From Deceit to Transformation:

How Connecticut Can Leverage Volkswagen Settlement Funds to Accelerate Progress to a Clean Transportation System

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Table of Contents

Environmental Mitigation Trust: An Opportunity for Transformation

Volkswagen (VW) perpetuated a fraud on the American people, deceiving consumers into believing that they were getting the best possible combination of performance and sustainability. But VW's promises were nothing more than lies that significantly harmed our collective health and the health of our environment. Yet, their deceit now represents a historic opportunity to drastically reduce harmful pollution that makes us sick and destroys the planet, while also providing an essential down payment toward the transition to a clean and modern 21st century transportation system.

This future, however, is not assured.

There remains a real risk that these funds will be wasted on outdated and polluting technologies, including those that rely on diesel and natural gas, while foregoing the transition to clean, all-electric vehicles (EVs) and supporting infrastructure. Indeed, of the numerous possible uses outlined in the VW settlement, many allow for the replacement of older, dirty diesel technology with new, still dirty, diesel technology, compressed natural gas (CNG) or diesel-electric hybrids.[1]

Relative to all-electric vehicles, diesel and natural gas produce significantly more tailpipe nitrogen oxides (NO_X) and greenhouse gas (GHG) emissions as well as more total emissions over their lifecycle. In fact, in 2012, the International Agency for Research on Cancer classified diesel engine exhaust as carcinogenic to humans based on evidence that exposure increased the risk for lung cancer, highlighting the importance of transitioning away from diesel in particular.[2]

Accordingly, investing in diesel and natural gas technologies with VW settlement funds would represent a significant missed opportunity to accelerate the transformation to an all-electric, clean-running transportation network that could help reduce illness, save lives and protect the planet. The VW settlement[3] clearly envisions and encourages such a use. For instance, the Environmental Mitigation Trust (EMT), established under the VW settlement, can be used to subsidize 100 percent of the purchase of clean all-electric buses for use in public transit agencies throughout the country. Similarly, up to 15 percent of each state's VW EMT funds may also be invested in the acquisition, installation, operation and maintenance of electric vehicle charging infrastructure, including along the states' highways.[4] Placing these publicly available charging stations on government owned property would allow the state to take advantage of the 100 percent subsidy provided under the VW settlement, while reducing key impediments to the transition to an all-electric vehicle fleet.[5]

Given the structure of the VW settlement and its available uses, the overwhelming need to reduce harmful emissions that make us sick and destroy the planet, along with the opportunity to accelerate a market transformation toward an electrified transportation system, our report recommends that the maximum allowable amount (15 percent) be invested in fast charging electric vehicle infrastructure and the remaining amount (85 percent) be spent on new, all-electric transit buses to replace older, outdated diesel buses.

Ensuring that the funds are used in this way has several distinct benefits including, but not limited to:

- Drastically reducing NO_X, ground-level ozone (smog) and particulate matter to protect our health and environment;
- Significantly reducing CO_2 and other greenhouse gas (GHG) emissions;
- Reducing long-term fuel consumption, maintenance and operation costs of public fleet vehicles;
- Adding needed stability to the price of energy inputs for vehicles;
- Increasing public awareness and adoption of EVs as cleaner alternatives to traditional gas-powered vehicles.

Volkswagen's Emissions Cheating

In 2014, researchers at West Virginia University discovered that Volkswagen Jettas and Passats were emitting nitrogen oxides over the legal limit. Upon further investigation, the Environmental Protection Agency (EPA) discovered VW had installed "defeat devices" in some 567,000 "clean diesel" cars in the United States to avoid emissions control laws. These cars, model years 2009 to 2016, were found to be illegally emitting NO_X pollution, up to 40 times allowable U.S. compliance levels in some cases.

In 2015, the EPA officially filed a complaint against VW, with other parties soon following suit. The defeat devices installed use elaborate software to turn on emissions controls when a vehicle's emissions are tested, to ensure they meet clean air standards, and then turn them off during regular driving.

Figure I. Impacted Models[6]

Volkswagen Beetle, Beetle Convertible (2013-2015)	Volkswagen Touareg (2009-2016)	Porsche Cayenne (2014-2016)
Volkswagen Gold (2010-2015)	Audi A6 Quattro (2014-2016)	Audi A8/A8L (2014-2016)
Volkswagen Golf Sport Wagen (2015)	Audi A7 Quattro (2014-2016)	Audi Q5 (2014-2016)
Volkswagen Jetta, Jetta Sport Wagen (2009-2014)	Audi A3 (2010-2013, 2015)	Audi Q7 (2009-2016)
Volkswagen Passat (2012-2015)		

Volkswagen marketed these "clean diesel" cars to their customers as vehicles that could meet clean air standards while also maintaining high levels of fuel economy and performance. Unfortunately, these vehicles were meeting the marketed fuel economy and performance standards only by disabling the emissions controls causing elevated levels of harmful emissions to enter the environment.

Health and Environmental Impacts

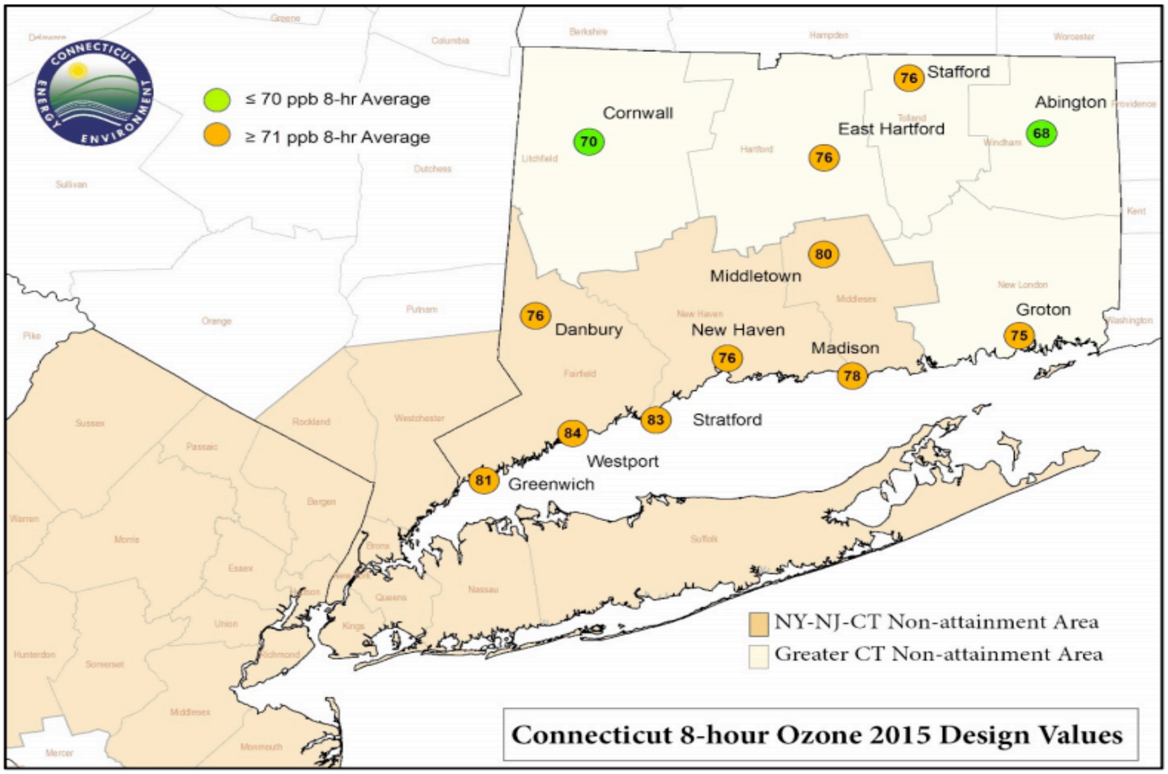
NO_X represents a family of seven compounds, of which NO_2 is the most prevalent and the only one regulated by the EPA. NO_2 is largely produced from the oxidation of nitric oxide that occurs in combustion engines, mostly from motor vehicles.[7] According to a report from the World Health Organization, NO_2 concentrations so closely follow vehicle emissions that in many situations, NO_2 levels are a reasonable marker of exposure to traffic-related emissions.[8] Reducing vehicle emissions has a direct impact on NO_X emissions.

Unfortunately, nitrogen oxides pose a serious threat to human health. The EPA warns that, "Breathing air with a high concentration of NO_X can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions, and visits to the emergency room. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to [other] respiratory infections."[9] Even worse, NO_2 emissions are particularly dangerous for the most vulnerable among us. The EPA has concluded that, "people with asthma, as well as children and the elderly, are generally at greater risk for the health effects of NO_2."[10]

In addition to direct health impacts, high concentrations of NO_X also mix with volatile organic compounds (VOC) to create ground-level ozone (smog), which has a negative impact on both our health and the environment.[11] Breathing smog can trigger various health issues, such as chest pain, coughing, throat irritation and airway inflammation, while reducing lung functions and harming lung tissue.[12] NO_X also contributes to acid rain, nutrient pollution in coastal waters and adds to fine particulate matter in the air.[13] Particulate matter, which forms as a result of complex reactions from chemicals such as nitrogen oxides and sulfur dioxide, can also have harmful effects on heart and lung health.[14]

For these reasons, reducing NO_X emissions must be a crucial part of the larger goal to ameliorate Connecticut's pollution problem, especially since the state suffers from some of the highest ozone levels in the eastern United States.[15] Between 2013 and 2015, ten of the twelve ozone monitors in Connecticut recorded ozone levels that exceeded the EPA's National Ambient Air Quality Standards for ozone of 70 parts per billion (ppb).[16]

Figure II. Ozone Monitors in Connecticut with 2015 Design Values[17]



Mobile sources (on-road vehicles, off-road vehicles and equipment) account for approximately two-thirds of total NO_X emissions in the state, with fuel combustion from electricity generation coming in a distant second with 25.8 percent of NO_X emissions.[18] In 2013, transportation accounted for 42 percent of all CO_2 emissions in the state or 14.4 million metric tons of CO_2.[19] Taking steps to accelerate the electrification of Connecticut's transportation system is therefore a necessary part of any emissions reduction plan and a critical component of building a 21st century transportation network capable of meeting current and future challenges.

Partial Volkswagen Settlement – October 2016

When Volkswagen was caught systematically cheating on emissions tests, the U.S. Department of Justice (DOJ) filed suit for violations of the Clean Air Act. On October 25, 2016, the company and the DOJ reached a partial settlement on 2.0-liter vehicles, covering about 475,000 cars, which was then approved by U.S. District Court Judge Charles Breyer in San Francisco.[20] The settlement allocates $10 billion in available compensation for owners of noncompliant Volkswagens and $4.7 billion for use in environmental mitigation actions.[21]

Figure III. 2.0-Liter Noncompliant Vehicles[22]

Volkswagen Beetle, Beetle Convertible (2013-2015)	Volkswagen Golf (2010-2015)	Volkswagen Golf Sport Wagen (2015)
Volkswagen Jetta, Jetta Sport Wagen (2009-2014)	Audi A3 (2010-2013, 2015)	Volkswagen Passat (2012-2015)

Pursuant to the settlement, the $4.7 billion available for environmental mitigation actions will be split into two funds:

1. $2.7 billion for an Environmental Mitigation Trust (EMT), designed to support programs and actions that reduce NO_X emissions. These funds will be allocated to each state via a formula, based on how many eligible VW cars were registered in the state at the time of the settlement. The funds can be used in a number of ways detailed in the VW settlement, leaving open the possibility of squandering this opportunity to truly lower NO_X emissions and transform the transportation sector for years to come.

2. $2 billion for a Zero Emission Vehicle (ZEV) Fund, of which $800 million is specifically earmarked for use in California to be distributed in equal 30-month installments of $200 million. The remaining $1.2 billion is for use in the rest of the country and will also be distributed in 30-month installments over the next 10 years. Investments will be proposed by VW and reviewed by the California Air Resources Board (CARB) for California-related projects and the EPA for all others.

How Does Connecticut Get its Share of Funding?

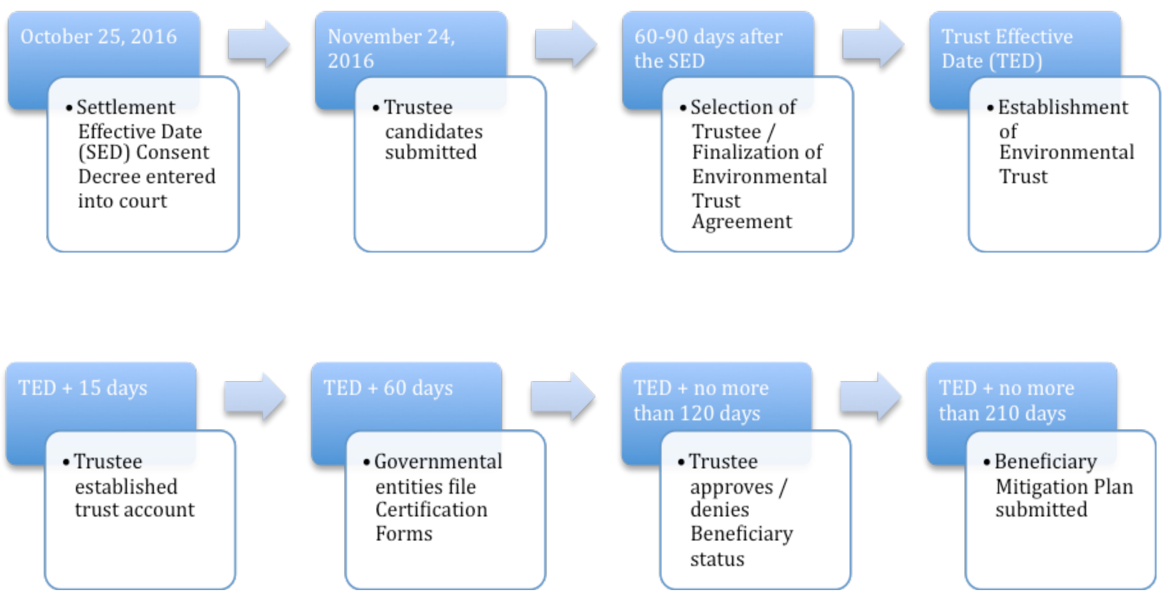
Pursuant to the VW settlement, the Environmental Mitigation Trust is distributed to each state via a formula based on how many noncompliant diesel cars were registered in that state. Each state may decide how to allocate their funds in order to "reduce emissions of NO_X where the 2.0-liter vehicles were, are, or will be operated."[23]

Figure IV. Environmental Mitigation Funds: Connecticut and Neighboring States[24]

Connecticut	$51.6 million
New York	$117.4 million
Massachusetts	$69.1 million
Rhode Island	$13.5 million
Vermont	$17.8 million
New Hampshire	$29.5 million

It will be up to the governor in each state to designate a lead agency to manage the funds. This is achieved by submitting a Beneficiary Certification Form and must be done within the first 60 days following the Environmental Mitigation Trust Effective Date, which is expected to be in January 2017.[25] The beneficiary agency will then have 90 days after being deemed a Beneficiary to submit and make public a Beneficiary Mitigation Plan describing how the state would spend its EMT funds.[26] Beneficiaries can expect to have access to trust funds within about six months of the Trust Effective Date and can plan to spend those funds over no less than 3 years and no more than 10 years.[27]

Figure V. Environmental Mitigation Trust Timeline



Already in Connecticut, the Department of Energy & Environmental Protection (DEEP) is seeking input on how the funds allocated to Connecticut should be spent and residents have been invited to submit comments and suggestions to DEEP.mobilesources@ct.gov. This is similar to steps taken in Colorado and California, where open comment periods allowed public input on uses for the EMT funds and ZEV funds.

The Case for Electrifying Connecticut's Highways

The VW settlement is a unique opportunity for Connecticut to make a substantial down payment on its commitment to increase the adoption of electric vehicles by making them more accessible and practical for trips anywhere in the state. Doing so has substantial economic, health and environmental benefits, including assisting in the reduction of GHG emissions and air pollution. In 2015, the Natural Resources Defense Council and the Electric Power Research Institute reported that switching 53 percent of U.S. vehicles to electric by 2050 would reduce GHG emissions from transportation by 52 to 60 percent.[28]

Yet, to meet this goal, it will be essential to provide consumers with the required infrastructure to support electric vehicle adoption. The best way to do this is through the use of fast chargers, which can fully charge a vehicle in fewer than 30 minutes. Such chargers are ideal for high-traffic commercial locations, gas stations, or along major transportation corridors, such as highways. In contrast, slow chargers are better suited for charging at home or work.

Not surprisingly, consumers have strong preferences for what kind of chargers they would like to see. A survey by NRG eVgo, a leading charge provider, found that drivers preferred fast charging 12-to-1 over Level 2 slow charging when both options were available at one site.[29] However, according to the U.S. Department of Transportation (U.S. DOT), only about 30 of the approximately 290 publicly available charging stations in the state, or about 10 percent, are fast charging stations. Given these advantages, the lack of substantial fast charging infrastructure, and the need for greater adoption of electric vehicles, funds invested in charging stations should focus on providing a fast charge along high-traffic corridors.

Reducing Range Anxiety

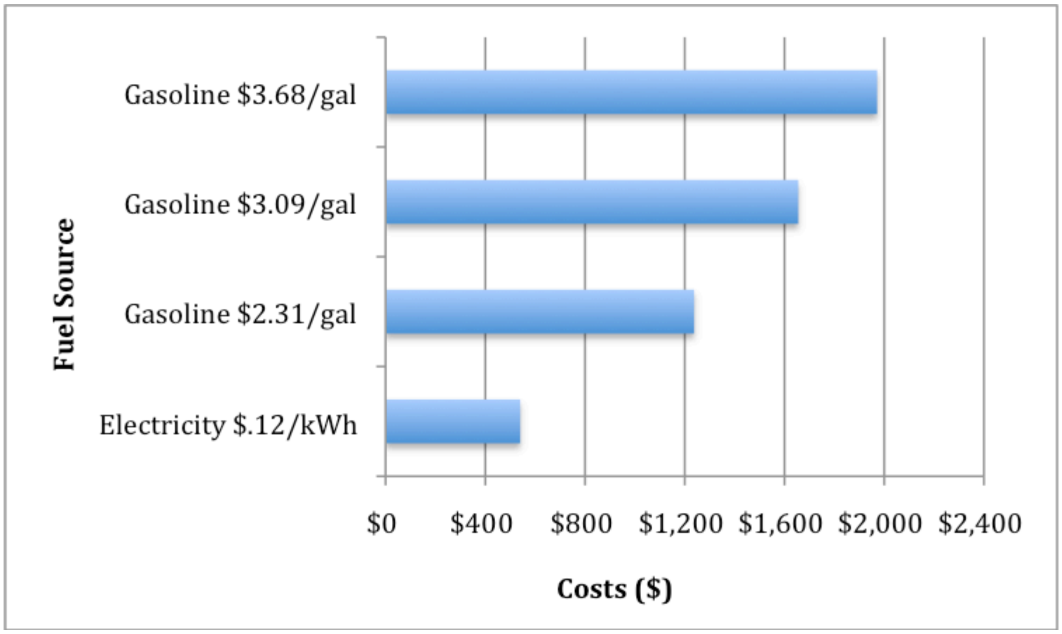
Even though most daily trips are easily within the current range of an EV, many people want assurances that they can take longer trips with their vehicle. In fact, one of the biggest challenges to electric vehicle adoption in Connecticut and the U.S. is the lack of charging infrastructure. According to the U.S. Department of Energy's Alternative Fueling Station Locator, there are only 1,981 publicly available fast charging stations in the entire country, or 1 fast charger for every 393 miles of state highway.[30] This failure creates apprehension on behalf of consumers in a phenomenon known as range anxiety, one of the biggest impediments to widespread adoption of electric vehicles.

There is strong evidence that increased investment in charging infrastructure leads to greater adoption of EVs. A 2016 study from Cornell University found that a 10 percent increase in charging stations leads to an 11 percent increase in EV sales.[31] Another analysis by the International Council for Clean Transportation also found a strong correlation between public charging infrastructure density and EV uptake.[32]

Creating Economic Savings

Owning an electric vehicle, including the initial purchase of the car, saves consumers money over time, mainly due to decreased fuel and maintenance costs. According to the U.S. Department of Energy, "on average, it costs about half as much to drive an electric vehicle" in terms of cost-per-gallon of gasoline versus the cost-per-gallon equivalent of electricity.[33] As of December 31, 2016, when prices were an average of $2.31 per gallon of gasoline, the gallon equivalent of electricity only cost $1.16.[34]

Figure VI: Fuel-related Savings[35]



At recent prices, assuming a consumer drives their vehicle 15,000 miles a year,[36] those owning EVs would spend only about $540 per year to charge their car.[37] In comparison, the owner of a gasoline-powered vehicle would spend $1,238 in fuel, more than twice as much as the EV owner.[38] If gas prices rose to $3.09 per gallon, representing the average price of gasoline nationwide over the last five years, the gas-powered car owner would spend $1,655 on gas yearly while the EV owner would save over $1,100 annually.[39] When prices reached their highest point in the last five years, about $3.68 per gallon, gasoline-powered vehicle owners were spending about $1,970 on fuel, while EV owners were saving $1,430 comparatively.[40] While gas prices are unpredictable and can fluctuate wildly, electric prices remain stable over time and give EV owners the added bonus of being able to calculate their long term input costs.

In addition to fuel savings, consumers can also save on yearly maintenance costs when they switch to an EV. In a recent study, electric vehicles saved the average driver about 46 percent in annual maintenance costs.[41] Given that the average yearly maintenance cost of a car is $766.50 a year, these savings equate to over $350 a year per consumer.[42] Taken together with the fuel savings, the total combined yearly economic savings would be between $1,050 and $1,782, depending on current gas prices.[43] Those savings amount to as much as six percent of median per capita income in the U.S.[44]

Critics of EVs frequently point to their higher upfront costs. However, the average price of an electric vehicle has dramatically decreased in recent years due to lower battery costs and increased competition between car manufacturers. In fact, since 2010, the global average cost of an electric car battery fell from $1,000 per kWh to $350 per kWh, a 65 percent decrease in price.[45] Today, a consumer can purchase a new all-electric vehicle for as little as $23,000.[46]

Moreover, almost all electric cars are eligible for a federal tax credit of $7,500 as well as state-specific incentives that can be used to further decrease initial costs.

In Connecticut, the Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) incentivizes purchase or lease of electric vehicles by offering up to $3,000 per vehicle in state-funded rebates to customers.[47]

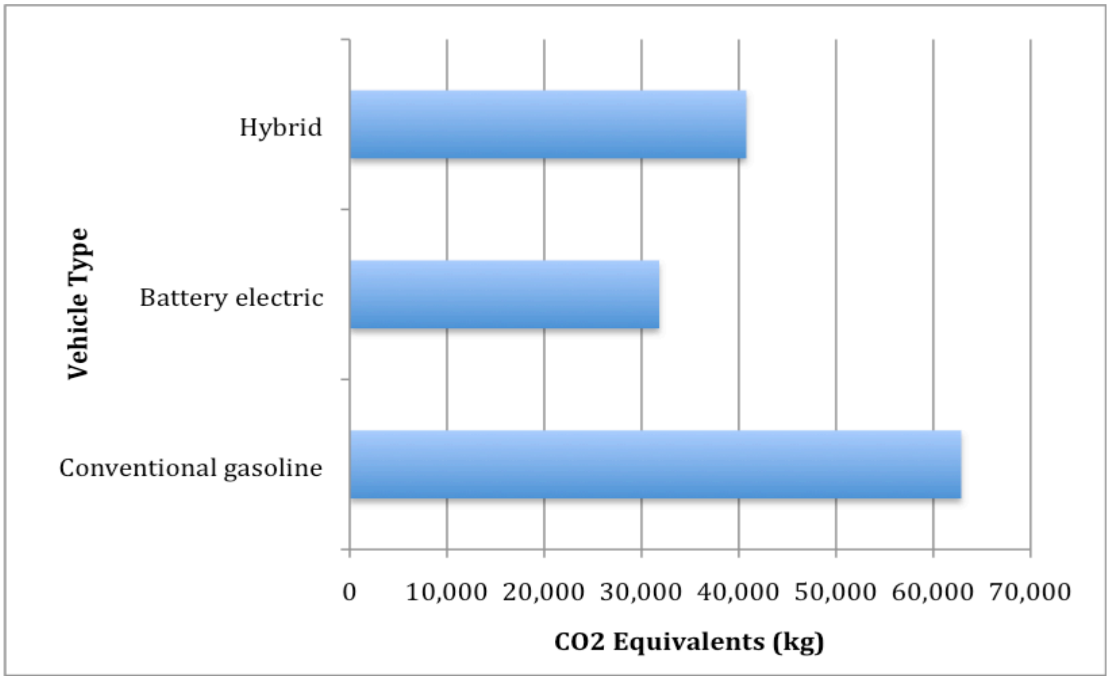
Emission Reductions

Electric vehicles are cleaner than traditional gas-powered vehicles, especially when lifecycle emissions are considered.[48] According to the "Model Year 2016 Fuel Economy Guide," the average vehicle releases seven to nine tons of GHG emissions per year, most of it in the form of CO_2.[49] It would take between 6.6 and 8.5 acres of U.S. forest, or between five and seven football fields worth of forest, one year to sequester the CO_2 emitted by one car in one year.[50]

On the dirtiest regional electric grid in the U.S., EVs produce the same global warming emissions as a 35-mpg gasoline car – almost 15 miles per gallon better than the current fleet mix (21.4-mpg), which represents the average mpg of light duty vehicles currently on the road.[51] Meanwhile on the cleanest grid, electric vehicles emit lower global warming emissions than 85-mpg gasoline cars, roughly four times the current fleet mix.[52]

Moreover, unlike gas-powered cars, EVs already on the road will become cleaner over time as the electric grid draws less power from coal and other fossil fuels and more from renewable resources. Already, between 2009 and 2012, emissions from charging an electric vehicle decreased in 76 percent of the U.S. as a result of cleaner electricity grids and more efficient EVs.[53]

Figure VII: CO_2 Equivalents Lifecycle Comparison[54]

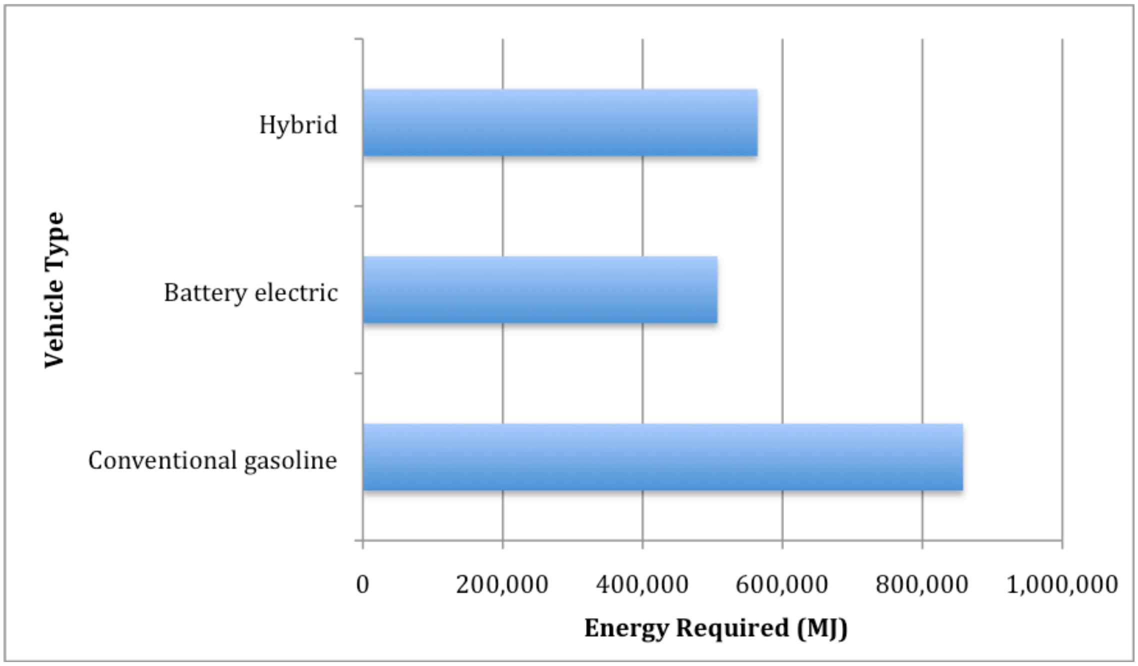


According to a lifecycle analysis of emissions by vehicle type, a gasoline-powered vehicle produces almost twice as much in CO_2 equivalent emissions compared to an all-electric vehicle. While the electric car produced only 31,821 kilos CO_2 equivalents, the gas-powered car produced 62,866 kilos CO_2 equivalents or about twice as much.[55] In terms of pollution, the extra emissions from the gas-powered car over its lifecycle would take 805 trees seedlings 10 years of growing time to sequester.[56] Emissions are drastically higher for the gas-powered vehicle because of the emissions produced from the production, refining and combustion of gasoline as compared to the cleaner nature of electricity production and the lack of tailpipe emissions from EVs.

Saving on Energy Use

Over their lifecycle, EVs also use less energy overall, compared to gasoline-powered and hybrid vehicles.[57] Becoming more energy efficient is a key part of lowering emissions and creating longterm cost savings for consumers and entire communities.

Figure VIII: Energy Input Requirements Lifecycle Comparison[58]



According to an analysis from the University of California Los Angeles, over their lifecycle, including vehicle part and battery/engine manufacturing, transportation, use, and disposal, a gasoline-powered vehicle uses the most energy at 858,145 MJ followed by a hybrid vehicle at 564,251 MJ of energy.[59] An electric vehicle uses by far the least energy at 506,988 MJ, or 41 percent less than the gas-powered vehicle.[60]

Improving Connecticut's Existing Charging Infrastructure

Recently, the federal government came out with a plan for electric charging corridors throughout the country. This included new signage designating areas with charging stations, similar to how we currently sign gasoline stations on highways, that were publicly available with EV charging stations within five miles of the highway.[61] Four routes in Connecticut were identified as alternative fuel corridors - corridors where EV charging stations are available, including: I-95 from the Rhode Island border to the New York border, I-91 from the Massachusetts border to New Haven, I-84 from the New York border to the Massachusetts border, and I-395 from Waterford to the Massachusetts border.[62]

How Much Progress Can We Make with VW Settlement Funds?

Assuming Connecticut invests the maximum allowable amount of EMT funds in EV charging stations, Connecticut could spend $7.7 million on further electrifying its highway system. This would be a significant down payment toward electrifying the state's entire transportation network, easing range anxiety, increasing the public awareness of electric vehicles, and ultimately accelerating market transformation.

A 2014 survey by the Rocky Mountain Institute placed the real price of each new fast charge station between $50,000 and $100,000.[63] Both standard fast charging options, CHAdeMO and Combined Charge System (CCS), can be provided at the same charging station and will allow all EV owners to charge while on the road, much like a regular gas stop for conventional gasoline-powered vehicles.[64]

At these prices and with the $7.7 million in available EMT funds for charging infrastructure, Connecticut could provide between 77 and 154 additional fast charging stations.[65] This would be a significant improvement to the state's current network of about 30 fast charging stations. If one of these stations were placed every 50 miles in Connecticut, it would be enough to cover between 3,850 to 7,700 additional miles of roadway. As of 2011, Connecticut had 3,722 miles of road owned by the state highway agency, much less than most states, meaning that it's possible Connecticut's *entire* state highway system could be equipped with fast chargers.[66]

The Case for Electrifying Public Transit Buses

Investing 15 percent of the available EMT funds in EV charging infrastructure still leaves Connecticut with approximately $43.9 million for additional investments. Under the terms of the VW settlement, there are a number of ways these funds may be allocated. Yet, not all allowable uses are created equal. Spending Connecticut's share of the remaining funds on new diesel technology, compressed natural gas, or diesel-electric hybrids would represent a critical misstep that will move us further away from achieving several essential goals. These goals include reducing pollution, costs and fuel consumption; increasing public awareness of the benefits of electrification; achieving market transformation; and addressing the needs of a broad and diverse set of consumers.

Why Transit Buses?

Bus transit accounts for the largest percentage of public transportation trips and total passenger miles. Nationally, bus trips represent 48.7 percent, or 5.19 billion, of all unlinked passenger trips, 1.37 billion more than its closest competitor, heavy rail.[67] Bus trips also account for the greatest number of total vehicle miles (VMT), 2.2 billion miles, or 41 percent of total transit VMT.[68] Each year, millions of people rely on transit buses to get to school, work and for recreation. For those that rely heavily on transit buses (particularly daily commuters), this can mean nearly a dozen instances of exposure to toxic fumes each week. These ramifications are especially hard felt by the most economically vulnerable consumers and extend to a broad swathe of the populace, including those who may not live in urban centers, but rely on buses for travel, making the consequences geographically diverse. Because transit buses are used in rural, suburban and urban areas, they represent the best opportunity to increase consumer awareness of the benefits of transforming the transportation system to electric. Given this, electrifying public bus fleets is likely to offer the most comprehensive and consequential pollution reduction benefits and the greatest opportunity for public visibility and market transformation.[69]

To accompany the purchase of electric buses, transit agencies would also invest some EMT funds in chargers for their new electric buses.[70] Public transit buses lend themselves well to planning electric charging stations because they follow fixed itineraries and often have intersecting routes over the course of a day. Charging stations for buses could be planned at depots and common intersection points where buses cross, easily allowing electric buses to travel the full length of their routes throughout the day. The installation of electric bus charging infrastructure now will also facilitate the future adoption of additional buses for transit agencies in the state.

Reducing Exposure to Pollution

Nationally, more than 45 million people in the U.S. live, work, or attend school within 300 feet of a major road, airport or railroad and are therefore exposed to elevated levels of air pollution on an almost constant basis.[71] In Connecticut, where about 88 percent of residents live in urban areas, the percent is likely to be even higher.[72] While all individuals would benefit from reduced pollution, riders who regularly take public transit, those that find themselves in compact urban areas and those that live close to major transit hubs would especially benefit from buses that do not contribute to air pollution while idling or in transit. Neither diesel nor CNG buses lead down that better path.

Figure IX. Annual Tailpipe Emissions by Bus Type[73]

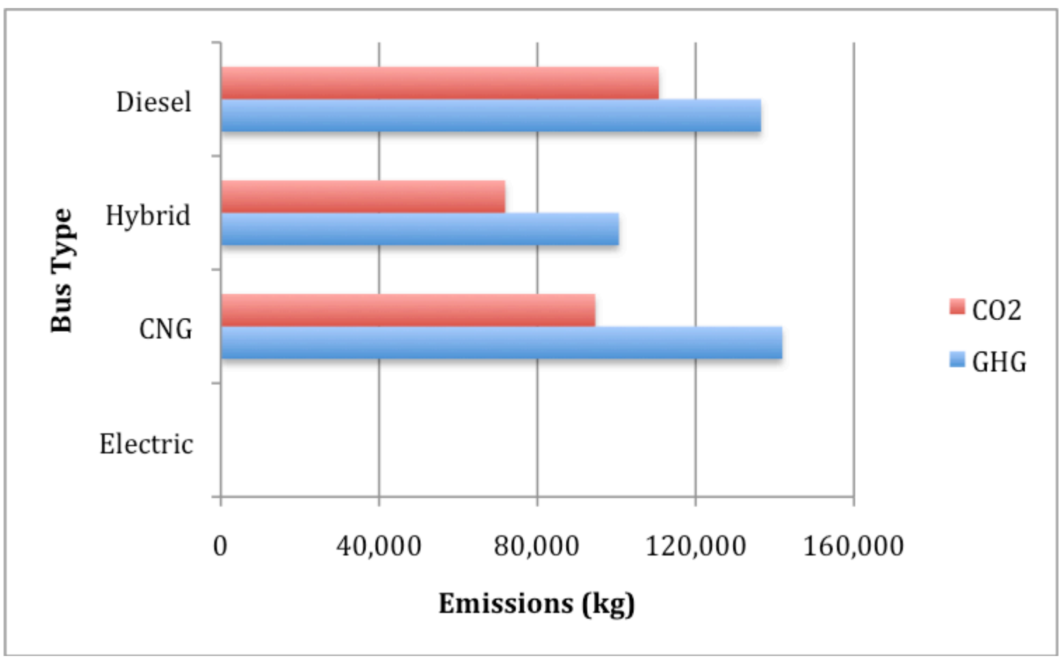
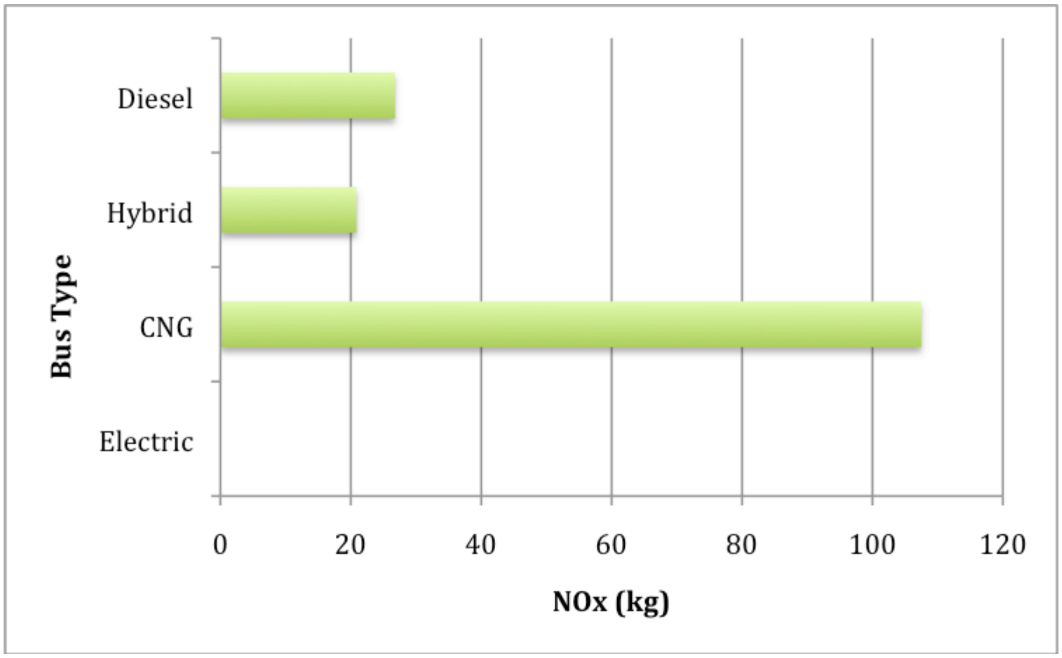


Figure X. Annual Tailpipe NO_X *Emissions by Bus Type*[74]



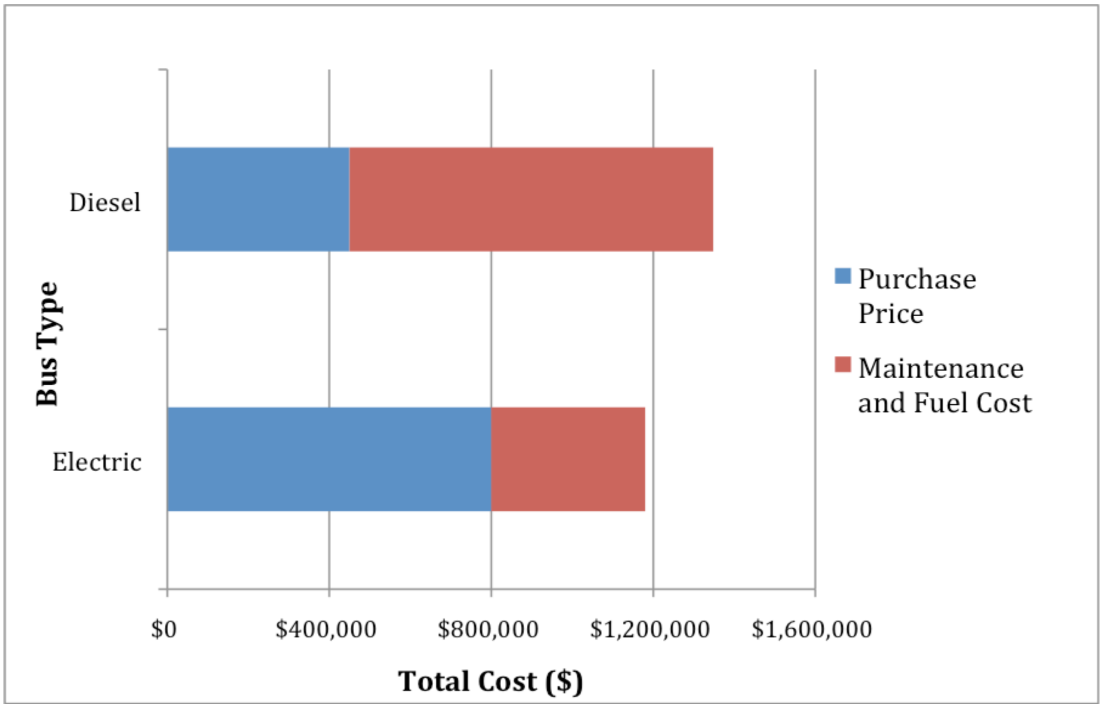
Compared to CNG, diesel and diesel-electric hybrids, all-electric buses produce no tailpipe emissions. CNG and diesel buses both produce over 120,000 kilos of GHG emissions annually, which is equal to the CO_2 emissions from about 1.8 tanker trucks worth of gasoline.[75] In terms of NO_X emissions, CNG buses emit appoximately 107 kilos of NO_X annually, more than four times as much as a diesel bus.[76] The lack of tailpipe emissions from electric buses helps improve air conditions on roads and near bus transit passengers, allowing them to breathe cleaner air on their daily commutes and other travels.

According to the U.S. DOT, switching from a diesel bus to an electric bus eliminates 10 tons of nitrogen oxides over a 12-year lifecycle, as well as 1,690 tons of CO_2 and 158 kilos of diesel particulate matter from the air.[77] Diesel and CNG buses emit very similar levels of CO_2 from their tailpipes, because while CNG has lower carbon content, the emissions reduction is offset by the higher average fuel economy of diesel buses.[78] In terms of carbon dioxide reduction over a 12-year lifecycle, switching *one* diesel bus to electric is the equivalent of removing about 357 gas-powered cars from the road for one year.[79]

Increasing Cost Savings

Over their lifecycle, electric buses lower expenditures for transit agencies. A recent Columbia University analysis for New York City Transit calculated that the all-in cost of transit buses – from the upfront bus procurement cost to lifetime fuel and maintenance costs – for electric buses is around $1,180,000. In comparison, diesel buses have a lifetime cost of $1,348,000, $168,000 more per bus over their 12 years of use.[80]

Figure XI: Lifetime Cost of Diesel vs. Electric Bus[81]



Even with higher initial purchase prices, electric buses are cheaper over their lifecycle due to large maintenance and fuel cost savings. Electric bus manufacturers claim large savings in maintenance costs year-over-year for all electric buses in comparison to conventional diesel buses. Proterra, an American electric bus manufacturer, estimates at least $135,000 in maintenance cost savings over the lifetime of a bus.[82]

As an added benefit, switching to all-electric vehicles will allow transportation agencies to accurately predict the future cost of energy inputs for their vehicles. Unlike diesel and natural gas, electricity prices do not fluctuate on international markets and are therefore much easier to predict into the future. This will allow agencies to better estimate future costs and determine with more precision their expenditures and revenue flows leading to better investment planning in the long-term.

Transit agencies that have started adopting electric buses, such as Albuquerque Rapid Transit and Dallas Area Rapid Transit, have realized substantial operational and maintenance cost savings compared to conventional buses. In Worcester, Mass., the transit agency has six fully operational electric buses and it is expecting the buses to cut operating costs by nearly $3 million over 12 years.[83] In Eugene, Ore., the Lane Transit Districts expects electric buses will cost $300,000 less to operate compared to a hybrid diesel-electric model during the 12-year life of the bus.[84]

Increasing Energy Efficiency

While VW settlement funds can be used to invest in newer diesel and compressed natural gas buses, they represent a misstep away from a cleaner transportation. A 2016 report from the National Renewable Energy Laboratory found that electric buses can be nearly four times more fuel-efficient than comparable CNG buses.[85] The report found that electric buses got about 17.48 miles per diesel-gallon-equivalent, while CNG buses were only at 4.51 miles per diesel-gallon-equivalent.[86]

Connecticut's Down Payment on a Clean Transit System

Assuming an initial cost of $800,000 for an electric bus, Connecticut's share of the EMT funds could purchase about 54 electric buses to replace existing diesel buses.[87] This would eliminate 91,260 tons of CO_2 and 8,532 kilos of diesel particulate matter from the air over their lifecycle.[88] In terms of CO_2 reductions, this is equivalent to removing 1,606 cars from the road for 12 years. These significant emissions reductions would help Connecticut lower air pollution, allowing residents to breathe less polluted air in both the short and long term.

In terms of cost savings, these new electric buses could save Connecticut's transit agencies about $9 million over their 12 years of use. Such savings would allow these agencies to invest in more electric buses over time, further increasing progress toward full electrification of the transit system and transportation sector.

How Recommended VW Settlement Investment Complement State's Existing Clean Air Goals

Governor Malloy has encouraged efforts to provide Connecticut with a more reliable, cleaner, and cheaper transportation system that supports the state's clean air goals. In accordance with Connecticut's Air Toxics Control Regulation law passed in 1986 and the 1990 Clean Air Act Amendments, the state focuses on lowering toxic pollution from mobile and other sources.[89] In furtherance of these efforts, Connecticut has already increased the number of electric vehicle charging stations to meet growing demand and accelerate the adoption of EVs in the state. Along with California, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont, Connecticut is part of a groundbreaking initiative to put up to 3.3 million additional zero emission vehicles on the road by 2025.[90]

Such action is urgently needed.

In 2012, greenhouse gas emissions from the transportation system accounted for almost 40 percent of the total emissions in Connecticut, making it more than twice as polluting as the electric power sector, which produced only 18 percent of the state's GHG emissions.[91] By powering vehicles with electricity instead of gasoline, Connecticut could drastically reduce emissions from its transportation sector, especially as the state's electric grid is increasingly powered by renewable sources. Indeed, Connecticut has set itself on a timeline to get 23 percent of the state's electricity from renewable energy source by 2020, meaning that lifecycle emissions from electric vehicles will only continue to decrease in the future.

Taken together, statewide adoption of the recommendations in this report will substantially further Connecticut's existing clean air strategies.

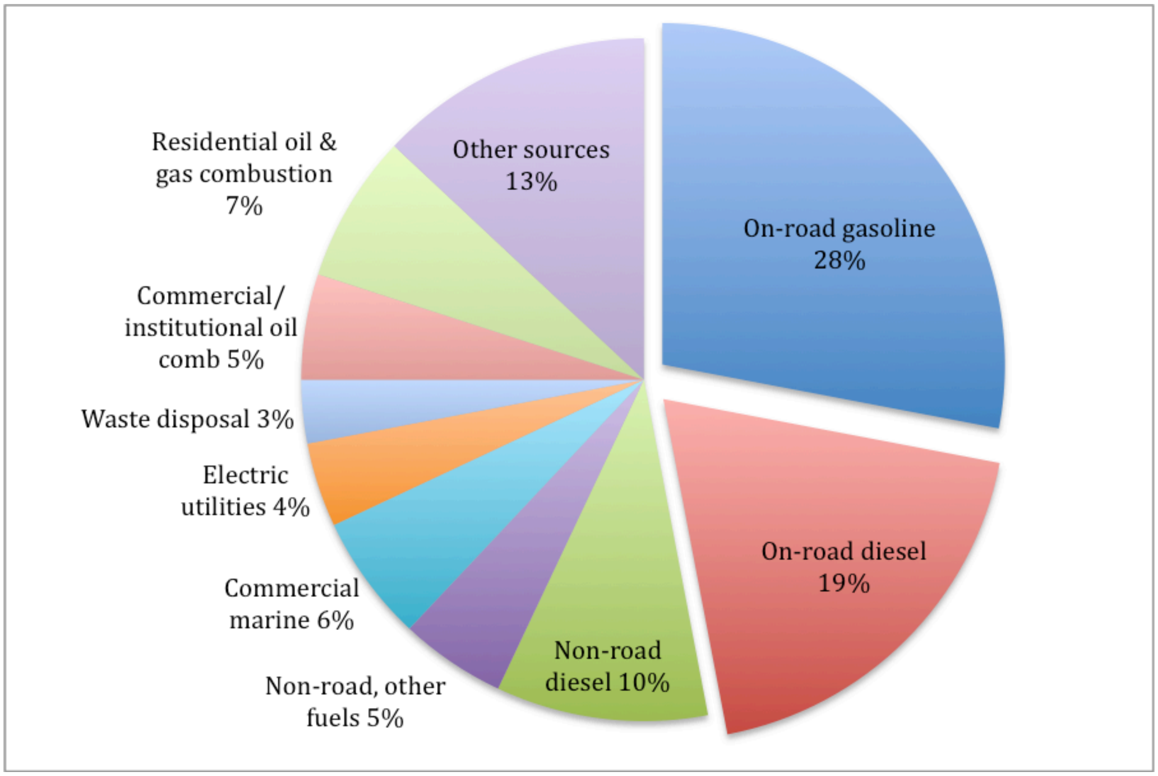
Zero Emission Vehicle (ZEV) Fund

In addition to the EMT funds, Volkswagen will also have to commit $2 billion to a Zero Emission Vehicle fund. Of this, $800 million will go to California and $1.2 billion to the rest of the country. This is intended to promote the development and use of clean vehicle technologies.

The current framework sets out that VW must propose the investments and the EPA must review and accept the plans for these funds before VW can move forward with them. Volkswagen Group of America recently announced it would focus ZEV fund investments in EV charging infrastructure and increasing awareness and fostering education of EVs.[92]

Connecticut and the rest of the northeastern states should immediately identify ways to maximize the likelihood of significant, well-targeted investments that further expand zero emissions vehicle infrastructure and sales across the region and aggressively pursue these objectives, working together with other neighboring states to leverage additional funds. To do this, the state should submit a proposal for ZEV fund use and cooperate with other states to ensure the final plan best accomplished the vision of increasing EV sales throughout the state and country.

Figure XII: Percent of NO_X Emissions by Sector in New England, 2011[93]



States in New England would have much to gain from working together to reduce their on-road emissions by accelerating the adoption of electric vehicles. Together, on-road gasoline and diesel account for 47 percent, or 170,238 tons, of all NO_X emissions in the region.[94]

Conclusion

Volkswagen's systematic emissions cheating resulted in 567,000 Americans purchasing a "clean diesel" vehicle that emitted NO_X pollution at up to 40 times the legal limit. Thankfully, VW was caught and the recently announced settlement is one way the company is being held accountable.

Connecticut has no way of clawing back the unnecessary and damaging pollution that spewed into its air because of Volkswagen's defeat devices. Therefore, we need to ensure that any money VW pays in settlements is invested in moving the transportation system toward a cleaner and cheaper future. Focusing this investment in electrification significantly reduces pollution from vehicles now and in the future, leading to a market transformation toward a zero-emission transportation system.

Connecticut is expected to receive $51.6 million from the Environment Mitigation Trust, which the Department of Energy and Environmental Protection will invest over the next three to 10 years. Connecticut should invest 15 percent of that money to build out an electric vehicle charging station grid along our highways and the rest should be invested to replace older diesel buses with electric buses and build the accompanying infrastructure for electrified transit.

In addition, Connecticut should actively compete for additional funds from the $1.2 billion available in the Zero Emission Vehicle Fund, working with neighboring states if that leverages additional money.

This approach will maximize the long-term benefits to Connecticut's air quality and create a fundamental market transformation towards electrifying transportation, leading us to a zero-emissions future, and further tipping the scale toward a cleaner, electrified transportation system.

Notes

[1] Allowable uses include replacing or repowering Class 8 Local Freight Trucks and Port Drayage Trucks; Class 4-8 School Bus, Shuttle Bus, or Transit Bus; Freight Switchers; Ferries/Tugs; Ocean Going Vessels (OGV) Shorepower; Class 4-7 Local Freight (Medium Trucks); Airport Ground Support Equipment, Forklifts, and Light Duty Zero Emission Vehicle Supply Equipment. See United States District Court Northern District of California, Partial Consent Decree, Appendix D-2, accessed at https://www.justice.gov/opa/file/871306/download (pg. 208-220).

[2] World Health Organization, International Agency for Research on Cancer, *IARC: Diesel Engine Exhaust Carcinogenic (press release),* 12 June 2012, accessed at http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf.

[3] The VW settlement refers to the partial consent decree between Volkswagen and the U.S. Department of Justice over the affected 2.0-liter vehicles.

[4] United States District Court Northern District of California, Partial Consent Decree, Appendix D-2, accessed at https://www.justice.gov/opa/file/871306/download (pg. 216).

[5] United States District Court Northern District of California, Partial Consent Decree, Appendix D-2, accessed at https://www.justice.gov/opa/file/871306/download (pg. 216).

[6] Jeff Bartlett and Michelle Naranjo, "Guide to Volkswagen Emissions Recall," *Consumer Reports*, 25 July 2016. List includes both 2.0-liter and 3.0-liter vehicles.

[7] World Health Organization, *Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide,* 13-15 January 2015, accessed at http://www.euro.who.int/__data/assets/pdf_file/0005/112199/E79097.pdf (pg. 47).

[8] World Health Organization, *Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide,* 13-15 January 2015, accessed at http://www.euro.who.int/__data/assets/pdf_file/0005/112199/E79097.pdf (pg. 46).

[9] U.S. Environmental Protection Agency, *Nitrogen Dioxide (NO2) Pollution*, accessed at https://www.epa.gov/no2-pollution/basic-information-about-no2.

[10] U.S. Environmental Protection Agency, *Nitrogen Dioxide (NO2) Pollution*, accessed at https://www.epa.gov/no2-pollution/basic-information-about-no2.

[11] U.S. Environmental Protection Agency, *Region 1: EPA New England: Ground-level Ozone (Smog) Information*, accessed at https://www3.epa.gov/region1/airquality/.

[12] U.S. Environmental Protection Agency, *Ozone Pollution: Effects on Health and the Environment*, accessed at https://www.epa.gov/ozone-pollution/ozone-basics#effects.

[13] U.S. Environmental Protection Agency, *Nitrogen Dioxide (NO_2) Pollution*, accessed at https://www.epa.gov/no2-pollution/basic-information-about-no2.

[14] U.S. Environmental Protection Agency, *Particulate Matter (PM) Pollution*, accessed at https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM.

[15] Connecticut Department of Energy and Environmental Protection Bureau of Air Management, *Ozone Designation Recommendation For the 2015 Ozone National Ambient Air Quality Standards,* October 2016, accessed at https://www.epa.gov/sites/production/files/2016-11/documents/ct-rec-tsd.pdf (pg. 7).

[16] Connecticut Department of Energy and Environmental Protection Bureau of Air Management, *Ozone Designation Recommendation For the 2015 Ozone National Ambient Air Quality Standards,* October 2016, accessed at https://www.epa.gov/sites/production/files/2016-11/documents/ct-rec-tsd.pdf (pg. 7).

[17] Chart: Connecticut Department of Energy and Environmental Protection Bureau of Air Management, *Ozone Designation Recommendation For the 2015 Ozone National Ambient Air Quality Standards,* October 2016, accessed at https://www.epa.gov/sites/production/files/2016-11/documents/ct-rec-tsd.pdf (pg. 7).

[18] U.S. Environment Protection Agency, *State and County Emission Summaries: State Summary*, accessed at https://www3.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.dw_do_all_multi.sas&stfips=09.

[19] U.S. Energy Information Administration, *State Carbon Dioxide Emissions, Transportation Emissions by State (1980-2013),* 26 October 2015; U.S. Census, "Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014", accessed at www.census.gov/popest/data/state/totals/2014/.

[20] A settlement for approximately 83,000 3.0-liter vehicles has yet to be finalized. In the proposed 3.0-liter settlement, VW and two of its subsidiaries, Porsche and Audi, would agree to fix about 60,000 vehicles and buy back about 20,000 older vehicles that cannot be fixed. $225 million would also be set aside for NO_X emission mitigation projects. Criminal investigations into wrongdoing by VW executives are still ongoing.

[21] U.S. Department of Justice, *Volkswagen to Spend Up to $14.7 Billion to Settle Allegations of Cheating Emissions Tests and Deceiving Customers on 2.0 Liter Diesel Vehicles* (press release), 28 June 2016, accessed at https://www.justice.gov/opa/pr/volkswagen-spend-147-billion-settle-allegations-cheating-emissions-tests-and-deceiving.

[22] United States District Court Northern District of California, Partial Consent Decree, accessed at https://www.justice.gov/opa/file/871306/download (pg. 8).

[23] United States District Court Northern District of California, Partial Consent Decree, Appendix D, accessed at https://www.justice.gov/opa/file/871306/download (pg. 183).

[24] United States District Court Northern District of California, Partial Consent Decree, Appendix D-1, accessed at https://www.justice.gov/opa/file/871306/download (pg. 207).

[25] United States District Court Northern District of California, Partial Consent Decree, Appendix D, accessed at https://www.justice.gov/opa/file/871306/download (pg. 192).

[26] United States District Court Northern District of California, Partial Consent Decree, Appendix D, accessed at https://www.justice.gov/opa/file/871306/download (pg. 192-193).

[27] Beneficiary may not request more than one-third of its allocation during the first year after VW makes the first deposit, or two-thirds of its allocations during the first two years after VW makes the first deposit into the EMT; see United States District Court Northern District of California, Partial Consent Decree, Appendix D, accessed at https://www.justice.gov/opa/file/871306/download (pg. 192-201);

[28] Electric Power Research Institute and Natural Resources Defense Council, *Environmental Assessment of a Full Electric Transportation Portfolio,* 17 September 2015.

[29] Stephen Edelstein, "Electric-Car Drivers Will Pay for DC Fast-Charging 12-to-1 Over Level 2," *Green Car Reports*, 9 November 9 2015, accessed at http://www.greencarreports.com/news/1100804_electric-car-drivers-will-pay-for-dc-fast-charging-12-to-1-over-level-2.

[30] Calculations of average number of state highway agency miles per 1 fast charging stations based on total of 790,046 miles of state highway owned roads in the U.S. (excluding Puerto Rico) and total number of publicly available fast charging stations as of 6 January 2017; see U.S. Department of Energy, Energy Efficiency & Renewable Energy, *Alternative Fueling Station Location,* 6 January 2017, accessed at

http://www.afdc.energy.gov/locator/stations/; U.S. Department of Transportation: Bureau of Transportation Statistics, "Table 1-2: Public Road Length, Miles by Ownership: 2011", accessed at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/state_transportation_statistics_2012/html/table_01_02.html.

[31] Shanjun Li, Tang Long, Jianwai Xing, Yiyi Zhou, Cornell University, *The Market for Electric Vehicles: Indirect Network Effects and Policy Design*, May 2016.

[32] Sarah Chambliss, International Council on Clean Transportation, *Electric vehicle incentives, chargers, and sales: What we see and what we don't (yet),* 25 March 2015.

[33] Gasoline gallon equivalent is the amount of alternative fuel it takes to equal the energy content of one liquid gallon of gasoline.

[34] U.S. Department of Energy, *eGallon: Compare the costs of driving with electricity,* 31 December 2016, accessed at https://energy.gov/maps/egallon.

[35] See notes 36-40 for input costs at $0.12 kWh, $2.31 per gallon, $3.09 per gallon, and $3.68 per gallon; s. See U.S. Energy Information Administration, *Petroleum & Other Liquids: U.S. All Grades All Formulations Retail Gasoline Prices,* 3 January 2016, accessed at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epm0_pte_nus_dpg&f=a.

[36] 15,000 miles a year is about the average number of miles driven by those between 20 and 54 years of age. See Federal Highway Administration, *Average Annual Miles per Driver by Age Group,* 13 July 2016, accessed at https://www.fhwa.dot.gov/ohim/onh00/bar8.htm.

[37] Calculations based on assumption of a $.12 per kilowatt hour rate. $.12 per kWh is the average kilowatt-hour cost for residential areas in 2014 based on total annual electric utility retail revenue divided by the total annual retail sales.

[38] Calculations based on assumption of a $.12 per kilowatt hour rate, $2.31 per gallon of gasoline, and a 28 mpg gasoline-powered vehicle.

[39] Continuing assumptions above but with $3.09 per gallon of gasoline. $3.09 average over past five years calculated using data from U.S. Energy Information Administration, *Petroleum & Other Liquids: U.S. All Grades All Formulations Retail Gasoline Prices,* 3 January 2016, accessed at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epm0_pte_nus_dpg&f=a.

[40] Continuing assumptions above but with $3.68 per gallon of gasoline from U.S. Energy Information Administration, *Petroleum & Other Liquids: U.S. All Grades All Formulations Retail Gasoline Prices,* 3 January 2016, accessed at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epm0_pte_nus_dpg&f=a.

[41] Touchstone Energy Business Energy Advisor, *Getting Charged Up Over Electric Vehicles*, accessed at http://touchstoneenergy.coopwebbuilder2.com/content/getting-charged-over-electric-vehicles.

[42] AAA Association Communication, *Your Driving Costs: How much are you really paying to drive?* 2015, accessed at http://exchange.aaa.com/wp-content/uploads/2015/04/Your-Driving-Costs-2015.pdf.

[43] Using calculations for total fuel savings based on the lowest gas price of $2.31/gal and the highest gas price of $3.68/gal as well as yearly maintenance savings of $766.50.

[44] In 2015, the median income in the U.S. was $29,930.13; see U.S. Department of Health and Human Services Social Security Administration, *Measures of Central Tendency for Wage Data,* accessed at https://www.ssa.gov/oact/cola/central.html.

[45] Frankfurt School-United Nations Environmental Programme Centre, *Global Trends in Renewable Energy Investment 2016,* 2016, accessed at http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf (pg. 36).

[46] Based on Mitsubishi i-MiEV, see Mitsubishi Motors, *2017 i-MiEV,* accessed at http://www.mitsubishicars.com/imiev#hero-area.

[47] State of Connecticut Department of Energy and Environmental Protection, "EVConnecticut: CHEAPR," last updated 28 July 2016, accessed at http://www.ct.gov/deep/cwp/view.asp?a=2684&q=561422&deepNav_GID=2183.

[48] Lifecycle emissions include pollution emitted during vehicle production, fuel production and transportation, and pollution that is released when the fuel is used. Lifecycle emissions from a gasoline vehicle include emissions released during production, refining and transportation of the oil and tailpipe pollution produced from combustion in the vehicle.

[49] U.S. Department of Energy Office of Energy Efficiency and Renewable Energy and U.S. Environmental Protection Agency, *Model Year 2016 Fuel Economy Guide*, 12 December 2016, accessed at https://www.fueleconomy.gov/feg/pdfs/guides/FEG2016.pdf (pg. 2).

[50] U.S. Environmental Protection Agency, *Energy and the Environment: Greenhouse Gas Equivalencies Calculator,* May 2016, accessed at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[51] MPG values refer to combined city and highway operation estimates. U.S Department of Transportation Bureau of Transportation Statistics, "Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles", accessed at https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html; Rachael Nealer, David Reichmuth, and Don Anair, *Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions,* November 2015, accessed at http://www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-full-report.pdf (pg. 11).

[52] Rachael Nealer, David Reichmuth, and Don Anair, *Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions,* November 2015, accessed at http://www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-full-report.pdf (pg. 11); U.S. Department of Transportation Bureau of Transportation Statistics, "Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles", accessed at https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html.

[53] Rachael Nealer, David Reichmuth, and Don Anair, *Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions,* November 2015, accessed at http://www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-full-report.pdf (pg. 11).

[54] Kimberly Aguirre, Luke Eisenhardt, Christian Lim, Brittany Nelson, Alex Norring, Peter Slowik, and Nancy Tu, University of California Los Angeles, *Lifecycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle*, June 2012, accessed at http://www.environment.ucla.edu/media/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf (pg. 8).

[55] Kimberly Aguirre, Luke Eisenhardt, Christian Lim, Brittany Nelson, Alex Norring, Peter Slowik, and Nancy Tu, University of California Los Angeles, *Lifecycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle*, June 2012, accessed at http://www.environment.ucla.edu/media/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf (pg. 8).

[56] U.S. Environmental Protection Agency, *Energy and the Environment: Greenhouse Gas Equivalencies Calculator,* May 2016, accessed at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[57] Lifecycle energy inputs includes energy required to extract and process gasoline as well as the generation of electricity needed to charge the electric battery.

[58] Authors calculated energy requirements by assuming each vehicle would be driven 180,000 miles over 15 years; see Kimberly Aguirre, Luke Eisenhardt, Christian Lim, Brittany Nelson, Alex Norring, Peter Slowik, and Nancy Tu, University of California Los Angeles, *Lifecycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle*, June 2012, accessed at http://www.environment.ucla.edu/media/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf (pg. 7).

[59] Authors calculated energy requirements by assuming each vehicle would be driven 180,000 miles over 15 years; see Kimberly Aguirre, Luke Eisenhardt, Christian Lim, Brittany Nelson, Alex Norring, Peter Slowik, and Nancy Tu, University of California Los Angeles, *Lifecycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle*, June 2012, accessed at http://www.environment.ucla.edu/media/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf (pg. 7).

[60] Authors calculated energy requirements by assuming each vehicle would be driven 180,000 miles over 15 years; see Kimberly Aguirre, Luke Eisenhardt, Christian Lim, Brittany Nelson, Alex Norring, Peter Slowik, and Nancy Tu, University of California Los Angeles, *Lifecycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle*, June 2012, accessed at http://www.environment.ucla.edu/media/files/BatteryElectricVehicleLCA2012-rh-ptd.pdf (pg. 7).

[61] Mary Fitzpatrick, Connecticut Office of Legislative Research, *Electric Vehicle Charging Stations*, 29 November 2016, accessed at https://www.cga.ct.gov/2016/rpt/pdf/2016-R-0302.pdf.

[62] Mary Fitzpatrick, Connecticut Office of Legislative Research, *Electric Vehicle Charging Stations*, 29 November 2016, accessed at https://www.cga.ct.gov/2016/rpt/pdf/2016-R-0302.pdf.

[63] Josh Agenbroad and Ben Holland, "Pulling Back the Veil on EV Charging Station Costs," Rocky Mountain Institute blog, 29 April 2014, accessed at http://blog.rmi.org/blog_2014_04_29_pulling_back_the_veil_on_ev_charging_station_costs.

[64] Charge Point, *ChargePoint Express 200,* accessed at https://www.chargepoint.com/products/commercial/cpe200/.

[65] Number of locations afforded calculated by dividing $43.9 million by $50,000 (as the lower cost estimate per charging station) and $100,000 (as the higher cost estimate per charging station).

[66] State highway agency owned roads do not include roads owned by counties, towns, townships, municipalities, other jurisdictions (includes state park, state toll, other State agency, other local agency and other roadways not identified by ownership), and federal agencies (includes roadways in federal parks, forests, and reservations that are not part of the State and local highway systems); see U.S. Department of Transportation, Bureau of Transportation Statistics, "Table 1-2: Public Road Length, Miles by Ownership: 2011", accessed at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/state_transportation_statistics_2012/html/table_01_02.html.

[67] American Public Transportation Association, *2015 Public Transportation Fact Book,* 66th Edition, November 2015, accessed at https://www.apta.com/resources/statistics/Documents/FactBook/2015-APTA-Fact-Book.pdf (pg. 10).

[68] See Table 6 from American Public Transportation Association, *2015 Public Transportation Fact Book,* 66th Edition, November 2015, accessed at https://www.apta.com/resources/statistics/Documents/FactBook/2015-APTA-Fact-Book.pdf (pg. 12).

[69] Other all-electric options that result in comparable pollution reduction benefits and similarly advance the goals of market transformation could be properly considered based on state needs.

[70] We did not provide cost estimates for the bus charging infrastructure because costs will be dependent on existing infrastructure, number of electric buses used by each transit agency, and the location of those bus routes.

[71] U.S. Environmental Protection Agency Office of Transportation and Air Quality, *Near Roadway Air Pollution and Health: Frequently Asked Questions,* August 2014, accessed at https://nepis.epa.gov/Exe/ZyPDF.cgi/P100NFFD.PDF?Dockey=P100NFFD.PDF.

[72] Iowa State University, Iowa Community Indicators Program, "Urban Percentage of the Population for States, Historical," accessed at http://www.icip.iastate.edu/tables/population/urban-pct-states.

[73] Based on calculations from Proterra, *Creating a Cleaner Earth with Zero Tailpipe Emissions*, accessed at https://www.proterra.com/performance/sustainability/.

[74] Based on calculations from Proterra, *Creating a Cleaner Earth with Zero Tailpipe Emissions*, accessed at https://www.proterra.com/performance/sustainability/.

[75] Based on calculations from Proterra, *Creating a Cleaner Earth with Zero Tailpipe Emissions*, accessed at https://www.proterra.com/performance/sustainability/; U.S. Environmental Protection Agency, *Energy and the Environment: Greenhouse Gas Equivalencies Calculator,* May 2016, accessed at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[76] Based on calculations from Proterra, *Creating a Cleaner Earth with Zero Tailpipe Emissions*, accessed at https://www.proterra.com/performance/sustainability/.

[77] U.S. Department of Transportation, *Zero Emissions Bus Benefits, updated 8 December 2016,* accessed at https://www.transportation.gov/r2ze/benefits-zero-emission-buses.

[78] M.J. Bradley & Associates LLC, *Comparison of Modern CNG, Diesel and Diesel Hybrid-Electric Transit Buses: Efficiency & Environmental Performance*, accessed at http://mjbradley.com/sites/default/files/CNG%20Diesel%20Hybrid%20Comparison%20FINAL%2005nov13.pdf (pg .4).

[79] Based on switching from a diesel to electric bus and eliminating 1,690 tons of carbon dioxide. See U.S. Environmental Protection Agency, *Energy and the Environment: Greenhouse Gas Equivalencies Calculator,* May 2016, accessed at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[80] Judah Aber, Columbia University, *Electric Bus Analysis for New York City Transit*, May 2016, accessed at http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf (pg. 16).

[81] Graph assumes an average of $.12 per kWh and $3.00 per gallon of diesel over the next 12 years. See Judah Aber, Columbia University, *Electric Bus Analysis for New York City Transit*, May 2016, accessed at http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf (pg. 16).

[82] California Environmental Protection Agency Air Resources Board, *Advanced Clean Transit Program: Literature Review on Transit Bus Maintenance Cost (Discussion Draft),* August 2016, accessed at https://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf (pg. 1).

[83] Klark Jessen, Massachusetts Department of Transportation, *Worcester Regional Transit: Electric Transit Bus Fleet*, accessed at https://blog.mass.gov/transportation/greendot/worcester-regional-transit-electric-transit-bus-fleet/.

[84] Christian Hill, "LTD Ordering Fleet's First All-electric Buses," *The Register-Guard,* 2 November 2015, accessed at http://projects.registerguard.com/rg/news/local/33651784-81/ltd-ordering-fleets-first-all-electric-buses.html.csp.

[85] U.S. Department of Transportation, *Zero Emissions Bus Benefits, updated 8 December 2016,* accessed at https://www.transportation.gov/r2ze/benefits-zero-emission-buses.

[86] U.S. Department of Transportation, *Zero Emissions Bus Benefits, updated 8 December 2016,* accessed at https://www.transportation.gov/r2ze/benefits-zero-emission-buses.

[87] Calculated based on 85 percent of the remaining Connecticut EMT funds after fast charging stations are bought, divided by $800,000 for lowest bus price and $1,000,000 for the total bus price over lifetime (not including fast charging stations for the electric buses); although the number could be lower depending on what additional money was needed to build the necessary charging infrastructure or potentially higher depending on what outside funding could be attained through state and federal grants.

[88] Calculations based on U.S. DOT reduction numbers from each bus switched (see note 76) and multiplying by 54 buses for the total emissions reductions that could be achieved

[89] Connecticut Department of Energy and Environmental Protection, *Ev Connecticut: CT's Path,* November 2005, accessed at http://www.ct.gov/deep/cwp/view.asp?a=2684&q=322230&deepNav_GID=1619.

[90] Connecticut Department of Energy and Environmental Protection, *Ev Connecticut: CT's Path,* November 2005, accessed at http://www.ct.gov/deep/cwp/view.asp?a=2684&q=322230&deepNav_GID=1619.

[91] Connecticut Department of Energy and Environmental Protection, *Greenhouse Gas Emissions from the Transportation Sector,* November 2005, accessed at http://www.ct.gov/deep/cwp/view.asp?a=4423&q=544460.

[92] Electrify America, LLC, *Our Plan,* accessed at https://www.electrifyamerica.com/our-plan.

[93] U.S. Environmental Protection Agency, *Region 1: EPA New England, Sources of Hydrocarbon and* NO_X *Emissions in New England,* accessed at https://www3.epa.gov/region1/airquality/piechart.html.

[94] U.S. Environmental Protection Agency, *Region 1: EPA New England, Sources of Hydrocarbon and* NO_X *Emissions in New England,* accessed at https://www3.epa.gov/region1/airquality/piechart.html.