January 16, 2018

VIA ELECTRONIC MAIL

Tennessee Department of Environment and Conservation
312 Rosa Parks Ave., 2nd Floor
Nashville, TN 37243
Email: TDEC.OEP@tn.gov

RE: Comments of the Sierra Club and Partners Regarding Use of Volkswagen Partial Consent Decree Environmental Mitigation Trust Funding for the Purpose of NOx Emissions Reductions in the State of Tennessee

On behalf of the Sierra Club and its Chapter and members in Tennessee, Clean Tennessee, Southern Alliance for Clean Energy, Southern Environmental Law Center, The Tennessee Conference of the National Association for the Advancement of Colored People, Tennessee Conservation Voters, Tennessee Environmental Council, Tennessee Interfaith Power and Light, and Statewide Organizing for Community Empowerment (collectively, the Commenters), we respectfully submit the following comments regarding the use of funding allocated to the State of Tennessee through the Volkswagen Partial Consent Decree Environmental Mitigation Trust (Mitigation Trust). Volkswagen’s installation of defeat devices on diesel vehicles sold in Tennessee resulted in emissions of nitrogen oxides (NOx) from these vehicles that exceeded limits established under the Clean Air Act by up to 3,400%. As a primary component of ground-level ozone (smog), as well as a source of fine particulate matter and acid rain, the excess NOx emissions contributed to diminished air quality levels in Tennessee and impeded the State’s efforts to bring its air quality into attainment of health-based National Ambient Air Quality Standards for ozone. The funding provided in the Mitigation Trust is intended to support programs that mitigate and reduce emissions of NOx. To maximize the emission reductions that can be achieved using the Mitigation Trust funding allocated to Tennessee we offer the following recommendations:

1. Tennessee should prioritize electric buses and garbage trucks. Most importantly, if the total lifetime costs are considered, the bus technology with the greatest NOx lb/$ ratio is a zero-emission electric bus.\(^1\)

2. Tennessee should allocate the maximum amount authorized by the settlement (15% of total state funding) to programs designed to expand access to electric vehicle (EV) charging in the State.

Explained in more detail below, heavy duty road vehicles and non-road vehicles and equipment are the second and third largest contributors of NOx pollution in the state. Specifically, the Commenters recommend spending the remaining funds on electric transit buses and electric school buses and providing funding for electric garbage trucks. These investments will most benefit low-income communities and communities of color who disproportionately

\(^1\) See Section II.A.1.d.
bear the burden of air pollution. Vehicle electrification benefits will only grow as the electricity used to power them continues to become cleaner. The Commenters strongly recommend NOT using the funds to invest in new diesel or natural gas vehicles. These investments would lock us into many more years of using fossil fuels dangerous for our air quality and climate stability. Additionally, while electric vehicles and equipment may have higher up-front costs than their diesel counterparts, they typically have lower maintenance costs and can be highly cost-effective on a life-cycle basis. These lower maintenance costs are particularly relevant to the extent they are not covered by settlement funds.

Light-duty vehicles are the single greatest contributor of NOx emissions in Tennessee.\(^2\) Electrification of the vehicle fleet is the most effective way to mitigate emissions from this source category. Access to electric vehicle charging is a key barrier that must be overcome in order for EV adoption in Tennessee to rapidly expand. We recommend that the charging infrastructure investments target access to fast chargers on major highways, and charging infrastructure to multi-unit dwellings and workplaces with a focus on ensuring that benefits redound to disadvantaged communities.

Consistent with the above recommendations, we believe the Mitigation Trust funds have the opportunity to advance the goals of environmental justice and should be targeted to do so. As discussed in these comments, people of color in Tennessee bear a disproportionate share of the NOx-driven ozone pollution in the state. Funding from the Volkswagen Settlement can support the state’s goals of cleaning up the air in these areas by focusing on programs that will electrify vehicles in these cities and municipalities.

While the focus of the Mitigation Trust is on reducing NOx emissions in Tennessee—which is critical given Tennessee’s historical and continuing struggle to maintain healthy ozone levels\(^3\)—strategies to mitigate NOx emissions can also have substantial climate co-benefits. In this respect as well, electrification is a superior strategy to trading one fossil fuel for another by replacing diesel with diesel or diesel with gas.

We want to emphasize that no Mitigation Trust funds should be used on administrative expenditures even if they are associated with the implementation of eligible mitigation actions. The entirety of the funds should go to electrification of bus and garbage truck fleets, and expansion of EV infrastructure.

I. Nitrogen Oxides and Their Impacts in Tennessee

The term nitrogen oxides (NOx) refers to a group of highly reactive gases produced during combustion of fossil fuels.\(^4\) Not only is NOx a pollutant in its own right, it is also a contributor to several other harmful forms of pollution including fine particulate matter, acid

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\(^3\) See Nonattainment Areas for Criteria Pollutants (Green Book), EPA, at https://www.epa.gov/green-book (according to past ozone NAAQs, Tennessee cities such as Memphis and Knoxville were designated as “Maintenance areas” or areas only in attainment through state implementation plans designed to improve air quality in otherwise nonattainment areas).
\(^4\) Basic Information About NOx, EPA, at https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects.
rain, and ground-level ozone. Acid rain is particularly damaging to land and water ecosystems like the Tennessee River watershed and the Mississippi River. The nitrogen from acid precipitation upsets the delicate chemical balances in these habitats.

Great Smoky Mountains National Park—America’s most popular national park and a major tourist attraction in Tennessee, receiving over 11 million visitors in 2016 alone—receives the highest level of acid deposition of any monitored national park, negatively impacting visibility, vegetation such as old growth red spruce trees, and aquatic species such as brook trout. A study of the park’s forest ecosystems found that the combined effects of nitrogen and sulfur deposition exceed a threshold defined as the “critical load,” meaning that significant harmful effects to sensitive ecosystem components are likely to occur. Consequences include losses in biodiversity, the release of toxic aluminum, upset ecological balances, and nutrient cycling. The State of Tennessee recently listed ten park streams as impaired under the Clean Water Act because of acidification. Further, the acid rain that falls in the Park does not stay there. The Great Smokies boast over 2,100 miles of waterways that supply drinking water for Tennessee residents such as those in the City of Gatlinburg, and those waterways are negatively impacted by this pollution.

Ground-level ozone also represents a serious public health issue in Tennessee. Ozone forms when NOx reacts with volatile organic compounds in the presence of heat and sunlight. It is a potent asthma trigger and a powerful irritant to lungs, especially in the most vulnerable populations: children, asthmatics, and the elderly. Ozone is also linked to reproductive impacts, and premature mortality. Jefferson, Shelby, and Sumner Counties are exceeding EPA’s 70 ppb 2015 ozone NAAQS based on Monitored Air Quality Data from 2012-2014, and Davidson County’s attainment and maintenance of the standard is in question.

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5 Id.
9 Air Pollution Impacts, supra note 7.
12 Hansen et al., Maternal exposure to low levels of ambient air pollution and preterm birth in Brisbane, Australia, BJOG.113 (2006), http://onlinelibrary.wiley.com/doi/10.1111/j.1471-0528.2006.01010.x/full (finding a 26% increase in risk of pre-term birth at maximum smog levels of only 61.1 parts per billion); see generally EPA Integrated Science Assessment for Ozone (2013) at 2–22 (summarizing existing research).
14 Id.
Moreover, the four most populated counties in the state, Shelby, Davidson, Knox, and Hamilton—which are home to over 2.3 million people—have all received an F ozone grade from the American Lung Association. Therefore, reducing ozone-forming pollution is especially critical for the people of Tennessee.

The impacts of toxic air pollution in Tennessee are also not equally distributed. Tennessee’s most severe ozone impacts fall unjustly on people of color, raising environmental justice concerns. The figure below compares monitored ozone levels for a county with the county’s demographic composition relative to the state as a whole using U.S. Census Bureau data. The data show that African American residents are under-represented in the counties with less severe ozone problems and severely over-represented in the counties with the most severe ozone problems. And this trend is observed nationwide—a census of the US near-roadway populations found that 19.3% of US population lives near a high volume road, and minorities and low-income households are over-represented in this population. Therefore, addressing transportation related NOx pollution will address the environmental justice inequities observed.

Figure 2: Over/Under-Representation of Groups By County Ozone Level in Tennessee
This graph compares monitored 2011-2013 ozone levels for a county with that county’s demographic composition relative to the state as a whole using U.S. Census Bureau data.

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In Tennessee, the primary sources of NOx are mobile sources (on-road and non-road vehicles and equipment) and fuel combustion (including electric generating equipment), of which the mobile sector accounts for approximately three-fourths of total NOx (71%). It is critical that emissions from these sources are reduced, especially in Tennessee’s major cities, which are the most heavily impacted by this pollution (note: sources with percentages less than 1% are not included in the table).

Table 1: 2014 NOx Emissions in Tennessee by Major Source Sector

<table>
<thead>
<tr>
<th>Major Sector Sources</th>
<th>2014 NOx Emissions (Tons)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>184,971.84</td>
<td>71%</td>
</tr>
<tr>
<td>Fuel Combustion</td>
<td>56,165.13</td>
<td>21%</td>
</tr>
<tr>
<td>Other Industrial Processes</td>
<td>9,339.318</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3,653.65</td>
<td>1%</td>
</tr>
<tr>
<td>Waste Disposal &amp; Recycling</td>
<td>2,994.74</td>
<td>1%</td>
</tr>
<tr>
<td>Petroleum &amp; Related Industries</td>
<td>2,131.88</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Source: U.S. EPA 2014 National Emissions Inventory*

The following figure breaks down the mobile source component in more detail. As the table shows, more than 70% of the mobile source NOx emissions come from on-road light-duty vehicles, diesel heavy-duty vehicles, and non-road vehicles and equipment. 50% come from on-road or highway vehicles alone, making this source category particularly important for the State to target in allocating Mitigation Trust funds.
II. For the Majority of the Mitigation Trust Funds, Tennessee Should Prioritize Electrification Over Alternate-Fueled Options, and Prioritize Electrification of Buses and Garbage Trucks

In addition to investing 15% of the Mitigation Trust funds in EV infrastructure (discussed further below), we recommend that Tennessee invest in electrification of buses and garbage trucks. These categories of vehicles contribute to a large fraction of Tennessee’s NOx pollution. At the same time, diesel buses disproportionately impact disadvantaged communities, meaning that these communities stand to benefit the most from investments in electrification. We emphasize the importance of replacing existing diesel buses with electric buses, rather than switching from diesel to alternate-fueled engines such as new diesel and compressed natural gas. As discussed above, electrification of Tennessee’s transportation sector keeps money in state, saves money through lower electricity rates, drastically reduces NOx, smog, and greenhouse gas levels to protect health and environmental justice communities, and likewise reduces greenhouse gas (GHG) emissions throughout the state. The same benefits apply when upgrading non-road equipment and heavy-duty vehicle engines. Electrification also makes good economic sense. Although the cheaper upfront costs for new-diesel and alternate-fueled engines may be initially attractive, the more important costs for the State to consider are the lifetime costs of these vehicles. This is particularly true because the Mitigation Trust funds will contribute to covering the upfront program costs to replace and repower engines, while subsequent fuel and maintenance costs will fall on the State, its residents, and its companies. Electrifying vehicles and equipment is a good investment since the lifetime costs are significantly cheaper than those of alternate-fueled vehicles and new diesel engines.
A. Zero-Emission Buses

On-road diesel heavy-duty vehicles, such as buses and trucks, are accountable for 23% of Tennessee’s 2014 mobile NOx pollution. As a result, zero-emission buses and their charging infrastructure are fantastic options for use of the VW Settlement funds. Nationwide, fleets of school, transit, and shuttle buses are already being converted to these clean, cost-effective, alternatives to traditional diesel power. Transit agencies in Shreveport, Lexington, Louisville, Reno, Columbus, Dallas, Oakland, and the Quad-Cities area of Illinois, are just a handful of those investing in electric and hydrogen fuel cell buses.\(^\text{17}\) Outside of the U.S., Tel Aviv,\(^\text{18}\) London,\(^\text{19}\) Barcelona,\(^\text{20}\) and a number of Chinese cities\(^\text{21}\) have invested in electric buses and charging stations. As of 2015 there were over 170,000 electric buses on the road worldwide.\(^\text{22}\) Navigant Research projects that “the battery EV (BEV) is expected to be the leading type of electric powertrain for buses through 2026.”\(^\text{23}\) Each of the four most populous cities in Tennessee—Nashville, Memphis, Knoxville, and Chattanooga—has a bus fleet that serves millions of people per year. In fact, Chattanooga has already electrified some of its shuttle buses and Nashville also placed orders for electric buses.\(^\text{24}\) These cities should continue this trend of electrification and be leaders in the field.

Mitigation Trust funds are available to further support the adoption of these highly efficient alternatives to fossil fueled transportation. In addition the Mitigation Trust covers installation of charging infrastructure to support these vehicles. As described in greater detail below, the economics already favor widespread investment in zero emission buses and their supporting infrastructure. Investment in these buses today will speed further integration as these technologies come to scale, bringing measurable economic and environmental benefits to the communities they service.

By using Mitigation Trust funds to procure zero emission buses now, our transit agencies can lock in annual savings on fuel ($40,000–$45,000 per year per bus over diesel) and

\(^\text{17}\) See Proterra, Our Customers, https://www.proterra.com/our-story/our-customers/, for a full list of just one company’s sales.


maintenance. The agencies can then procure additional zero emission buses, which will lock in
further cost savings going forward for the agency.

1. **EV Buses Already Have Lower Comparative Lifetime Costs Than Diesel Buses and Compressed Natural Gas Buses—And Costs Continue To Drop Rapidly**

   As discussed below, even today the lifetime cost of an electric bus is significantly lower
than that of a new diesel or alternative fuel bus, though the upfront cost is higher. The all-in cost
of buses—that is, the upfront cost of the bus purchase, fuel costs, and maintenance costs—for
electric buses is around $1,000,000, and around $1,400,000 for diesel and compressed natural
gas (CNG) buses.\(^\text{25}\) Moreover, as EV bus manufacturing scales up, and as battery costs—the
most expensive part of an EV—plummet over time, EV bus prices will fall rapidly as well.

   a. **Up-front Costs**

      The current sticker price of a new electric bus is about $750,000.\(^\text{26}\) A comparable new
diesel vehicle costs $480,000 and a CNG bus $490,000, while a Fuel Cell Bus (FCB) costs over
$1,000,000.\(^\text{27}\) Transitioning to electric technology can also be accomplished through repowering
existing diesel vehicles with all-electric components, a process that costs around $500,000.\(^\text{28}\)

      Government estimates of electric bus prices sharply decline as advances in battery
manufacturing and increased demand drive down costs. By 2025—within the 10-year timeframe
of the VW Environmental Mitigation Trust grant program—an electric bus is expected to cost
$480,000, equal to or less than the cost of a new diesel vehicle.\(^\text{29}\) Much of this decrease is
attributable to projected reductions in battery costs. A California Air Resources Board-conducted
literature review concluded that studies consistently place the cost of batteries below $500/kWh
by 2020, and approaching $200/kWh by 2030.\(^\text{30}\) These estimates are already outdated and clearly
understate the rate of reductions in battery costs. GM announced that, even in 2016, it was
procuring batteries for its Bolt EV for $145/kWh.\(^\text{31}\) As explained below, even without future
reductions in costs, EV buses, with their far lower fuel, operating, and maintenance costs, exhibit
lower lifetime costs than diesel and CNG buses.

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\(^\text{26}\) Proterra’s Catalyst bus cost $749,000 in 2016 while BYD’s all-electric bus costs $770,000. Draft, Cost Model
Discussion with ACT Cost Subgroup, slides 9–10 (Aug. 23, 2016) available at

\(^\text{27}\) Id. at slides 9 (CNG), 10 (diesel), 12 (Hydrogen Fuel Cell).

\(^\text{28}\) Repowering refers to the removal of the existing motor and drivetrain and replacement with all-electric
http://www.fleetsandfuels.com/fuels/evs/2014/12/21-all-electric-zeps-buses-for-indygo/ (21 rebuilds at a total cost
of $12.2 million).

\(^\text{29}\) Air Resources Board Cost Model, slide 10 (all values in 2016 dollars).

\(^\text{30}\) Id. slide 11.

b. Total Cost of Ownership

Despite their greater purchase price, current analysis using Argonne National Laboratory’s AFLEET Model demonstrates that electric buses have a **total cost of ownership 19% lower than new diesel buses**. Maintenance costs for electric buses are between 70% and 79% lower than for CNG and new diesel buses respectively, contributing to significant cost savings over the lifetime of a bus. Based on currently reported data, **each all-electric bus will save Tennessee's transit agencies over $250,000** as compared to a new diesel bus purchase.

As this electric bus technology continues to develop, all-electric bus up-front capital costs will continue to drop, whereas CNG and diesel bus capital cost trends are continually increasing. In addition, although reliable, current publicly available data on hybrid diesel-electric buses are lacking, a lifecycle analysis using data compiled by the California Air Resources Board in 2016 shows that hybrid diesel-electric buses have a total cost of ownership of $1,909,847, over $700,000 greater than an electric bus.

![Total Cost of Ownership - Tennessee Transit Buses](chart)

*Source: Argonne National Laboratory's AFLEET Model (2017); fuel and electricity costs adjusted for Davidson, County, TN*

The total cost of ownership is derived from Argonne National Laboratory’s AFLEET Model (2017). Fuel prices are adjusted for the Nashville, Tennessee region. Model inputs are populated using averages of fuel economy and maintenance costs reported directly by transit agencies from the years 2014 to 2017 (see “AFLEET Inputs and Sources” attached).

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c. Maintenance and Fuel Costs

Maintenance and fueling expenses typically account for a significant portion of the lifetime costs of a transit bus. An investment in zero-emission vehicles will dramatically reduce this figure. As highlighted above, all-electric bus maintenance and repair costs are 79 and 70% lower than the maintenance and repair costs for new diesel and CNG respectively.\textsuperscript{33} Furthermore, all-electric buses are fueled by regionally generated electricity, which has demonstrated far more reliable pricing as compared to diesel oil and natural gas.\textsuperscript{34}

<table>
<thead>
<tr>
<th></th>
<th>Fuel Economy (MPGDE)</th>
<th>Maintenance &amp; Repair ($/mi)</th>
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<tbody>
<tr>
<td>Electric</td>
<td>19.44</td>
<td>$0.17</td>
</tr>
<tr>
<td>Diesel</td>
<td>4.16</td>
<td>$0.80</td>
</tr>
<tr>
<td>CNG</td>
<td>3.87</td>
<td>$0.56</td>
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\textit{d. NOx Reductions (lb/$)}

Specific to the Volkswagen Settlement, agencies are instructed to demonstrate their anticipated NOx reductions as a result of their state’s environmental mitigation transportation investments. Many agencies are in search of the investment that results in the greatest NOx lb/$ ratio, but they are only considering the upfront purchase costs in these calculations. If the total lifetime costs are considered, the \textbf{bus technology with the greatest NOx lb/$ ratio is a zero-emission bus.}

\textsuperscript{33} Metrics derived from Argonne National Laboratory’s AFLEET Model (2017) and ZEB transit studies.  
\textsuperscript{34} https://www.afdc.energy.gov/fuels/prices.html.
e. Charging Infrastructure Costs

There are two options for electric bus charging infrastructure. First, a typical Class 3 slow charger can charge a bus in 3-5 hours. These chargers cost around $65,000 to purchase and install.\(^{35}\) Again, this cost can be covered by Mitigation Trust funds. With advances in battery technology increasing bus range, new models can achieve up to 350 miles on a single charge, enough to allow an operator to charge its buses overnight and then operate all day without needing to stop to refuel.\(^ {36}\)

Alternatively, fast chargers can provide 30 miles worth of charge in 8-13 minutes.\(^ {37}\) This design allows a bus to charge during the course of its normal route, eliminating the need to come out of circulation to refuel.

\(^{35}\) Air Resources Board Cost Model, slide 24.
2. Mitigation Trust Funds Can Be Used To Purchase and Install Electric Buses and Charging Equipment; Locked in O&M Savings Can Then Be Used to Expand the EV Bus Fleet, Generating Further Savings

Mitigation Trust funds are available to meet the higher capital requirements of an electric bus fleet, allowing a transit agency to then lock in the lower lifetime costs of EV buses. The agency can then use the lifetime savings on fuel and maintenance to procure additional EV buses and build on lifetime savings going forward. For the reasons discussed above and depicted in the table below, once costs are viewed on a lifetime basis, investing in electricity is far preferable to diesel or CNG vehicles.

<table>
<thead>
<tr>
<th>Costs (Capital + O&amp;M) for Diesel, CNG, Electric Buses</th>
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<tbody>
<tr>
<td><strong>Purchase Price</strong></td>
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<tr>
<td>---------------------</td>
</tr>
<tr>
<td>$480,000</td>
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<tr>
<td><strong>Fuel Cost (DGe)</strong></td>
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<tr>
<td><strong>Fuel Cost (annual)</strong></td>
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<tr>
<td><strong>Fuel Efficiency</strong></td>
</tr>
<tr>
<td><strong>O&amp;M cos ($/mile)</strong></td>
</tr>
<tr>
<td><strong>Additional Lifetime O&amp;M (compared to electric)</strong></td>
</tr>
<tr>
<td><strong>Approximate Lifetime Cost</strong></td>
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These savings are not exclusive to transit buses. Electric school buses are in use by a number of municipalities throughout the country.\(^41\) School buses are ideal fits for electrification. Buses typically operate two shifts each day, once in the morning and again in the afternoon. Down time between shifts allows buses to fully recharge. In King County, California, two electric school buses were estimated to save roughly 16 gallons of fuel per bus per day. This amounted to an annual fuel saving of over $11,000 per bus.\(^42\)

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\(^{40}\) Id.


B. Electric Garbage Trucks

While electric garbage trucks are still relatively new technology, there are inherent benefits to replacing fossil-fueled garbage trucks, which emit about twenty times the carbon of the average U.S. home.43 Similar to electric buses, electric trucks are a smart option for Mitigation Trust funds and have the opportunity to provide great NOx emissions reductions for the state of Tennessee. Electric medium duty trucks (Class 4-6) are widely used and in active service on the road today. They are available from Smith Electric, ZeroTruck, Boulder Electric Vehicle, EVI-USA, and Freightliner Customer Chassis Corp.44 These companies offer a number of configurations, primarily for localized/urban (so-called “last mile”) delivery and goods/refuse hauling.45 Because of limited battery range—typically a 100-mile maximum—today’s electric medium duty trucks are most effectively deployed in urban or short haul settings.46 Fossil-fueled garbage trucks tend to achieve just two to three miles per gallon and stick to standard routes. Like the electric school bus, these short, fixed routes make garbage trucks ideal candidates for electrification.

Converting to electric garbage trucks makes economic sense. A 2013 study placed the total cost savings of electric versus diesel truck ownership at 22%.47 That study assumed a cost premium of $25,000 to $37,000 for electric compared to diesel trucks. Notably, since that study was published, battery prices have dropped from $625/kWh, the value used in the study, to under $200/kWh.48 Because the up-front cost of an electric truck is significantly influenced by the cost of the battery pack, the study likely understates current lifetime cost savings of switching to electric trucks.

Electric garbage trucks also save significant maintenance costs over their lifetime. For example, a diesel “last mile” truck registers maintenance costs around $0.22/mile.49 These costs include oil changes, brake repairs, belt replacements, and regular inspections. An electric garbage truck, by contrast, costs only $0.056-$0.111/mile.50 Electric trucks simply have fewer parts to replace and repair. Additionally, electric drive trains and regenerative braking reduce wear and tear on remaining parts like brake pads. Because garbage trucks make frequent stops

46 Id.
50 Id.
and travel in congested urban areas, brakes are historically one of the most frequent and expensive costs. With electric drive-trains brake repairs can be reduced by 20-30%.  

Diesel powered class 4-7 trucks emit, on average, between 4.35 and 7.47 grams of NOx per mile traveled. Electric vehicles have zero tailpipe emissions. Converting to electricity therefore has a significant impact on local air pollution. Additionally, from a well-to-wheels perspective, electric garbage trucks can reduce greenhouse gas emissions by 27-61%, and they keep improving their environmental performance as our electricity grids get cleaner and cleaner.

C. Multiplying Funds Through the DERA Program

States have the option to apply for Volkswagen funding through a partnership with the Federal Diesel Emissions Reductions Act (“DERA”), a program enacted by Congress in 2011 to help reduce diesel engine emissions nationwide. Through this suggested partnership of Volkswagen Settlement and DERA Programming, Tennessee could receive additional funding for electrification of its mobile sector. To achieve this, VW Settlement funds may be used for the DERA Program’s voluntary non-federal matching option. Specifically, we encourage Tennessee to apply for program funding through DERA from the EPA, and then use Volkswagen Settlement funds to participate in the DERA voluntary match program. As a result, the EPA will increase their DERA Program funding by an additional 50%.

For example, suppose Tennessee submits a zero-emission transit bus program proposal and receives $200,000 through DERA. If the state matches this amount with $200,000 from VW Settlement funds, the EPA will add a bonus $100,000 to the total program funding. Consequently, Tennessee would receive a total of $500,000 for its zero-emission transit bus proposal, as compared to the initial $200,000.

The goal of eligible DERA programs is to reduce vehicle or vessel NOx emissions, so many of the eligible programs are comparable to those outlined in the VW Settlement. There are some additional programs, however, included in DERA but not included in the Settlement. These include repowering non-road engines (e.g., agricultural irrigation pump engines, bull-dozer engines), building up Truck Stop Electrification (or “Electrified Parking Spaces”), and programming for increased Idle Reduction Technology. Ultimately, we support any action that will increase the available funds, so long as the funds are directed towards electrification of Tennessee’s mobile source sector.

III. Tennessee Should Use the Full 15% of Allowable Mitigation Trust Funding to Foster Development of Electric Vehicle Charging Infrastructure

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51 Id.
53 Electric Urban Delivery Trucks, supra note 49 at 8028–29. This variation depends on the operational characteristics of the diesel truck being replaced. If a diesel truck runs a small route and uses less fuel/day then there are less GHGs to reduce. Id.
In order to maximize reductions in NOx emissions and foster demand for EVs, Tennessee should utilize the full 15% of allowable Mitigation Trust funding for EV charging infrastructure. On-road non-diesel light duty vehicles (LDVs) presently account for 26% of all NOx emissions in the state, exceeding emissions from power plants (21%) and all other mobile source categories. Tennessee also has the opportunity for increased economic opportunities from electric vehicle growth. Tennessee is home to not only the Nissan LEAF manufacturing facility, but also to Denso’s electric and autonomous parts manufacturing. Strategic investments in EV charging infrastructure targeting this mobile source segment can simultaneously advance multiple state goals.

A. Investments in EV Charging Infrastructure Will Produce Significant NOx and Climate Benefits

Transportation plays a significant role in driving unsafe levels of smog and other pollution that adversely affects public health. A 2013 MIT study found that, of all sectors, the transportation sector was the greatest contributor to premature emissions-related deaths in the U.S., resulting in 53,000 early deaths per year from vehicle tailpipe emissions.54

Not only will accelerating vehicle electrification reduce tailpipe NOx emissions, it will also generate significant climate benefits. Well-to-wheel studies (studies that consider all sources of greenhouse gases, including fuel production, fuel storage, fuel delivery, and vehicle energy use) agree that electric vehicles emit the far fewest amounts of pollutants into the air.55 Additionally, as the power grid becomes cleaner, EVs will leave a continually declining carbon footprint.

B. In Order to Strategically Build out Tennessee’s Light Duty Vehicle Charging Infrastructure, the State Should Target the Following Areas: Highways, Multi-unit Dwellings, Workplaces, and Disadvantaged Communities

Investments in EV charging infrastructure are critical to putting zero emission vehicles on the road in Tennessee. Studies have concluded that the absence of an adequate, existing charging infrastructure for EVs is an impediment to their adoption.56 This is true for several reasons. First, it creates a higher up-front capital cost to an EV user to install a charger. Second, many potential EV owners neither own nor operate a parking space in which they can install a charger. Third, the lack of a robust charging infrastructure on highways contributes to consumer concern about travel limitations. Fourth, the lack of visible, installed charging infrastructure results in range anxiety and lower public awareness of EVs. Using the settlement funding to build out charging infrastructure in appropriate locations can overcome these hurdles.

54 Massachusetts Institute of Technology Laboratory for Aviation and the Environment, Air Pollution Causes 200,000 early deaths each year in the U.S. (2013), http://lae.mit.edu/air-pollution-causes-200000-early-deaths-each-year-in-the-u-s/.
Several factors provide helpful guidance in determining where to build out charging infrastructure and the level of charging needed:

1. **Is there an impediment to the market providing charging in these locations?**
2. **Are the locations places where the parked vehicles have long “dwell” times (i.e., are parked for periods of time sufficient to charge the vehicle)?**
3. **Are the locations accessible by large numbers of potential EV drivers?**
4. **Are the locations likely to increase public awareness? and**
5. **Are the investments providing benefits equitably, including to disadvantaged communities?**

Based on consideration of these factors in Tennessee, we believe prudent near-term investments in LDV EV charging infrastructure should be made in the following types of locations: Highways, Workplaces, and Disadvantaged Communities.

1. **LDV Charging Priorities: Highways**

Mitigation Trust funding should be used to build out high speed direct current (“DC”) charging infrastructure on highways. To do so will be critical to resolving consumer concern about travel limitations and increasing public awareness.

Access to DC fast charging influences consumer’s choices and is therefore an important part of a comprehensive charging network. One critical benefit of DC fast charging is that it enables planning inter-city and long-distance travel that is otherwise impossible or impractical for battery-only electric vehicle drivers.\(^{57}\) In addition to inhibiting distance travel and exacerbating range anxiety, consumer research indicates that a “lack of robust DC fast charging infrastructure is seriously inhibiting the value, utility, and sales potential” of typical pure-battery electric vehicles.\(^{58}\) Consequently, increased access to DC fast charging stations must be achieved in order to build an effective EV infrastructure that will drive EV adoption.

As with many network industries, the development of DC fast charging networks suffers from a “chicken-or-the-egg” market coordination problem. Prospective EV owners are reluctant to purchase an electric car in the face of limited access to charging infrastructure because the EV’s range and use would be limited. Likewise, prospective hosts and private funders of EV charging infrastructure cannot see a business case for EV charging station investment where too few EVs are in use to provide a return on investment.

The market coordination problem is acute for DC fast charging stations, which have high upfront costs and require significant revenues for the owner-operator to achieve profitability.\(^{59}\) However, quantitative research on this “chicken-or-the-egg” problem in the EV context not only indicates that the increased supply of more EVs would drive the deployment of more public charging and vice-versa, but that a financial subsidy given to infrastructure investment will

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\(^{59}\) Nigro et al., *supra* note 57.
increase EV sales by more than twice the amount of the increase if the financial incentive is provided for EV purchase.  

While more study is needed in this area, given the discrete number of high-traffic commuting corridors in Tennessee, a robust network of DC fast chargers could be established fairly easily in the State. As the maps below illustrate, high power EV charging stations are largely concentrated in Nashville, with additional clusters in Knoxville, Chattanooga, and Memphis. EV drivers, the Tennessee economy and local air quality would all benefit from additional EV charging stations: between Memphis and Nashville on the I-40 corridor; north along I-81 from Knoxville to the state border; along I-65 north and south of Nashville; on the high-traffic I-24 corridor that passes through Nashville and by Chattanooga; on I-40 east of Nashville; going north from Memphis; spanning the length of southern Tennessee.

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Charging Stations in Central Tennessee

Charging Stations in Eastern Tennessee

High speed charging infrastructure installed with EMT funds should be coordinated with Electrify America’s work under the Zero Emissions Infrastructure Investment Plan. Electrify America will be spending $2 Billion over the next ten years or so on EVSE, including on highways.

Moreover, when Tennessee installs these chargers it should install the highest speed chargers the market offers. Sites should incorporate multiple connector types to help
accommodate various manufacturer differences, and provide at least four DC fast chargers per location. Tennessee should also plan ahead by installing infrastructure that allows for rapid scale up, such as stringing high voltage/high capacity cables to highway locations that can service the larger number of EVs that will be on the road in the future. This will also serve as a way to meet customer demand for faster charging times.

2. **LDV Charging Priorities: Workplaces**

Mitigation Trust funds should also be used to build out charging at workplaces. Workplaces offer another location with long dwell times to recharge batteries, and access to electricity fuel at workplaces reduces range anxiety, improves the EV value proposition, and greatly increases consumer awareness of EVs. According to the U.S. Department of Energy, people who have access to workplace charging stations are twenty times more likely to become EV owners.  

Likewise, the National Research Council study also reports that charging at workplaces offers an important opportunity to increase EV adoption and to increase electric miles driven.

3. **LDV Charging Priorities: Disadvantaged Communities**

In siting both charging infrastructure and in education and outreach, Tennessee should seek to serve disadvantaged communities, which overwhelmingly tend to be low-income and communities of color. As noted in a 2011 report by The Greenlining Institute, such communities are more heavily impacted by air pollution and are more concerned by it. These communities are a natural but largely untapped market for EVs. As section 5.2.10 of the Settlement Agreement provides, in approving plans states must include:

A description of how the Eligible Mitigation Action mitigates the impacts of NOx emissions on communities that have historically borne a disproportionate share of the adverse impacts of such emissions.

Ensuring that multi-unit dwellings and workplaces in disadvantaged and environmental justice communities are provided charging infrastructure is a critical component of any plan to use Mitigation Trust funds.

Use of funding for LDV charging infrastructure should be conditioned on a load management tool, such as time-of-use rates, and should result in opportunities for fuel cost savings compared to fossil fuels. In addition, electricity is a fundamentally cheaper fuel than gasoline, and that advantage for EV drivers should not be overridden, particularly using settlement funds intended for public benefit. Fuel cost savings are a key driver of EV purchases. One survey of over 16,000 EV drivers found that “saving money on fuel costs” was the most

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important motivator of their EV purchase.\textsuperscript{64} The use of Mitigation Trust funds should therefore be conditioned on charging rates being reasonable and delivering the fuel cost savings that electricity can provide.

\textbf{C. An Investment in EV Charging Infrastructure Will Produce In-State Economic Benefits, Increase In-State Jobs, and Save Tennessee Residents Money}

To electrify Tennessee’s transportation sector, the state will have to build out the charging network and other assets. Doing so creates well-paying construction jobs. For example, NRG estimated that just its initial build-out of charging infrastructure in California would generate 1,500 in-state jobs.\textsuperscript{65} NRG expects that its $102.5 million investment to build EV charging infrastructure in California will also “create a gross output of more than $185 million when the employment and procurement of goods and services are factored together, equating to an additional $83.3 million in indirect economic activity by 2016.”\textsuperscript{66} As Terry O’Day, NRG Director of California Business Development, explained, the project will “build out the California EV infrastructure . . . while also contributing to the California economy through job creation and infrastructure spending.”\textsuperscript{67} Jobs are also created as people are needed to manufacture the charging equipment itself. Rocky Mountain Institute reports that EnerDel added 1,400 jobs at its Indiana-based EV lithium-ion battery plant and plans to add another 3,000 to meet growing demand.\textsuperscript{68} California-based charging station manufacturers Coulomb Technologies has grown from two to 100 jobs over the early stages of vehicle electrification efforts, according to a company representative.\textsuperscript{69}

The Tennessee economy stands to benefit from increased demand for electric cars in general. One of every 400 new cars sold in the state in 2016 was an electric vehicle, putting Tennessee at number 11 for electric vehicle popularity.\textsuperscript{70} As referenced above, Tennessee is also home to the most productive auto plant in North America, Nissan, in Smyrna, TN, which produces the Nissan Leaf (an EV) and electric car batteries—two products that saw the addition of 300 manufacturing jobs in 2016 alone.\textsuperscript{71}

Electrifying Tennessee’s transportation will also save residents money on fuel costs. It is cheaper to fuel a vehicle with electricity than with oil, or even natural gas. As the US Department of Energy (“USDOE”) explains, using gasoline as a surrogate, “[o]n average, it costs about half as much to drive an electric vehicle” in terms of cost per gallon of gasoline versus the

\textsuperscript{64} Center for Sustainable Energy, California Plug-in Electric Vehicle Owner Survey Dashboard.
\textsuperscript{66} Id.
\textsuperscript{67} Id.
\textsuperscript{68} Matthew Mattila & J.L. Bellew, Do EVs Create Jobs and Improve the Economy?, Rocky Mountain Institute, 2011, http://blox.rmi.org/EVCreateJobsImproveEconomy.
\textsuperscript{69} Id.
\textsuperscript{70} Auto Alliance, https://autoalliance.org/economy/consumer-choice/electric-vehicles/.
\textsuperscript{71} Tennessee Department of Economic & Community Development, http://www.tnecd.com/industries/automotive/.
cost per “gallon equivalent” of electricity. In Tennessee, despite persistent low gas prices, an “e-gallon” retails for only $0.96, while regular gasoline costs $2.37.

Furthermore, the price volatility of fossil fuels is notorious and subjects Tennessee’s residents and businesses to expected fluctuations in the costs of living and conducting business. In comparison, electricity prices are highly stable and consistent over time, especially considering that Tennessee is mostly serviced by the Tennessee Valley Authority (TVA), which has historically had electricity prices far more stable than those for liquid transportation fuels. The stability of electricity is evident in the graph below comparing the fluctuating cost of fossil fuels versus electricity since 2000, using data from the USDOE:

**Figure 4**

![Average Retail Fuel Prices in the U.S.](image)

*Source: USDOE Alternative Fuels Data Center*

Using the Mitigation Trust funds to advance engine electrification therefore keeps Tennessee’s hard earned money in state and leads to lower fuel costs for Tennessee’s residents and businesses. It will also help protect them from the price shocks that come from fossil fuel price volatility. In addition, unlike the fossil fuel supply chain, the majority of new demand financed by EV fuel cost savings goes to in-state services, “a source of diverse, bedrock jobs that are less likely to be outsourced.”

Investment in electric transportation also saves Tennessee’s electric customers money by placing downward pressure on electricity rates. This benefits all utility customers, regardless of whether they own electric vehicles. Electric vehicle charging will increase electricity sales, which, if well integrated into the electric power system, can dilute the fixed costs of electricity

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transmission and distribution and lower electricity rates for all utility customers. Vehicles are used for transportation during only a small fraction of the day, and therefore an EV can be charged nearly any time. If vehicle charging is managed to occur during off-peak periods (when the electric grid is underutilized and there is plenty of spare capacity in the generation, transmission, and distribution system) this new load can be served by existing and often underutilized infrastructure without proportionally increasing a utility’s costs. In turn, this can reduce the average cost of power for all utility customers. Similarly, EV load can be shifted to facilitate the integration of variable generation from renewable sources. By managing EV charging to match electricity demand with renewable generation, we can stabilize power flows and reduce the average cost of power.

Analysis performed by the Pacific Northwest National Laboratory shows that large numbers of EVs charging during off-peak hours could significantly lower the marginal cost of energy. The same analysis found that there is sufficient spare generation capacity in the nation’s electric grid to power nearly the entire light-duty passenger fleet if vehicle load is integrated during off-peak hours and at lower power levels.

IV. Conclusion

With the funds from the VW Environmental Mitigation Trust, Tennessee should maximize the 15% of the total allowed for the expansion of electric vehicle charging infrastructure throughout the state. The remaining funds should then be used to electrify bus fleets and garbage trucks, concentrating on large cities that feel the worst impacts of NOx pollution like Nashville, Memphis, Knoxville, and Chattanooga. Electrifying these bus and truck fleets will lead to cost savings and, if the total lifetime costs are considered, the greatest NOx lb/$ ratio. Particular attention should be paid to environmental justice communities. As previously stated, people of color and low-income individuals in Tennessee bear a disproportionate share of the NOx-driven ozone pollution in the state. Funding from the Mitigation Trust can support the state’s goals of cleaning up the air in these areas. Electrification of the mobile sector is the best investment the state of Tennessee can make, and we strongly encourage Tennessee to use the Mitigation Trust funds to that effect.

Thank you for your consideration.

78 Id.
Respectfully submitted,

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Appendix A—Cited Resources and Further Information


Live Tracking of King County Metro’s Electric Buses: http://energy.proterra.com/KCM/

### AFLEET Inputs and Sources:

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