from: https://www.dallasnews.com/news/transportation/2018/07/10/darts-fleet-electric-buses-roll-downtown-dallas.

[49] *DART Rolls Out D-Link All-Electric Buses*. Retrieved from: http://dartdallas.dart.org/2018/07/06/dart-rolls-out-d-link-all-electric-buses/.

[50] Lydia Rainville, "Taxing for Transit: An Exploratory Analysis of Local Option Transportation Taxes," *Tufts University*, available at https://sites.tufts.edu/MaryDavis/files/2013/06/LRainville-Thesis.pdf.

[51] Ibid.

[52] American Public Transportation Association (2018). "Nearly 90% of Transit Ballot Initiatives Pass in 2017". Retrieved from: https://www.masstransitmag.com/press_release/12380115/nearly-90-of-transit-ballot-initiatives-pass-in-2017.

[53] Lawhorn, Chad (2011). "City Adds 3 Hybrid Diesel-Electric Buses to Public Transit Fleet". Retrieved from: http://www2.ljworld.com/news/2011/aug/11/city-adds-3-hybrid-diesel-electric-buses-public-tr/.

[54] Transportation for America (2018). "Regional ballot measures fund transportation projects." Retrieved from: https://d3n8a8pro7vhmx.cloudfront.net/t4ma/pages/261/attachments/original/1523037903/T4A_ballot_measure_case_studies.compressed.pdf?1523037903.

[55] Ibid.

[56] Ibid.

[57] Myers, Mackenzie (2018). "Cleaner buses coming to local schools", *Mountain Democrat.* Retrieved from: https://www.mtdemocrat.com/news/cleaner-buses-coming-to-local-schools/.

[58] Lance Noel and Regina McCormack. 2014. "A Cost Benefit Analysis of a V2G-Capable Electric School Bus Compared to A Traditional Diesel School Bus," Applied Energy, 126: 246- 265. Available at https://www1.udel.edu/V2G/ resources/V2G-Cost-Benefit-Analysis-NoelMcCormack-Applied-Energy-As-Accepted.pdf.

[59] Clinton Global Initiative V2G EV School Bus Working Group, ZEV School Buses – They're Here and Possibly Free (presentation), 22 April 2016, available at https://green-technology.org/gcsummit16/images/35-ZEV-School-Buses.pdf

[60] Kljaic, Vanja (2018). *Let's Look At How States Are Spending VW Dieselgate Settlement Money*. Retrieved from: https://insideevs.com/lets-look-at-how-states-are-spending-vw-dieselgate-settlement-money.

[61] Jackson, Brianna (2018). "States Got $3 Billion in VW Scandal. Here's How They'll Spend It", *Bloomberg News*. Retrieved from: https://www.bloomberg.com/news/articles/2018-07-06/states-got-3-billion-in-vw-scandal-here-s-how-they-ll-spend-it.

[62] The award amounts range from $8 million to 422.6 million.

[63] Kljaic, Vanja (2018). *Here's How New York Will Spend Its $127 Million VW Dieselgate Funds.* Retrieved from: https://insideevs.com/new-york-127-million-vw-dieselgate-funds/; More information on each state's plan and for more information on how to apply for funding can be found at: http://4cleanair.org/Volkswagen_Settlement_Information.

[64] Stringfellow, Barry (2017). "VTA scores big state grant", *MV Times.* Retrieved from: http://www.mvtimes.com/2017/12/11/vta-scores-big-state-grant/.

[65] Fiscal Year 2018 Low or No-Emission (Low-No) Bus Program Projects, Federal Transit Administration. Retrieved from: https://www.transit.dot.gov/funding/grants/fiscal-year-2018-low-or-no-emission-low-no-bus-program-projects.

[66] *FTA Grant Programs.* Retrieved from: https://www.transit.dot.gov/grants.

[67] EPA (2017). *Clean Diesel Rebates.* Retrieved from: https://www.epa.gov/cleandiesel/clean-diesel-rebates.

[68] *Retrofitting Your Buses From Fossil Fuel to Battery-Electric and Why it Makes Sense.* Retrieved from: https://www.ebus.com/.

[69] *FTA Urbanized Area Formula Grants*. Retrieved from: https://www.transit.dot.gov/funding/grants/urbanized-area-formula-grants-5307.

[70] California Air Resources Board, 5th Innovative Clean Transit Workgroup Meeting (presentation– slide 40), 26 June 2017.

[71] *BUILD Discretionary Grants.* Retrieved from: https://www.transportation.gov/BUILDgrants.

[72] Eudy, Leslie, et al (2018). "Zero-Emission Bus Evaluation Results: King County Metro Battery Electric Buses", *Federal Transit Administration.* Retrieved from: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/115086/zero-emission-bus-evaluation-results-king-county-metro-battery-electric-buses-fta-report-no-0118.pdf.

[73] Kelety, Josh (2018). "King County Rolls on With Its Electric Buys Fleet Plans", *Seattle Weekly*. Retrieved from: http://www.seattleweekly.com/news/king-county-rolls-on-with-its-electric-bus-fleet-plans/.

[74] Proterra (2018). *Battery-Electric Bus Fleet Data.* Retrieved from: http://energy.proterra.com/KCM/.

[75] Ibid.

[76] CARB, Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project. (2018). Retrieved from: https://www.californiahvip.org/eligible-technologies/#your-clean-vehicles.

[77] Center for Climate and Energy Solutions (2018). "California Cap and Trade." Retrieved from: https://www.c2es.org/content/california-cap-and-trade/.

[78] Center for Climate and Energy Solutions (2018). "Cap and Trade Basics." Retrieved from: https://www.c2es.org/content/cap-and-trade-basics/.

[79] Center for Climate and Energy Solutions (2018). "California Cap and Trade." Retrieved from: https://www.c2es.org/content/california-cap-and-trade/.

[80] Ibid.

[81] The Regional Greenhouse Gas Initiative: An Initiative of New England and the Mid-Atlantic States of the U.S. (2018). Retrieved from: https://www.rggi.org/.

[82] Ibid.

[83] Mass. Dept. of Energy Resources and the Vermont Energy Investment Corporation (2018). *Electric Bus Pilot Project Evaluation.* Retrieved from:

https://www.mass.gov/files/documents/2018/04/30/Mass%20DOER%20EV%20school%20bus%20pilot%20final%20report.pdf.

[84] In November of 2015, RI, CT, NY, VT, DE and DC committed to develop market based climate policy for the transportation sector: http://www.georgetownclimate.org/articles/five-northeast-states-and-dc-announce-they-will-work-together-to-develop-potential-market-based-policies-to-cut-greenhouse-gas-emissions-from-transportation.html. In September 2016, Gov. Baker EO committed MA to collaborate with regional partners to develop transportation climate policy. See Sec 1(c): http://www.mass.gov/governor/legislationexecorder/execorders/executive-order-no-569.html.

[85] Tim Shannon, Twin Rivers Unified School District Director of Transportation, personal communication, Sept. 2018; Claudia Newton (2018). "Webinar Answers Common Questions on Electric School Buses," *School Transportation News*. Retrieved from: http://stnonline.com/news/latest-news/item/9512-webinar; California Air Resources Board (2018). "School Bus Fleet Webinar." Retrieved from: https://www.arb.ca.gov/msprog/truckstop/video/carbschoolbuswebinarpresentation.pdf.

[86] Mass. Dept. of Energy Resources and the Vermont Energy Investment Corporation (2018). *Electric Bus Pilot Project Evaluation.* Retrieved from: https://www.mass.gov/files/documents/2018/04/30/Mass%20DOER%20EV%20school%20bus%20pilot%20final%20report.pdf.

[87] *Drive Clean Chicago's Grant Programs*. Retrieved from: http://www.drivecleanchicago.com/.

[88] Ibid.

[89] Ibid.

[90] US Dept. of Energy (2018). *Clean Cities Coalition Network.* Retrieved from: https://cleancities.energy.gov/coalitions/. Information on the specific grants available can be found at this web address.

[91] *Financing your Electric Bus.* Retrieved from: https://www.proterra.com/financing/.

[92] *Accelerating Investment in Electric Transit Buses with Pay as You Save.* Retrieved from: http://cleanenergyworks.org/clean-transit/.

[93] Miller, Alana et al (2018). "Electric Buses: Clean Transportation for Healthier Neighborhoods and Cleaner Air", *U.S. PIRG Education Fund.* Retrieved from: https://uspirg.org/sites/pirg/files/reports/Electric%20Buses%20-%20National%20-%20May%202018%20web.pdf.

[94] Betsy Lillian, "Portland General Electric's Transportation Electrification Plan Moves Forward," NGTNews, 27 February 2018.

[95] Wilson, Colleen (2018). "Leading the charge: White Plains rolling out electric school buses this fall", *Lohud.* Retrieved from: https://www.lohud.com/story/news/education/2018/06/20/white-plains-first-electric-school-buses-new-york/698067002/.

[96] Ibid.

[97] Ibid.

[98] Hanlin, Jason et al (2018). "Battery Electric Buses: A State of the Practice", *Transit Cooperative Research Program*, National Academies Press.

[99] See note 16

[100] Interest rates will vary based off of a city or district's credit rating. The Bond Buyer 20-Bond GO Index is an index of certain long-term bonds with an S&P rating of AA. For more information, see note 40.

[101] See note 23.