FROM DECEIT TO TRANSFORMATION:

HOW STATES CAN LEVERAGE VOLKSWAGEN SETTLEMENT FUNDS TO ACCELERATE PROGRESS TO A CLEAN TRANSPORTATION SYSTEM

U.S. PIRG Education Fund

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Introduction

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. As a result of the settlement that followed this fraud, an Environmental Mitigation Trust (EMT) was set up with $2.9 billion dollars to be distributed to states to reduce transportation emissions. In effect, VW's 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There remains a real risk that these funds will be wasted on outdated and polluting technologies, including those that rely on diesel and natural gas, while foregoing the transition to clean, all-electric vehicles (EVs) and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, cleanrunning transportation network that could help reduce illness, save lives and protect the planet. The VW settlement clearly envisions and encourages such a use.[3] For instance, the EMT can be used to subsidize 100 percent of the purchase of clean, all-electric buses and accompanying charging infrastructure 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 carbon dioxide (CO_2) and other greenhouse gas emissions;
- Reducing long-term fuel consumption, maintenance and operating costs of public fleet vehicles;
- Adding needed stability to the price of energy inputs for vehicles;
- Increasing public awareness and adoption of electric vehicles 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 cheat 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.

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.

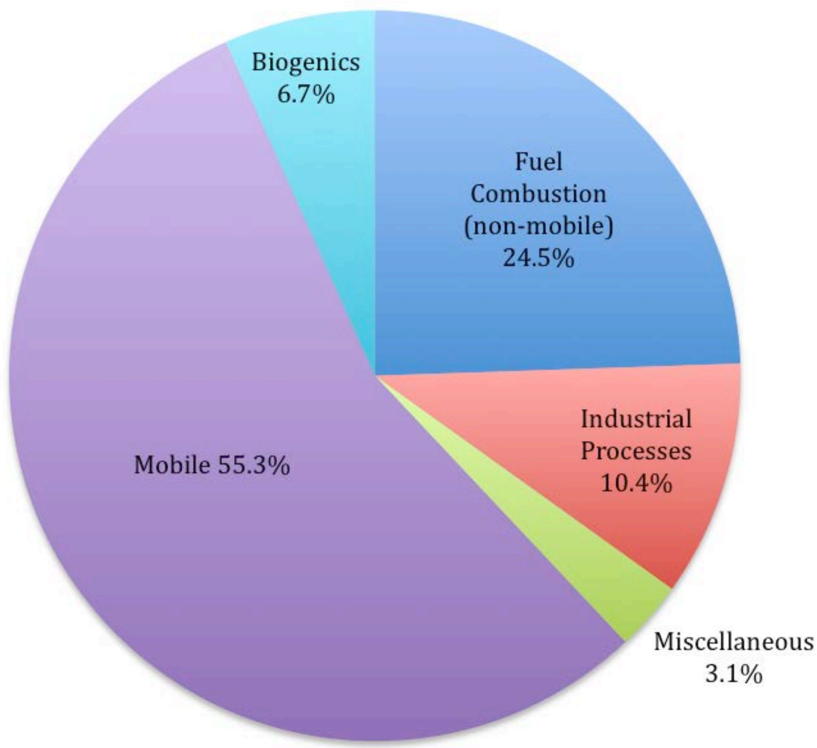
Table I. Impacted Models[6]

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)		

VW and Greenhouse Gas Emissions

VW's emissions' cheating has serious consequences for our health and environment. The lack of emissions control on VW vehicles directly contributed to additional NO_X in our air, worsening air quality and impacting our health. Nitrogen dioxide (NO_2), the most common NO_X compound, is produced from the oxidation of nitrogen oxide (NO) that occurs in combustion engines, mostly from motor vehicles.[7]

Figure 1: Percent of NO_X Emissions by Sector in the U.S., 2014[8]



Mobile sources (on-road vehicles, off-road vehicles and equipment) accounted for 55.3 percent of total NO_x emissions in the country in 2014, with fuel combustion from electricity generation coming in a distant second with 24.5 percent.[9] Specifically relating to N_2O emissions, agricultural soil management and fuel combustion in both stationary and mobile sources contribute most.[10]

However, considerable progress has been made on reducing N_2O emissions. Nitrous oxide emissions from mobile combustion decreased by 24.9 million metric tons of CO_2 Equivalent[11] (60.4 percent) from 1990 through 2014, because of national emission control standards and emissions control technologies for on-road vehicles. Considering the detrimental effects of NO_X, including N_2O, on our environment and climate, more progress to lower emissions is still needed.

Moreover, in 2014, transportation accounted for 26 percent of total CO_2 equivalent emissions in the U.S.[19] In June 2016, the transportation sector officially overtook the electricity sector as the number one emitter of carbon dioxide in the U.S.[20] Taking steps to accelerate the electrification of the country's transportation system is therefore a necessary part of any GHG emissions, and specifically NO_X emissions, reduction plan and a critical component of building a 21st century transportation network capable of meeting current and future challenges.

Health and Environmental Impacts of NO_X

NO_X represents a family of seven compounds, of which nitrous oxide (N_2O), nitrogen oxide (NO), and nitrogen dioxide (NO_2) are the most prevalent. 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."[12] 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."[13]

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.[14] 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.[15] NO_X also contributes to acid rain, nutrient pollution in coastal waters, and adds to fine particulate matter in the air.[16] 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.[17]

Of the nitrogen oxides, N_2O is one of the most salient greenhouse gases that humans directly emit. N_2O is approximately 300 times more potent than CO_2 at trapping heat in the atmosphere and it is considered an ozone depleting substance because it reacts with O_3 (ozone), in both the troposphere and the stratosphere.[18]

The VW Settlement and Environmental Mitigation Trust: An Opportunity for Transformation

When Volkswagen was caught systematically cheating on emissions tests, the U.S. Department of Justice (DOJ) sued them 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.[21] The settlement allocates $10 billion in available compensation for owners of noncompliant Volkswagens and $4.7 billion for use in environmental mitigation actions.[22]

Table II. 2.0-Liter Noncompliant Vehicles[23]

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)

On February 1, 2017, VW entered into a second partial settlement with the Department of Justice on 3.0-liter vehicles, covering about 77,000 cars, which was also then approved by Judge Breyer. This settlement allocates $1.22 billion in available compensation for owners of noncompliant Volkswagens and $225 million for use in environmental mitigation actions.[24]

Table III. 3.0-Liter Noncompliant Vehicles[25]

Volkswagen Touareg (2009-2012)	VW Touareg (2013-2016)	Audi Q7 (2009-2012)
Audi Q7 (2013-2015)	Audi A6 (2014-2016)	Audi A7 (2014-2106)
Audi A8, A8L (2014-2016)	Audi Q5 (2014-2016)	Porsche Cayenne (2013-2016)

Pursuant to the settlement, the $4.9 billion available for environmental mitigation actions will be split into two funds:

1. $2.9 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 several 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 Each State 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 to "reduce emissions of NO_X where the [ ] vehicles were, are, or will be operated."[26]

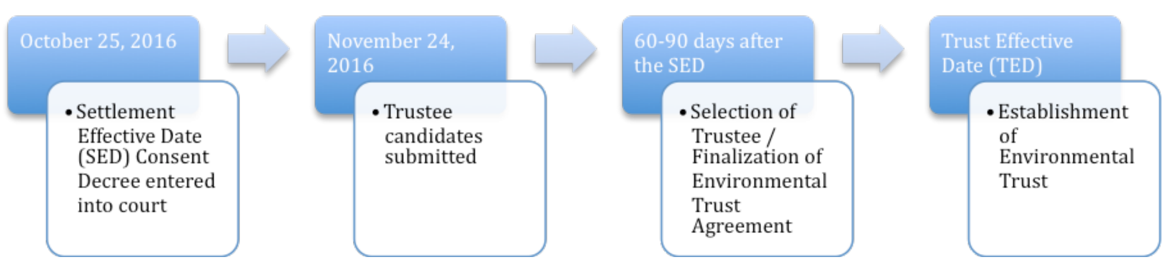
Table IV. Environmental Mitigation Funds by State[27]

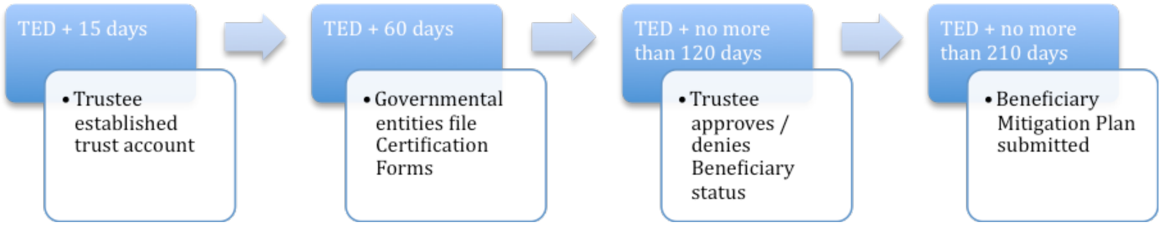
Alabama	$25,480,967.86	Maine	$21,053,064.48	Pennsylvania	$118,569,539.52
Alaska	$8,125,000.00	Maryland	$75,714,238.01	Puerto Rico	$8,125,000.00
Arizona	$56,660,078.00	Massachusetts	$75,064,424.40	Rhode Island	$14,368,857.94
Arkansas	$14,647,709.10	Michigan	$64,807,014.63	South Carolina	$33,895,491.39
California	$422,636,320.14	Minnesota	$47,001,661.43	South Dakota	$8,125,000.00
Colorado	$68,739,918.33	Mississippi	$9,874,413.91	Tennessee	$45,759,914.40
Connecticut	$55,721,169.94	Missouri	$41,152,051.74	Texas	$209,319,163.57
Delaware	$9,676,682.97	Montana	$12,602,424.88	Utah	$35,177,506.14

District of Columbia	$8,125,000.00	Nebraska	$12,248,347.48	Vermont	$18,692,130.18
Florida	$166,278,744.541	Nevada	$24,874,024.48	Virginia	$93,633,980.48
Georgia	$63,624,725.56	New Hampshire	$30,914,841.09	Washington	$112,745,650.15
Hawaii	$8,125,000.00	New Jersey	$72,215,085.39	West Virginia	$12,131,842.13
Idaho	$17,349,037.39	New Mexico	$17,982,600.90	Wisconsin	$67,077,457.70
Illinois	$108,679,676.98	New York	$127,701,806.94	Wyoming	$8,125,000.00
Indiana	$40,935,880.59	North Carolina	$92,045,658.00	Tribal Admin Cost	$1,088,958.15
Iowa	$21,201,737.70	North Dakota	$8,125,000.00	Tribal Allocation	$54,447,921.22
Kansas	$15,662,238.80	Ohio	$75,302,522.67	Trust Admin Cost	$29,250,000.00
Kentucky	20,378,649.58	Oklahoma	$20,922,485.12		
Louisiana	$19,848,805.30	Oregon	$72,967,518.46		

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 early in 2017.[28] 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.[29] 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 three years and no more than 10 years.[30]

Figure II. Environmental Mitigation Trust Timeline



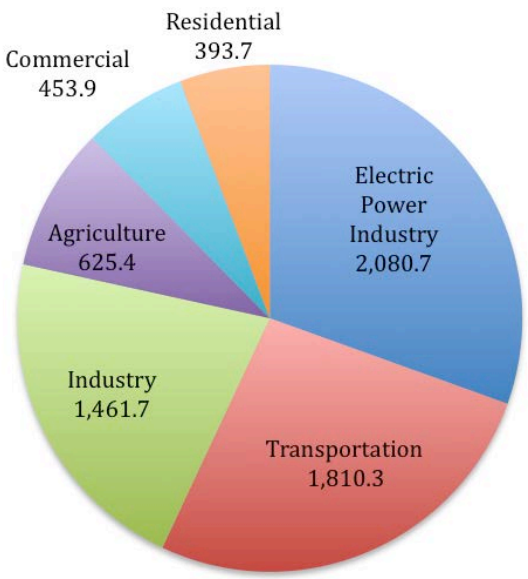


Some governors have already identified the agency they will designate as the Beneficiary. States like Connecticut, California, and Colorado opened public comment periods and invited residents to give suggestions on how they believe the funds should be used. All state governments should be encouraged to have open comment periods so they can consider people's preferences on EMT investments.

The Case for Electrifying U.S. Highways

The VW settlement is a unique opportunity for states to make a substantial down payment on the adoption of electric vehicles by making them more accessible and practical for trips anywhere in the country. Doing so has significant 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.[31]

Figure III: U.S. Greenhouse Gas Emissions by Economic Sectors (MMT CO_2 Equivalent), 2014[32]



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 by using fast chargers, which can fully charge a vehicle in fewer than 30 minutes. Fast 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. Investments in charging infrastructure should focus on improving the convenience of charging, to make it comparable to going to the gas station with a gas-powered vehicle.

Not surprisingly, consumers have strong preferences for what kind of chargers they would like to see. A survey by NRG eVgo, a leading charger provider, found that drivers preferred fast charging 12-to-1 over Level 2 slow charging when both options were available at one site.[33] However, according to the U.S. Department of Transportation (U.S. DOT), only about 2,027 of the approximately 15,431 publicly available charging stations in the country, or about 13 percent, are fast charging stations.[34] 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.

Electric Vehicle Charging Explained

Most EV charging is done through Electric Vehicle Service Equipment (EVSE). An EVSE is simply a device that brings AC power to EVs, where it is then turned into direct current (DC) power and fills the EV's battery via the car's onboard charger.[35] Not all EVs receive electric power the same way, with some charging faster than others due to their different onboard charging systems. Additionally, EVs can be charged through DC fast charging stations, which are much faster and more comparable to a traditional trip to the gas station.

These different types of electric chargers offer a range of charging speeds and consequently vary widely in cost of installation as outlined in the chart below.

Table V: Types of Electric Charging Stations[36]

Classification	Description	Range	Notes	Cost
AC Level 1 EVSE	Charges through a common 120 volt three-prong household plug	1.1 kW or about 4 miles of range per hour of charging[37]		$300-$1,500 for the unit and $0-$3,000 for the installation[38]
AC Level 2 EVSE	Uses the same connector and charge port as Level 1 Requires a 240 volt or 208 volt electrical service (can be installed in residential locations)	can yield up to 70 miles of range per hour of charging	Level 2 chargers max out at 26 miles of range or 6.6 kilowatts (kW) per hour of charging*	$400-$6,500 for the unit and $600-$12,700 for the installation[39]

DC Fast Charging	Provides direct current (DC) electricity to an EV batteries, bypassing the onboard charger	50 kW and can yield up to 40 miles of range for every 10 minutes of charging.[40]	Mainly used for in-transit charging, versus home charging	$10,000-$40,000 for the unit and $4,000-$51,000 for installation[41]
Tesla Superchargers	these chargers are a network of 480-volt fast-charging stations for the Tesla vehicles	120 kW of power per car; 480-volt fast-charging stations for the Tesla vehicles		

* This is largely the result of capacity limits in existing EVs, for example the Nissan Leaf and even the new electric Ford Focus support charging at only 6.6 kW.

For DC fast chargers, there are currently three standard plugs:

- CHAdeMO standard: This is the standard employed by Japanese and Chinese car manufacturers. CHAdeMO fast chargers have a max power output of 50 kW.[42]

- SAE Combo Connector (also known as the CCS or Combined Charging System): This is the standard used by German and U.S. car manufacturers. SAE Combo fast chargers also have a max power output of 50 kW.

- Tesla Superchargers: The Tesla chargers use their own standard plug that has a max power output of 120 kW. Tesla also sells a CHAdeMO adapter so that its vehicles can interface with those stations.

- Charging stations can offer both CHAdeMO and SAE Combo connectors, making them usable for all vehicles with fast charging capabilities.

Reducing Range Anxiety

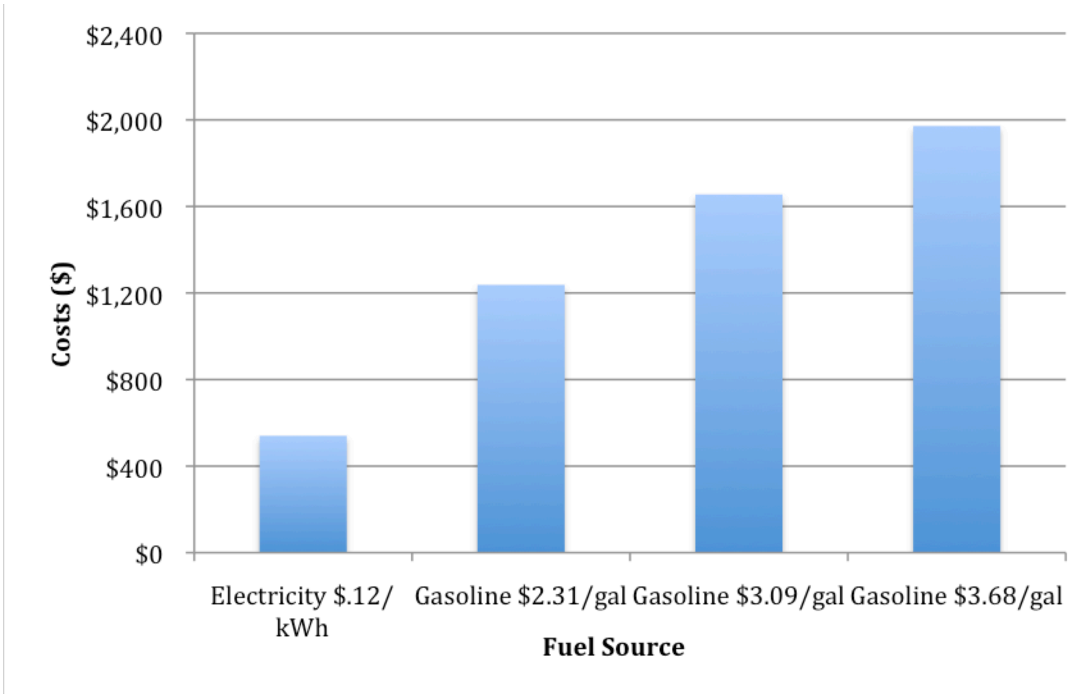
One of the biggest challenges to electric vehicle adoption in the U.S. is the lack of charging infrastructure. According to the U.S. Department of Energy's Alternative Fueling Station Locator, there are only 2,027 publicly available fast charging stations in the entire country, or 1 fast charger for every 390 miles of state highway.[43] In comparison, according to the U.S. Census Bureau, in 2012 there were 114,533 gas stations in the U.S, or about 1 for every 6.8 miles of state highway.[44] One of the biggest impediments to widespread adoption of electric vehicles is the consumers apprehension, known as "range anxiety," that their car will not hold a charge for the duration of their trip.

There is compelling 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.[45] Another analysis by the International Council for Clean Transportation also found a strong correlation between public charging infrastructure density and EV uptake.[46]

Creating Economic Savings

Owning an electric vehicle, including the initial purchase of the car, saves consumers money over time, 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.[47] 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.[48]

Figure IV: Fuel-Related Savings[49]



At recent prices, assuming a consumer drives their vehicle 15,000 miles a year,[50] those owning EVs would spend only about $540 per year to charge their car.[51] In comparison, the owner of a gasoline-powered vehicle would spend $1,238 in fuel, more than twice as much as the EV owner.[52] 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.[53] 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.[54] While gas prices are unpredictable and can fluctuate wildly, electricity prices remain stable over time and give EV owners the added bonus of being able to calculate their long-term input costs.

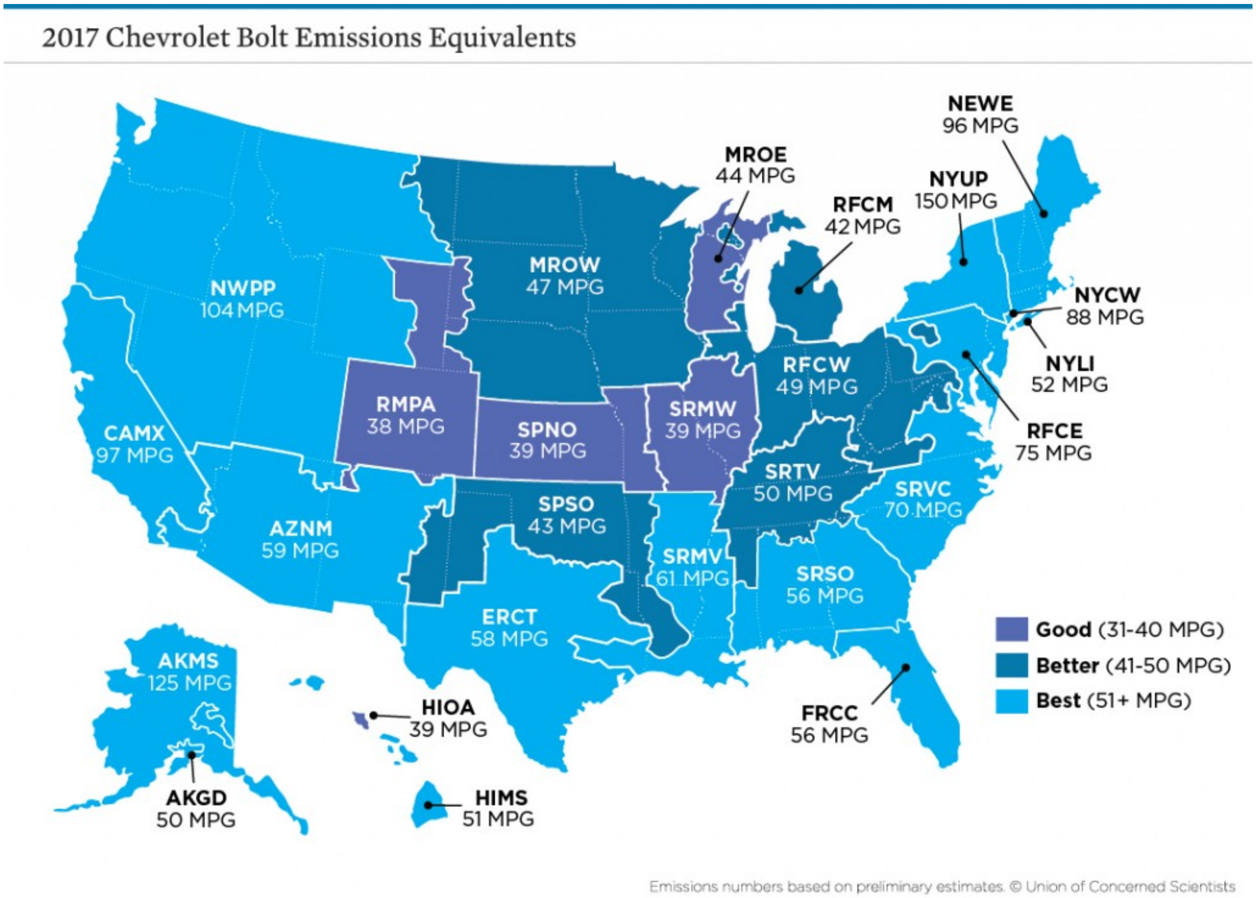
In addition to fuel savings, consumers can also save on yearly maintenance costs when they switch to an EV. In a recent study, electric vehicles saved the average driver about 46 percent in annual maintenance costs.[55] Given that the average yearly maintenance cost of a car is $766.50 a year, these savings equate to over $350 a year per consumer.[56] 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.[57] Those annual savings amount to as much as 6 percent of median per capita income in the U.S.[58]

Critics of electric vehicles 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.[59] Today, a consumer can purchase a new, all-electric vehicle for as little as $23,000.[60] 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.[61]

Emission Reductions

Electric vehicles are cleaner than traditional gas-powered vehicles, especially when lifecycle emissions are considered.[62] According to the "Model Year 2016 Fuel Economy Guide," the average recent-model vehicle releases seven to nine tons of GHG in tailpipe and upstream emissions a year, most of it in the form of CO_2.[63] It would take between 6.6 and 8.5 acres of U.S. forest, or between five and seven football fields worth of forest, to capture and store, or "sequester," the CO_2 emitted by one car in one year.[64]

Figure V: 2017 Chevrolet Bolt Emissions Equivalents to MPG Gas-Powered Vehicles[65]

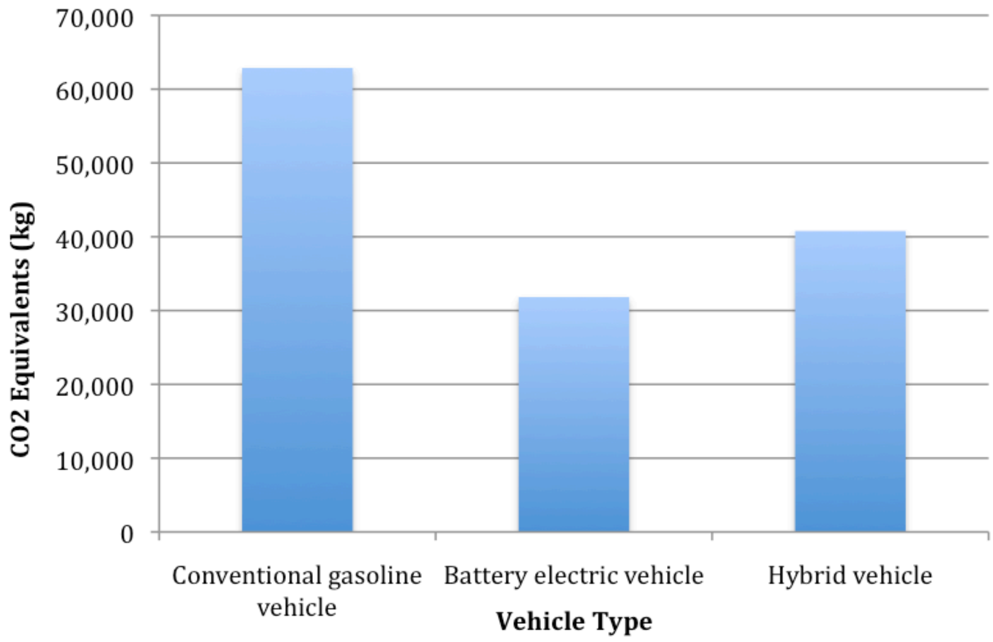


The recently produced Chevrolet Bolt is a great example of the emissions reductions possible when switching to an EV. On the dirtiest regional electric grid in the U.S., EVs produce the same global warming emissions as a 35-mpg gasoline car – almost 15 miles per gallon better than the current fleet mix (21.4-mpg), which represents the average mpg of light duty vehicles currently on the road.[66] Meanwhile on the cleanest grid, electric vehicles emit lower global warming emissions than 85-mpg gasoline cars, roughly four times the current fleet mix.[67]

Moreover, unlike gas-powered cars, EVs already on the road will become cleaner over time as electric grids draw 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. because of cleaner electricity grids and more efficient EVs.[68]

Figure VI: CO_2 Equivalents Lifecycle Comparison[69]

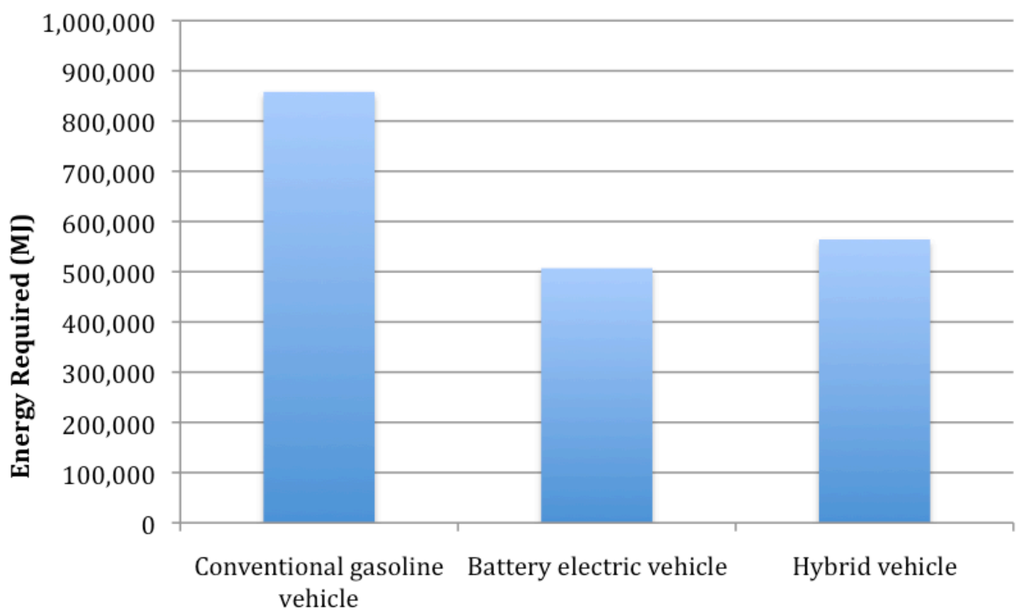


According to a University of California Los Angeles (UCLA) lifecycle analysis of emissions by vehicle type, a gasoline-powered vehicle produces almost twice as much in CO_2 equivalent emissions compared to an all-electric vehicle. While the electric car produced only 31,821 kilos CO_2 equivalents, the gas-powered car produced 62,866 kilos CO_2 equivalents.[70] 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.[71] 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.[72] Becoming more energy efficient is a key to lowering emissions and creating long-term cost savings for consumers and entire communities.

Figure VII: Energy Input Requirements Lifecycle Comparison[73]



According to an analysis from the UCLA, 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.[74] An electric vehicle uses by far the least energy at 506,988 MJ, or 41 percent less than the gas-powered vehicle.[75]

Improving the Country's Existing Charging Infrastructure

Following the growth in EV adoption in the country, the federal government came out with a plan for 48 electric charging corridors throughout the country. The Obama administration partnered with the private sector to ensure drivers would have convenient access to charging stations at work, at home, and on the road.

Figure VIII: Existing Electric Charging Corridors in the U.S.[76]

As illustrated in Figure XI, the designated electric vehicle charging corridors total almost 25,000 miles in 35 states.[77] Within the corridors, electric charging stations will be installed at least every 50 miles with new signage designating areas with charging stations, similar to how we currently indicate gasoline stations on highways.[78] Some of the key corridors include Interstates 25 and 70 through Colorado; parts of Interstate 10, 20, 30, 35, and 45 in Texas; Interstate 80 from Nebraska to New York City; Interstate 95 from Washington D.C. to Portland, Maine; Interstates 75 and 85 in Georgia; and Interstate 5 from San Diego to the Canadian border.[79] As shown above though, many states are lacking in charging infrastructure and do not have identifiable charging corridors.

Regional Electric Vehicle Infrastructure Initiatives

Texas River Cities Plug-In Electric Vehicle Initiative

The Texas River Cities, formed by Austin Energy and initially funded through the Department of Energy, is intended "to promote plug-in electric vehicles in the Central Texas region, including the greater Austin and San Antonio communities."[80] This initiative is a partnership among 50 regional stakeholders, through the Central Texas Fuel Independence Project. The group has also been engaging auto manufacturers and car dealers to focus more on EV marketing and visibility – a crucial step in moving away from regional-popular pick-up trucks.[81] Additionally, Nissan has been identified as a partner to install DC fast charging stations to expand access in an area that currently only has two fast chargers and 218 public Level 2 chargers.[82] Since the start of the initiative, charging infrastructure has already doubled from 113 publicly available charging stations to more than 200 with more than 3,000 electric vehicles purchased already in Austin.[83]

Northeast Electric Vehicle Network

The Northeast Electric Vehicle Network, a partnership started in 2011 among 10 northeastern states working along with Washington D.C. and parts of Maine and more than 100 companies, organizations, and jurisdictions, has already made progress on building a network of more than 300 fast chargers and 2500 Level 2 charging stations to ease range anxiety in the region.[84] Most of the states in the network have seen increases in EV adoption as barriers to ownership have decreased through ease of charge, rebates, and incentive programs.

West Coast Electric Highway

The states of Washington, Oregon and California also joined together to form the West Coast Electric Highway, a network of thousands of Level 2 chargers and dozens of fast chargers built along I-5 and other major roadways on the west coast.[85] Regional efforts were intended to accelerate the adoption of electric vehicles, in order to lower air pollution and emissions in the region as well as ease travel along the coast for EV owners.

Other initiatives to increase EV adoption by focusing on expanding access to charging infrastructure include: the Clean Energy Coalition in Michigan, a recently announced initiative by the governors of Colorado, Utah and Nevada, and the Metropolitan Energy Center in Kansas City. States, cities and municipalities working cooperatively have increased electric charging infrastructure connectivity in their regions, demonstrating how successful such efforts can be. Coordinating efforts has also helped these initiatives work efficiently with private companies and the federal government to supplement existing funding.

States without designated electric corridors include: Arizona, New Mexico, Wyoming, Montana, North and South Dakota, Kentucky, Louisiana, Arkansas, Mississippi, Alabama, and most of Florida. It is worth noting that most of these states could be regionally grouped, such as the Great Plains states and the South, where regional coordination to develop charging networks has the potential to be incredibly effective.[86]

How Much Progress Can We Make with VW Settlement Funds?

Assuming all states invest the maximum allowable amount of EMT funds in EV charging stations, the country (not including Puerto Rico and tribal groups) could spend about $435 million electrifying the highway system. This would be a significant down payment toward electrifying the country's 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 actual price of each new fast charge station between $50,000 and $100,000.[87] Both standard fast charging options, CHAdeMO and SAE Combo Connector can be provided at the same charging station, allowing all EV owners to charge while on the road, much like a regular gas stop for conventional gasoline-powered vehicles.[88]

At these prices and with the about $435 million in EMT funds that could be allocated to charging infrastructure, states throughout the country could supply between 4,350 and 8,700 additional fast charging stations.[89] This would be a significant improvement to the country's current network of about 2,027 fast charging stations. Several states will have sufficient funds to cover their entire state highway systems with fast charging infrastructure.[90] Such states could even place the charging stations at closer intervals to allow for more charging capacity and convenience for consumers or could allocate the remaining funding to Level 2 chargers in areas with high charging demand.

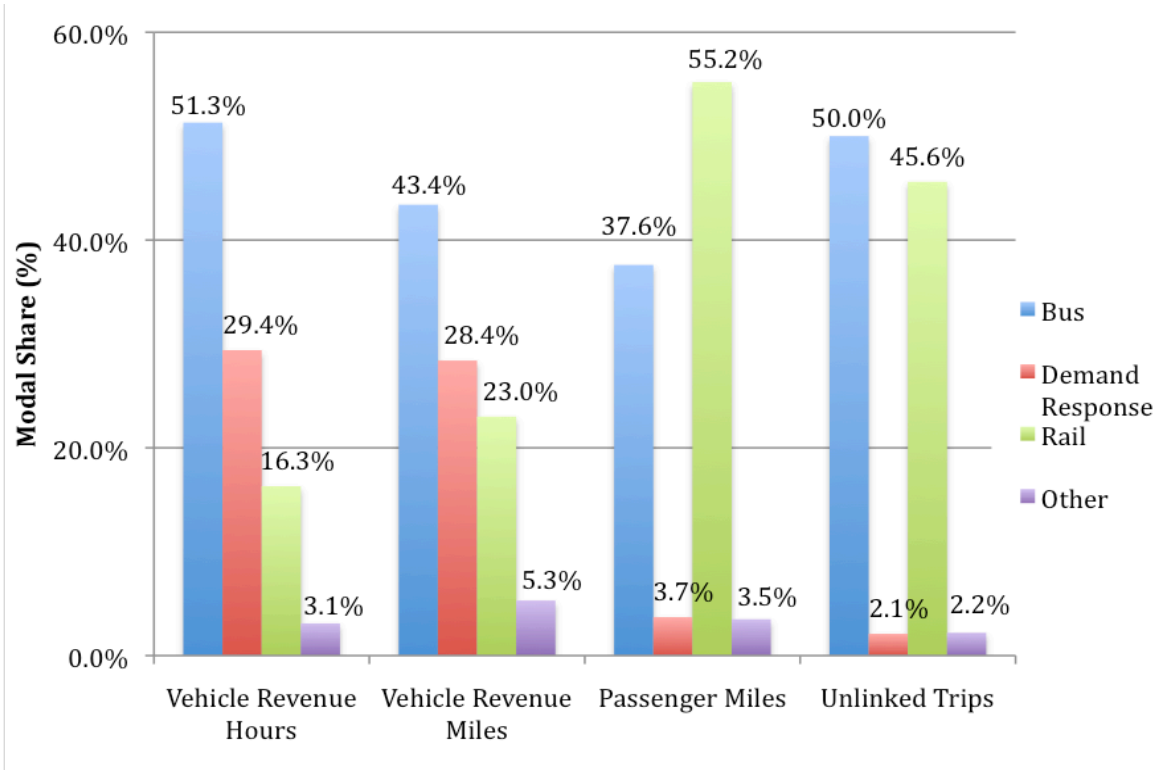
The Case for Electrifying Public Transit Buses

Investing 15 percent of the available EMT funds in EV charging infrastructure still leaves states with approximately $2.4 billion for additional investments. Under the terms of the VW settlement, there are several ways these funds may be allocated. Yet, not all allowable uses are created equal. States should spend these funds on electrifying public transit buses, to pave the way for a complete transformation of today's public transportation system to a clean, all-electric system. Spending the remaining EMT funds on any of the other options, new diesel technology, compressed natural gas or diesel-electric hybrids would represent a critical misstep that would move us further away from achieving several essential goals, including 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 annual unlinked passenger trips, 1.37 billion more than its closest competitor, heavy rail.[91] Bus trips also account for the greatest number of total vehicle miles ("VMT"), 2.2 billion miles, or 41 percent of total transit VMT.[92]

Figure IX: Modal Shares of Service Provided and Consumed, 2013[93]



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 consequences are particularly hard felt by the most economically vulnerable consumers, who are more likely to rely to public buses. This is not only true in urban centers, but in diverse geographic regions throughout the country. Because transit buses are used in all areas around the country - 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 will offer the most comprehensive and consequential pollution reduction benefits as well as the greatest opportunity for public visibility and market transformation.[94]

To accompany the purchase of electric buses, transit agencies would also need to invest some EMT funds in chargers for their new electric buses.[95] Planning electric charging stations would not be difficult because public transit buses follow fixed itineraries and often have intersecting routes over the course of a day. Charging stations 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 electric 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.[96] While all individuals would benefit from reduced pollution, riders who regularly take public transit, those that live or work 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 would have that effect.

Figure X. Annual Tailpipe Green House Gas Emissions by Bus Type[97]

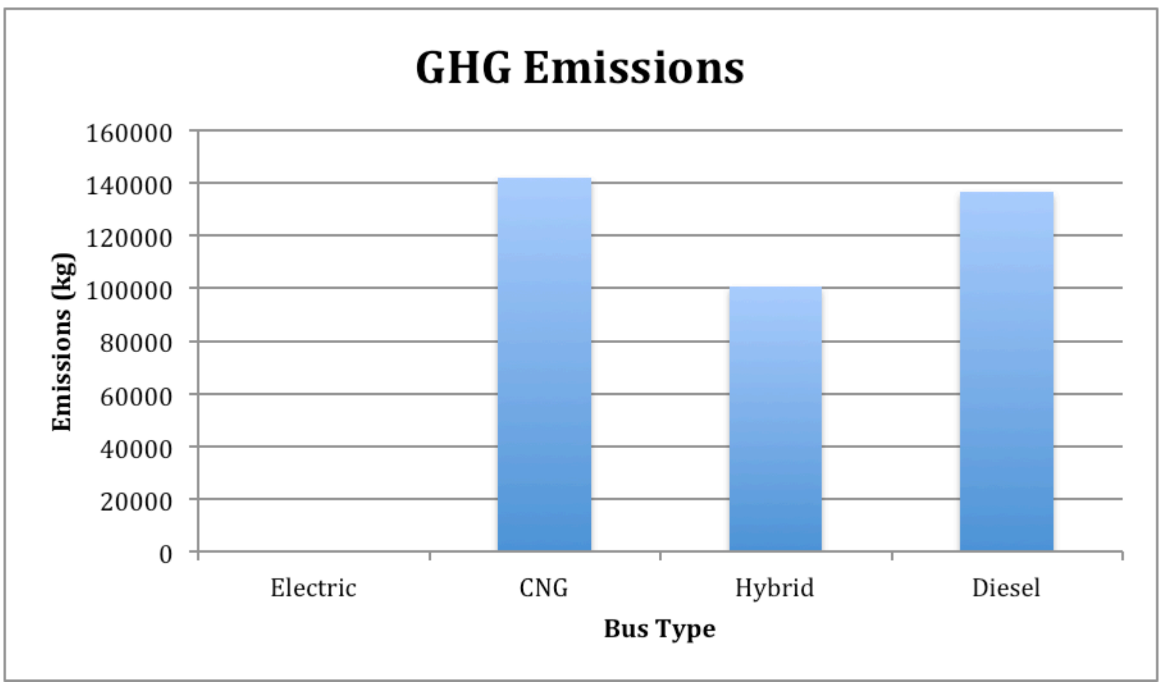
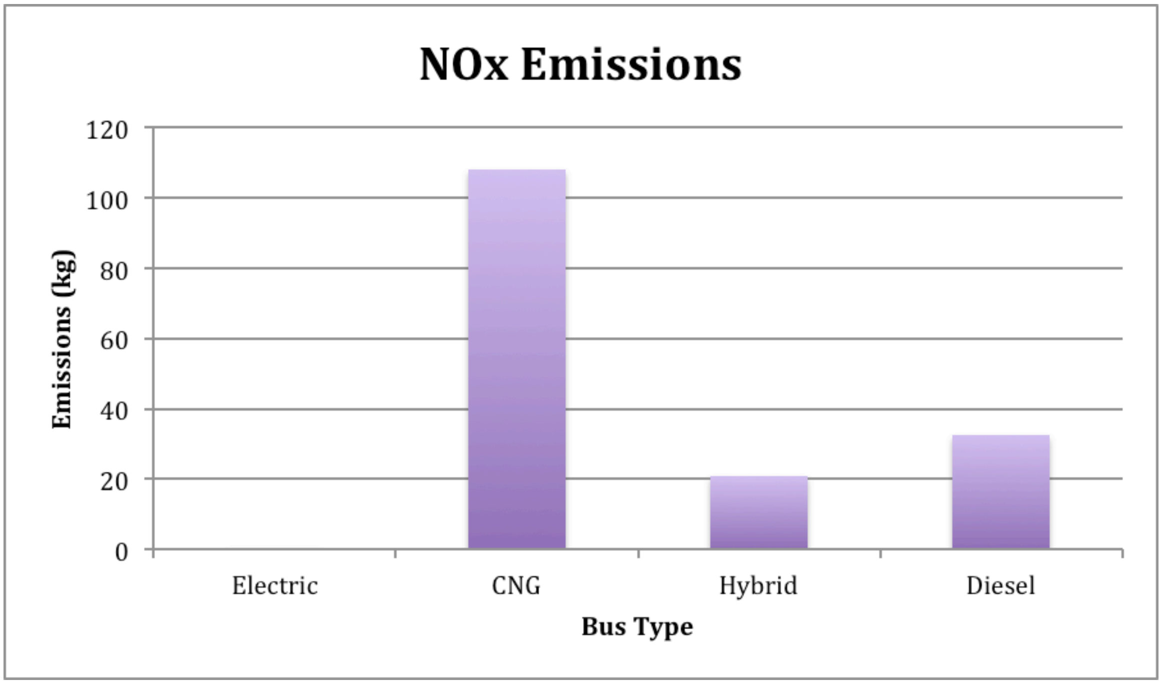


Figure XI. Annual Tailpipe NO_X Emissions by Bus Type[98]



All-electric buses produce no tailpipe emissions. CNG and diesel buses, however, 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.[99] CNG buses emit appoximately 107 kilos of NO_X annually, more than four times as much as a diesel bus or hybrid diesel-electric bus.[100] The lack of tailpipe emissions from electric buses helps improve air quality on roads and near bus transit passengers, allowing people to breathe cleaner air on their daily commutes and other travels.

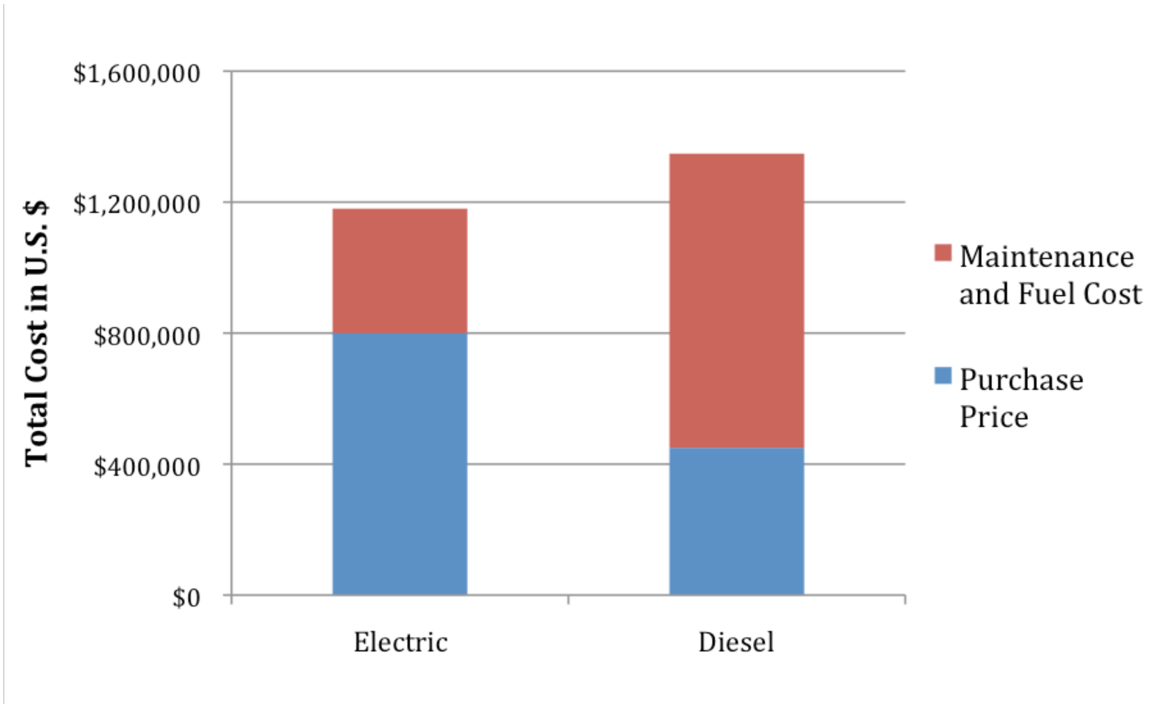
According to the U.S. DOT, switching from a diesel bus to an electric bus eliminates 10 tons of nitrogen oxides over a 12-year lifecycle, as well as 1,690 tons of carbon dioxide and 158 kilos of diesel particulate matter from the air.[101] Diesel and CNG buses emit very similar levels of CO_2 from their tailpipes, because, while CNG has lower carbon content, the emissions reduction is offset by the higher average fuel economy of diesel buses.[102] In terms of CO_2 reduction over a 12-year lifecycle, switching *one* diesel bus to electric is equivalent to keeping about 30 gas-powered cars off the road for 12 years.[103]

Moreover, natural gas vehicles contribute high levels of methane to the air. Natural gas-powered vehicles emit methane during both the production and transport of natural gas and during fuel combustion. Because methane traps 30 times more heat than CO_2, this can have devastating consequences on the climate and the environment.[104] Additionally, leakage during natural gas production is hard to evaluate because of the lack of accurate data and may be high enough to contribute significantly to the methane levels in the air, even before natural gas is combusted in vehicles.[105] In addition to the high CO_2 emissions, the damage caused by increased methane levels further argues for the adoption of fully electric buses instead of investing more in dirty technologies like natural gas and diesel.

Increasing Cost Savings

Over their lifecycle, electric buses lower costs 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, without including the health costs of diesel pollution.[106]

Figure XII: Lifetime Cost of Diesel vs. Electric Bus[107]



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.[108]

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 national and international markets and are 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 using 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.[109] In Eugene, Ore., the Lane Transit Districts expects electric buses will cost $300,000 less to operate over their lifetime compared to a hybrid diesel-electric model.[110]

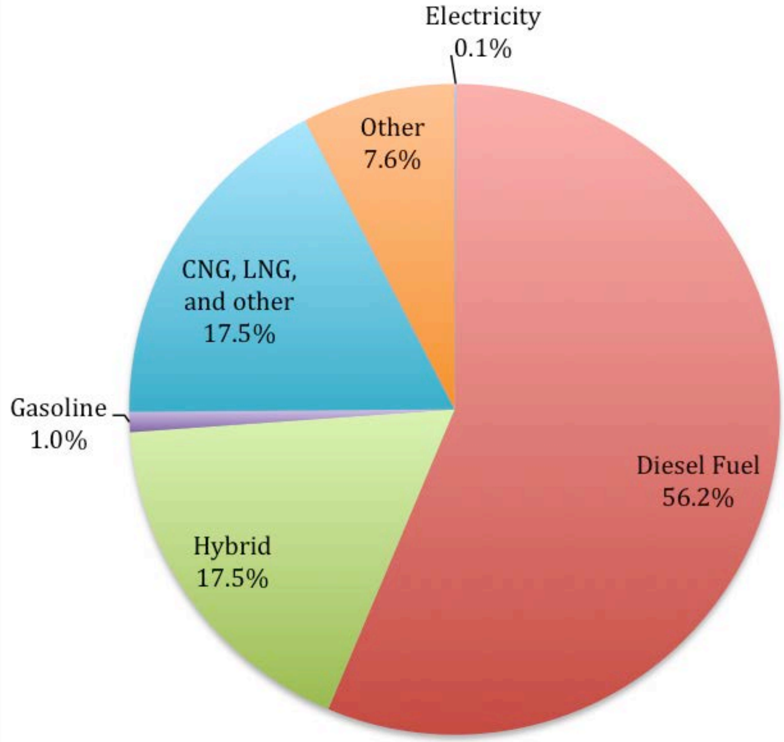
Increasing Energy Efficiency

While VW settlement funds can be used to invest in newer diesel and natural gas buses, these technologies represent a misstep away from a cleaner transportation system. 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.[111] 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.[112]

The United States' Down Payment on a Clean Transit System

Assuming agencies would need to invest the full initial cost of $800,000 for an electric bus, states' share of the EMT funds could purchase about 3,000 electric buses to replace existing diesel buses.[113] This would be a significant increase in the country's use of electric buses, which currently represent less than 1 percent of total buses in use.

Figure XIII: Percentage Power Source for Buses, January 2014[114]



Because electric buses are significantly cleaner than diesel and natural gas buses, the purchase of 3,000 buses would eliminate about 5 million tons of CO_2 and 476,271 kilos of diesel particulate matter from the air over 12 years.[115] In terms of CO_2 reductions, this is equivalent to removing about 80,000 cars from the road for 12 years or stopping over 10 million barrels of oil from being consumed.[116] These significant emissions reductions would improve air quality throughout the country, allowing residents to breathe cleaner air. Fewer nitrogen oxides would be spread and less smog would be formed.

In terms of cost savings, these new electric buses could save the country's transit agencies about $500 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 Investments Complement Existing U.S. Clean Air Goals

Since 1970, the Clean Air Act (CAA) has helped lower the levels of six pollutants – ozone, lead, carbon monoxide, nitrogen dioxide, particles, and sulfur dioxide. Through the CAA, the EPA established the National Ambient Air Quality Standards (NAAQS) to "protect public health and to regulate emissions of hazardous air pollutants."[117] Between 1970 and 2015, countrywide emissions of these six pollutants, many of which are produced by vehicle combustion engines, dropped about 70 percent due to efforts by national, state and local governments. NO_X emissions decreased 51 percent between 1990 and 2014.[118]

Under the Clean Air Act Amendments of 1990, New England, the Mid-Atlantic States, and the District of Columbia formed the Ozone Transport Commission (OTC) to create the nitrogen oxides (NO_X) Budget Program and lower ozone levels in the region.[119] Following the success of the OTC, the EPA enacted a Cross-State Air Pollution Rule (CSAPR) for the 2008 NAAQS.[120] This rule is intended to reduce NO_X emissions in 22 states in the eastern parts of the country and improve air quality in regards to ozone pollution that crosses state lines.[121]

Despite these improvements, as of October 2015, 122 million people in the U.S., or 40 percent of the population) still lived in counties with pollution levels above the NAAQS requirements for 8-hour ozone pollution.[122] Since ozone is formed from the chemical reactions of NO_X and VOC, NO_X must be lowered before ozone levels can truly improve.

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

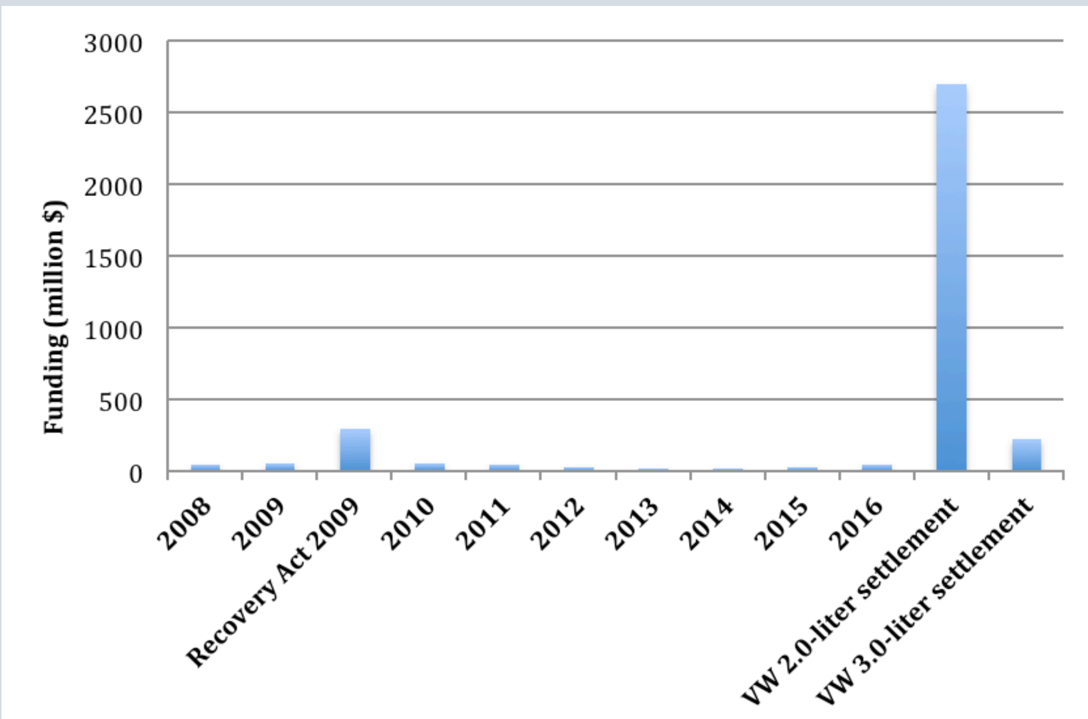
Supplementing VW Funds with DERA

The federal government could also be a source of supplemental funding for states looking to stretch their VW EMT money. The settlement includes the option to use EMT funds in conjunction with a Diesel Emissions Reduction Act (DERA) grant. As part of the Energy Policy Act of 2005, the Diesel Emissions Reduction Act gave the EPA the authority to provide eligible entities grants and loans to reduce diesel emissions.[123] From fiscal year 2008 to fiscal year 2016, the DERA program was given about $670 million in funding, which included an increase of $300 million in funding through the American Recovery and Reinvestment Act of 2009.[124] With these funds, DERA has helped fund thousands of diesel engine retrofits and replacements to lower diesel emissions throughout the country.[125]

The DERA option could be used to get complementary funding from the EPA, which offers a matching incentive of 50 percent for projects where voluntary matching funds are obtained. Using $200,000 from the VW trust fund as a voluntary match could result in an additional $300,000 in funding: a base of $200,000 from DERA and an additional EPA bonus of $100,000, according to a January 2017 EPA factsheet.[126]

The DERA program's funding, however, is extremely limited. In the past, the program's funding has been too low to fill state demand for upgrading their older diesel technology. In fact, funding requests have exceeded grant availability by a ratio of seven-to-one, according to a 2016 EPA report to Congress.[127] While attempting to increase funding through matching grants is a worthwhile idea, most eligible entities will not be able to get funding as the DERA program is incredibly limited in its bandwidth to fill demand.

Figure XIV: VW Settlement Compared to Federal Diesel Grants, 2008-2016[128]



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 on EV charging infrastructure and increasing awareness and fostering education of EVs.[129]

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

The First ZEV Investment Plan

For the first of four 2.5-year investment cycles, VW has submitted a draft plan for the first investment of $200 million in California and $300 million outside the Golden State.[130] Of these funds, VW plans to spend $120 million directly on charging infrastructure in California including $65 million for 50 DC fast-charging sites, each with five individuals charging station at each site.[131] Half of these stations would be rated at 150 kW, with the other half at 320 kW, according to the draft VW plan. Stations with the higher voltage would be competitive with Tesla's Superchargers and therefore "future proof" from electric cars with larger battery packs or onboard chargers capable of higher-rate charging.[132] About half of these 50 fast-charging stations would be located along the I-5 ad US-101 highway corridors, with the rest on intersecting highways.[133]

Additionally, $40 million of first-round funding in California would be invested in about 350 local, public charging stations, including a mix of DC and 240-volt Level 2 AC stations – in Los Angeles, San Francisco, San Jose, San Diego, and Sacramento metropolitan areas.[134] $15 million is being set aside for the maintenance and operating costs not covered through user fees.[135] All stations installed with the VW funds will be universally accessible – so as not to favor VW vehicles - and therefore be equipped with CHAdeMO plugs alongside CCS plugs.[136]

As part of California's ZEV fund, VW will spend $44 million for a "Green City Initiative." The "Green City Initiative" will center on one California city – currently assumed to be Sacramento - and focus on ZEV car-sharing, ZEV delivery fleet, and ZEV taxi fleet provider.[137] Foundational work for these initiatives is expected to begin in late 2017 with the installation of 75 supporting electric chargers.[138]

Lastly, VW will spend $20 million in California and $25 million in the rest of the country on ZEV promotion, primarily through television ads.[139]

Conclusion

Volkswagen's systematic emissions cheating caused 567,000 Americans to purchase "clean diesel" vehicles that emitted NO_X pollution at up to 40 times the legal limit. Thankfully, VW was caught and steps are being taken to hold the company accountable.

States have no way of clawing back the unnecessary and damaging pollution that spewed into their air because of Volkswagen's defeat devices. Therefore, we need to ensure that any settlement money VW pays is invested in moving the transportation system toward a cleaner and cheaper future. Investing in electrification will increase the adoption of EVs and lead to reduced pollution vehicles, while ushering in a market transformation toward a zero-emission transportation system.

Altogether, $2.9 billion will be allocated through the Environment Mitigation Trust, which states, Washington D.C., Puerto Rico, and tribal groups can invest over the next three to 10 years. States should invest 15 percent of that money on fast charging electric stations along state highways and the remaining 85 percent should be invested to replace older, diesel buses with electric buses throughout the country's transit systems.

In addition, states 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 the country's air quality, 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] U.S. Environment Protection Agency, *Air Emissions Inventories*, 24 May 2016, accessed at https://www3.epa.gov/cgi-bin/broker?polchoice=NOX&_debug=0&_service=data&_program=dataprog.national_1.sas.

[9] U.S. Environment Protection Agency, *Air Emissions Inventories*, 24 May 2016, accessed at https://www3.epa.gov/cgi-bin/broker?polchoice=NOX&_debug=0&_service=data&_program=dataprog.national_1.sas.

[10] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014,* 15 April 2016, accessed at https://www.epa.gov/sites/production/files/2016-04/documents/us-ghg-inventory-2016-main-text.pdf (pg. ES-14).

[11] The unit of million metric tons of carbon dioxide equivalents (MMT CO_2) describes the magnitude of greenhouse gas emissions in comparison to carbon dioxide.

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

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

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

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

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

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

[18] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014,* 15 April 2016, accessed at https://www.epa.gov/sites/production/files/2016-04/documents/us-ghg-inventory-2016-main-text.pdf (pg. ES-14); U.S Environmental Protection Agency Office of Air Quality Planning and Standards, *Technical Bulletin: Nitrogen Oxides (NOx), Why and How They are Controlled,* November 1999, accessed at https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf (pg. 3).

[19] Environmental Protection Agency, *Sources of Greenhouse Gas Emissions,* accessed at https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[20] Brad Plumer, "Power Plants are Longer America's Biggest Climate Problem. Transportation is." *Vox,* 13 June 2016, accessed at http://www.vox.com/2016/6/13/11911798/emissions-electricity-versus-transportation.

[21] Criminal investigations into wrongdoing by VW executives are still ongoing.

[22] 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.

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

[24] United States Environmental Protection Agency, *Volkswagen Clean Air Act Civil Settlement*, accessed at https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement.

[25] United States District Court Northern District of California, Second Partial Consent Decree, accessed at https://www.vwcourtsettlement.com/en/docs/3Liter/Notices/VW%203L%20Settlement%20Notice.pdf.

[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. 183).

[27] 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).

[28] 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).

[29] 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).

[30] 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).

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

[32] United States Environmental Protection Agency, US Greenhouse Gas Inventory 2016, accessed at https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf (pg. ES-23)

[33] 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.

[34] U.S. Department of Energy, Energy Efficiency & Renewable Energy, *Alternative Fueling Station Location,* 2 February 2017, accessed at http://www.afdc.energy.gov/locator/stations/.

[35] Zach, "Electric Car Charging 101 – Types of Charging, Charging Networks, Apps & More!" *EV Obsession,* 10 September 2016, archived at http://web.archive.org/web/20170405140951/http://evobsession.com/electric-car-charging-101-types-of-charging-apps-more/.

[36] Tom Saxton, "Understanding Electric Vehicle Charging," *Plug In America,* 31 January 2011, archived at http://web.archive.org/web/20170405140530/https://pluginamerica.org/understanding-electric-vehicle-charging/.

[37] Cynthia Shahan, "EV Charging is Easy," *Clean Technica,* 13 April 2016, accessed at https://cleantechnica.com/2016/04/13/ev-charging-easy/.

[38] Mary Fitzpatrick, Connecticut Office of Legislative Research, *Electric Vehicle Charging Stations,* 29 November 2016, archived at http://web.archive.org/web/20170404204139/https://www.cga.ct.gov/2016/rpt/pdf/2016-R-0302.pdf (pg.3)

[39] Mary Fitzpatrick, Connecticut Office of Legislative Research, *Electric Vehicle Charging Stations,* 29 November 2016, archived at http://web.archive.org/web/20170404204139/https://www.cga.ct.gov/2016/rpt/pdf/2016-R-0302.pdf (pg.3).

[40] Cynthia Shahan, "Nissan, BMW, & EVgo Expand DC Fast Charging Across US," *Clean Technica,* 26 January 2017, accessed at https://cleantechnica.com/2017/01/26/nissan-bmw-evgo-expand-dc-fast-charging-across-u-s/.

[41] Mary Fitzpatrick, Connecticut Office of Legislative Research, *Electric Vehicle Charging Stations,* 29 November 2016, archived at http://web.archive.org/web/20170404204139/https://www.cga.ct.gov/2016/rpt/pdf/2016-R-0302.pdf (pg.3).

[42] Zach, "Electric Car Charging 101 – Types of Charging, Charging Networks, Apps, & More," *EV Obsession,* 10 September 2015, archived at http://web.archive.org/web/20170404203922/http://evobsession.com/electric-car-charging-101-types-of-charging-apps-more/.

[43] 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,* 2 February 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.

[44] Paul Ausick, Why Are There 115,000 (or 150,000) Gas Stations in America? *24/7 Wall St.,* 22 May 2014, accessed at http://247wallst.com/economy/2014/05/22/why-are-there-115000-or-150000-gas-stations-in-america/.

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

[46] 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.

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

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