City of Virginia Beach Electrification and AFLEET Analysis Report

Prepared by:
John Maiorana, Josh Crawford, Alleyn Harned

August 8, 2022

Overview

Virginia Clean Cities received an inquiry from the city of Virginia Beach, met and discussed technology options, and presented this analysis for the fleet pilot of electric vehicles as assistance for the fleet. This process is one that is repeated often in fleets throughout Virginia and is a complementary component of our Drive Electric Virginia effort for 2022.

Drive Electric Virginia is a collaborative initiative led by Virginia Clean Cities and partnering organizations. This shared effort engages individuals, utilities, legislators, dealerships and other stakeholders toward removing EV adoption barriers and accelerating plug-in EV use in the Commonwealth of Virginia. In order to accomplish this goal, project leaders and implementers will educate consumers, utilities, utility regulators, and government officials while engaging auto dealers and fleet leaders, conducting EV infrastructure planning, and developing local EV chapters. All of this will occur under the banner of each branded, statewide EV initiative which will be guided by that state's stakeholders. The project also provides resources to produce electric vehicle planning reports such as this as requested by localities and fleets.

Executive Summary

After two program meetings with Virginia Beach staff, developing a shared understanding of technology integration preferences with the fleet, as well as initial details of cost, Virginia Clean Cities staff ran approximately four technology comparison calculations using the Argonne National Labs AFLEET model for each vehicle type. These comparisons resulted in positive outcomes for the integration of pilot scale electric vehicle clusters into the fleet.

At this time, electric vehicles are possible for this fleet and could present a serious cost savings. The vehicle clusters were Sport Utility Vehicles (SUVs), Trucks, and Vans.

> Model suggests fleet could save half a million dollars operating ten electric SUVs over gasoline in a pilot.

10 sport utility vehicles represent a local fleet comparison of the gasoline Ford Explorer, with either the Chevrolet Bolt or the Ford Mach E electric vehicles and positive outcome for cost and emissions for Virginia Beach. The financial performance is very positive for electrified SUVs/Crossovers as the comparison between a set of Bolts over a set of Explorers shows Bolts at approximately 54% of the cost of owning and operating Ford Explorers. **Electrification represents a savings of nearly a half million dollars for purchase and operation of 10 vehicles for the fleet standard 15 years. There is also a deep reduction in greenhouse gas emissions**

of greater than 70% and a near-total reduction in other criteria pollution. The cohort of Ford Explorers also have an annual health impact on the community of approximately $4500 while the EVs reduced emissions only have around $750 in externality costs. The net savings to the community for the electric vehicle pilot is significant. The Mach E option is a little more expensive but still represents a quarter million dollars in savings over the Explorer Cohort.

10 trucks represent a localized comparison of the gasoline Ford F-150, with the all-electric Ford F-150 Lightning. The financial performance is very positive for electrified F-150 Lightning as the comparison between a set of gasoline F-150's over a set of F-150 Lightnings shows Lightnings at approximately 70% of the cost of owning and operating gasoline F-150's. **Electrification represents a savings of nearly $300,000 for operating 10 vehicles for 15 years. There is also a deep reduction in greenhouse gas emissions of greater than 60% and a near-total reduction in other criteria pollution.** The cohort of Ford F-150 also have an annual health impact on the community of approximately $5500 while the EVs reduced emissions only have around $1200 in externality costs.

10 vans represent a localized comparison of the gasoline Ford Transit, with the all-electric Ford E-Transit. The financial performance is very positive for electrified E-Transit as the comparison between a set of gasoline Ford Transit over a set of E-Transits shows **Electric E-Transits at approximately 70% of the cost of owning and operating gasoline Ford Transits.** The savings and reduction in greenhouse gas emissions are very similar to that of the Ford Transit and Ford E-Transit specifications. The cohort of Ford Transit also have an annual health impact on the community of approximately $4000 while the EVs reduced emissions only have around $800 in externality costs.

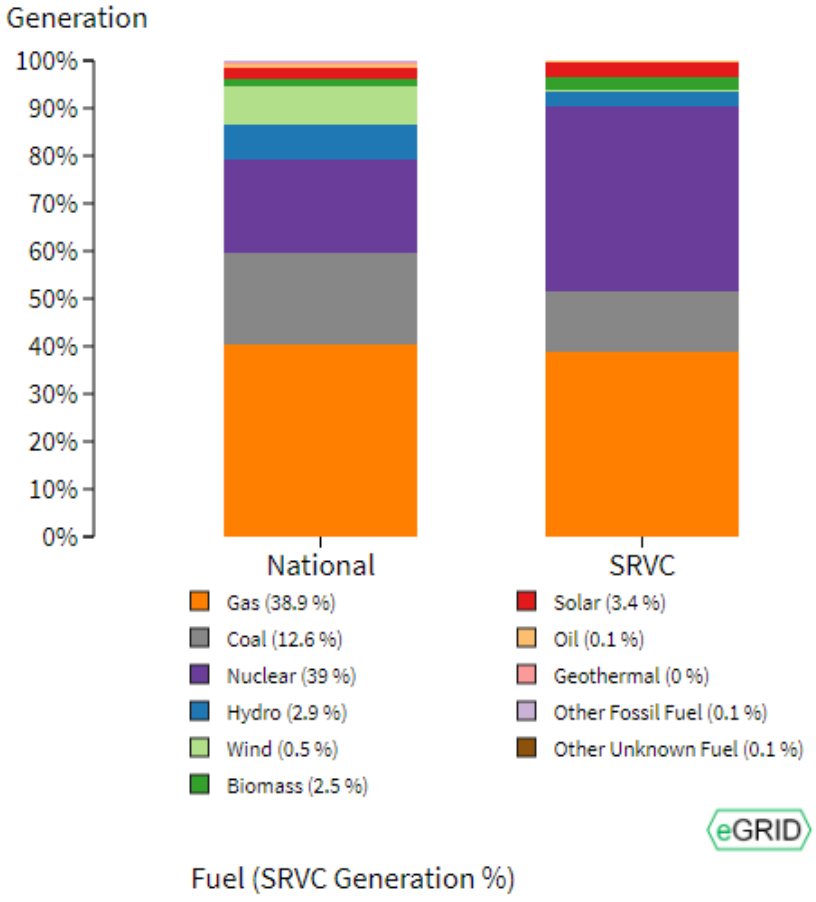
Vehicle Comparison AFLEET Analysis:

Created by Argonne National Laboratory, The Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) is used to estimate petroleum use, greenhouse gas emissions, air pollutants, and cost of ownership of light-duty and heavy-duty vehicles. In this analysis, we compare 10 traditional gasoline SUVs, Pick-up trucks, and Vans to electric alternatives.

To sharpen the tool for the purposes of deployment in the City of Virginia Beach, we have made multiple assumptions. First, the assumption of fuel cost is $5.00 per gallon for public stations and $4.00 for private fueling and the price of electricity is .30 cents a kilowatt and private charging is .08 cents a kilowatt. These price points were determined from the average annual pricing for the region.

The next assumption is the local energy mix used for the region's electricity. Using the EPA power profiler, we were able to determine Virginia Beach's profile is detailed below. The graph below is

the energy comparison between the Virginia Beach region's electrical energy mix and the nation's average.



The next assumption is the $7,500 federal tax credit incentive for the 2022 Ford F-150 Lightning and the 2022 Ford E-Transit Connect. These incentives are shown in the total cost of ownership calculation. Chevy Electric vehicles are no longer eligible for the Federal tax credit. Even though municipal fleets are not taxed, vehicle financing and leasing entities can pass through that tax credit to municipalities in Virginia.

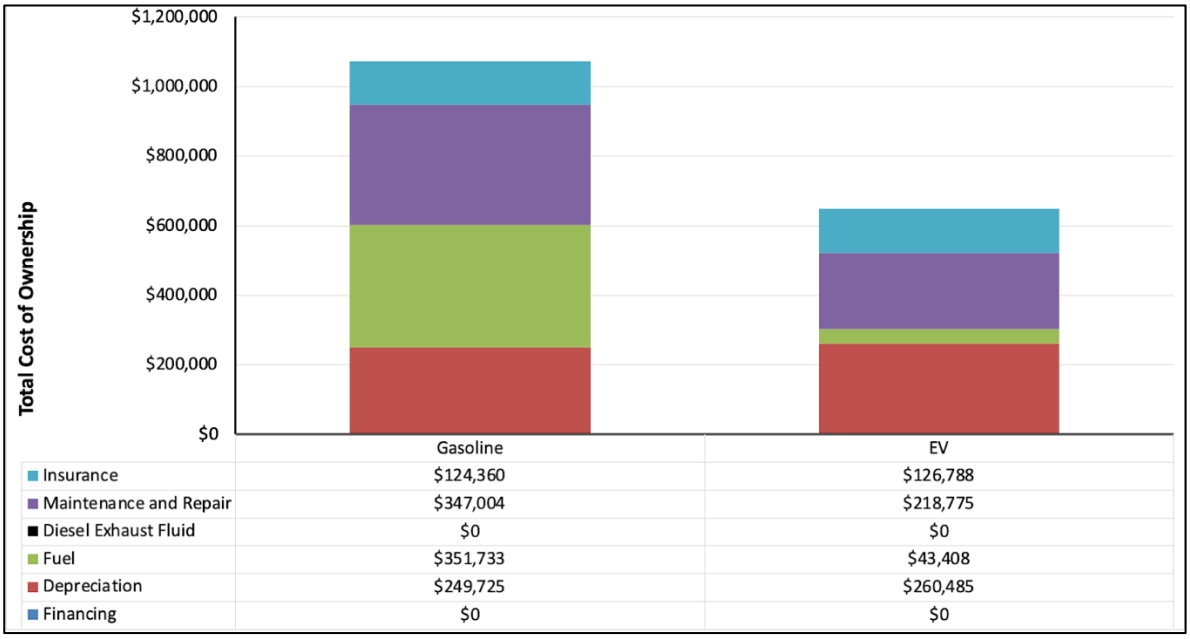
Sport Utility Vehicle Comparison – Explorer and Bolt EUV

2022 Ford Explorer: Base MSRP - $28,278

2022 Chevy Bolt EUV: Base MSRP - $29,496

Key Vehicle and Fuel Inputs					
Primary Vehicle Location					
State	VIRGINIA				
County	VIRGINIA BEACH CITY				
Light-Duty Vehicle Information					
Vehicle Type	Passenger Truck				
Vocation Type	SUV				
Light-Duty Fuel Type	Number of Light-Duty Vehicles	Annual Vehicle Mileage	Fuel Economy (MPGGE)	Purchase Price ($/vehicle)	Maintenance & Repair ($/mi)
Gasoline	10	12,000	24.0	$28,278	$0.15
All-Electric Vehicle (EV)	10	12,000	115.0	$29,496	$0.10

Our first AFLEET calculation compared the 2022 Chevy Bolt EUV with the 2022 Ford Explorer at 12,000 annual miles for 10 vehicles. A 2022 Ford Explorer costs $28,278, has a fuel economy of 24 miles per gallon, and averages a maintenance cost per mile of .15 cents. The 2022 Chevy Bolt EUV costs $29,496 has a fuel economy of 115 miles per gallon and averages a maintenance cost per mile of .10 cents. The vehicle purchase prices were taken from the Virginia Sheriff's shared contract.

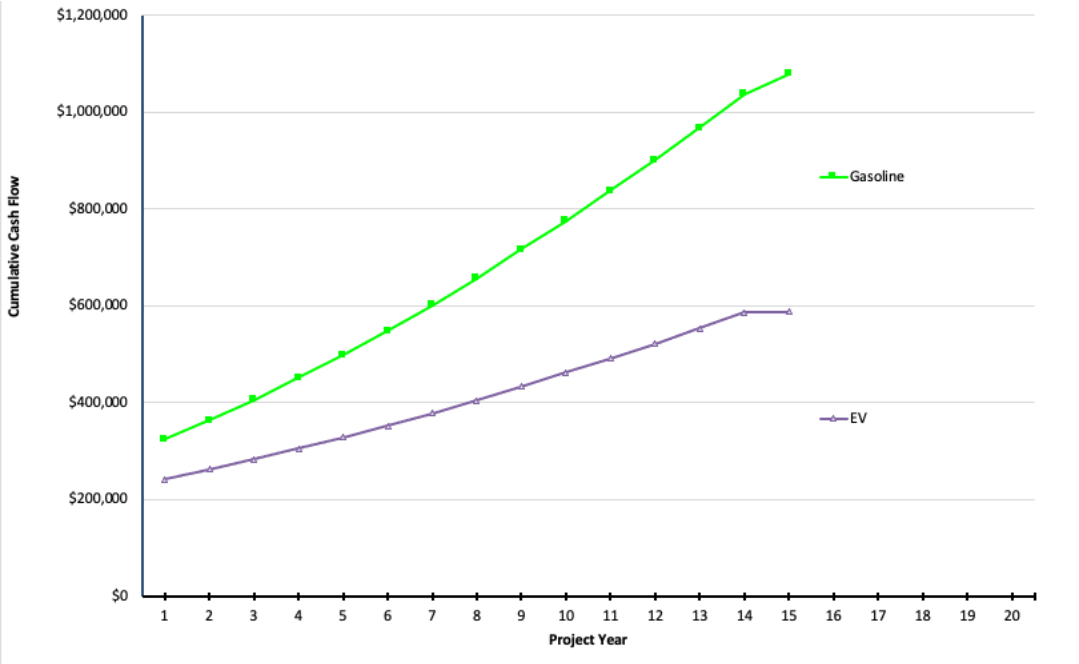


	Gasoline	EV
Insurance	$124,360	$126,788
Maintenance and Repair	$347,004	$218,775
Diesel Exhaust Fluid	$0	$0
Fuel	$351,733	$43,408
Depreciation	$249,725	$260,485
Financing	$0	$0

Total Cost of Ownership **$1,077,758 Gasoline** **$588,201 EV**

This graph above represents the cost of ownership between the 2022 Ford Explorer and 2022 Chevy Bolt EUV over a 15-year period. Viewing the graph we can see that the fuel cost, maintenance/repair, and depreciation value all currently drastically reduce the overall cost when switching over to electric. Considering that electricity is far lower cost transportation energy fuel than gasoline, electric vehicles do not acquire as much money to fuel. Electric vehicles also have fewer moving parts than combustion engine vehicles allowing the maintenance and repair to be cheaper. Since electric vehicles are on the rise within the transportation industry, the past assumptions of high depreciation of an electric vehicle may have changed to a market where fleets will still have high resale value to used EVs at end of life.

Because the price of a Bolt is similar to the price of an Explorer, cost savings in year 1 are expected, and those continue. The below AFLEET chart shows project costs over time.

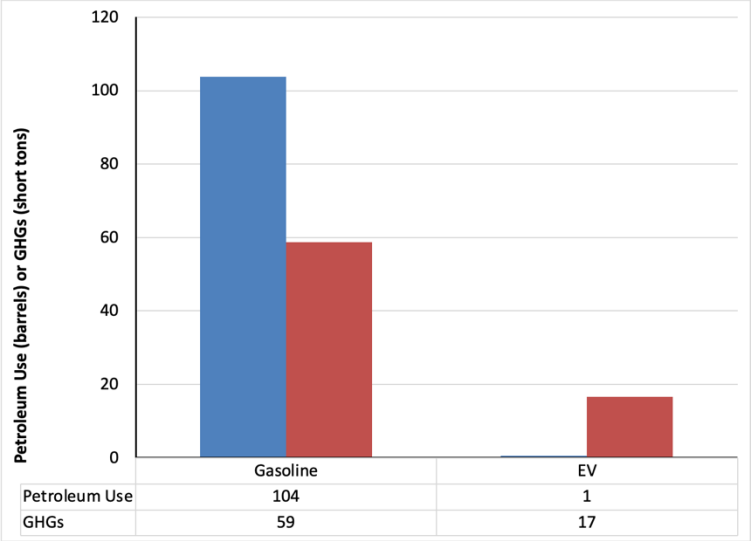


Municipalities do not pay some registration fees or gasoline tax in the use for their government vehicles, but private fleets often pay these fees. Electric vehicles do not pay gas taxes creating different revenue recovery mechanism in Virginia for highway maintenance. In order to recover these funds, higher registration fees are imposed for individual and private electric vehicles. Virginia recently released a program that allows individual consumers to pay highway fees on a per-mile basis instead of an annual fee. This allows the cost of registration to potentially drop if the vehicle registered travels less than 11,000 miles within the year. The model assumes some fees and this could be adjusted for future models.

SUV Cargo Space is reduced in the Bolt EUV Over the Explorer:
The available cargo volume in the 2022 Ford Explorer is 18.2 ft^3, and 87.8 ft^3 with seat area.
The available cargo volume in the 2022 Chevy Bolt EUV is 16.3 ft^3, and 56.9 ft^3 with seat area.

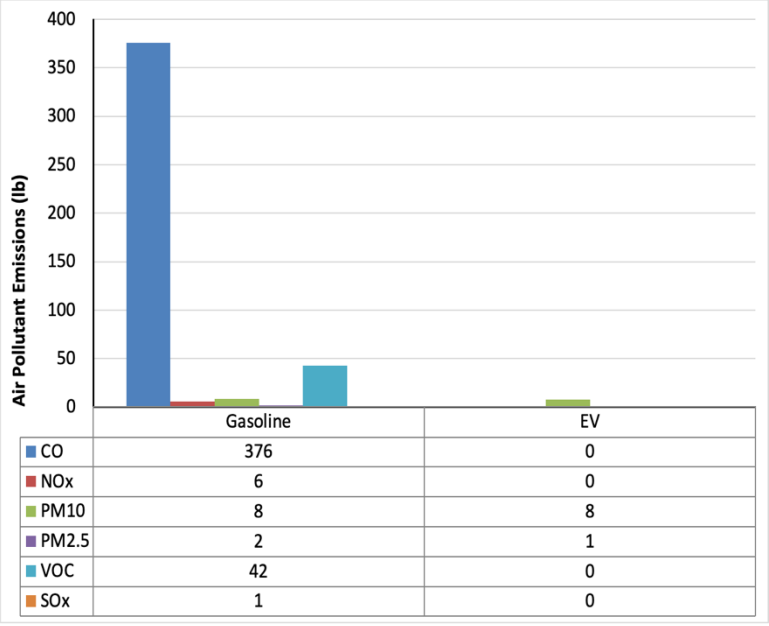
Annual Well-to-Wheels Petroleum and Emissions

This graph is showing the amount of barrels of petroleum and short tons of Green-house-gasses released during the entire lifespan of the vehicle. Well-to-Wheels refers to the involvement of the production of the vehicles before the vehicle is placed in operation. Although the EV still requires the emission of GHGs in its production, that emission stops once the vehicle is on the road. By the end of their life cycles, a Ford Explorer will release three times more GHG emissions than a Chevy Bolt.



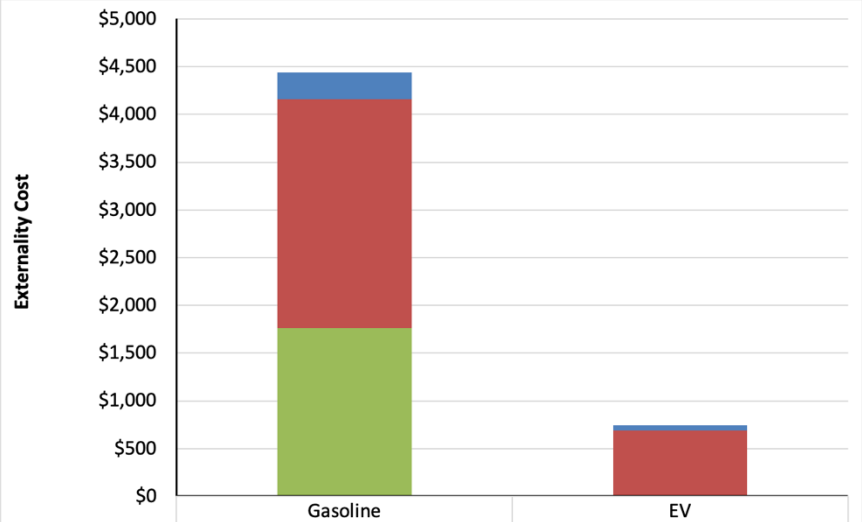
Annual Vehicle Air Pollution

This graph is showing the annual air pollution produced by both the 2022 Chevy Bolt EUV and 2022 Ford Explorer. Viewing the chart, the highest emission pollutant is carbon dioxide. Carbon dioxide is released through the combustion of gasoline and exits out the exhaust pipe. The reason we want to prevent carbon dioxide pollution is that it poses harmful threats for the air and the surrounding environment.



Annual Externality Costs

Most of the costs seen in the data above are from the production of energy through the utilization of fossil fuels. Fossil fuels release greenhouse gasses into the atmosphere when burned, the reason we notice costs by greenhouse gasses for EV's is that it takes fossil fuels to produce electricity, which later results in damages to the environment as well as personal health.



	Gasoline	EV
Air Pollutants	$281	$61
GHGs	$2,397	$677
Petroleum Use	$1,760	$9

Sport Utility Vehicle Comparison – Explorer and Mustang Mach-E

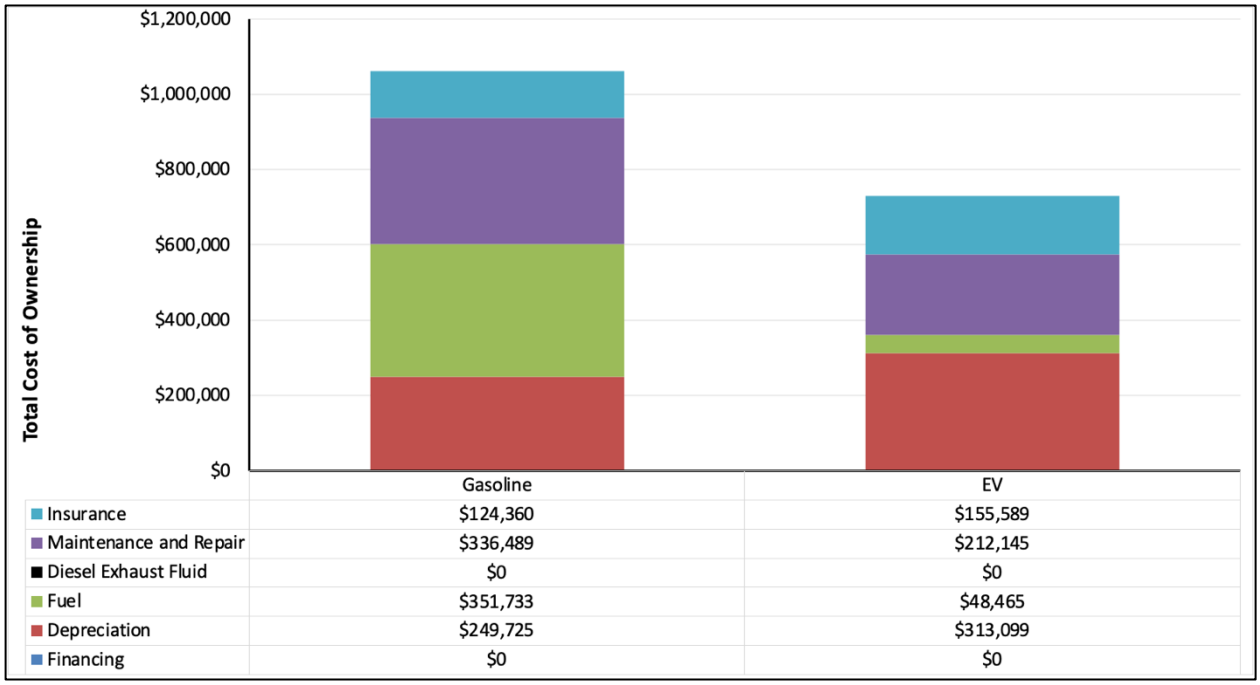
2022 Ford Explorer: Base MSRP - $28,278

2022 Ford Mustang Mach-E: Base MSRP - $43,947

Key Vehicle and Fuel Inputs						
Primary Vehicle Location						
State	VIRGINIA					
County	VIRGINIA BEACH CITY					
Light-Duty Vehicle Information						
Vehicle Type	Passenger Car					
Vocation Type	Car					
Light-Duty Fuel Type	Number of Light-Duty Vehicles	Annual Vehicle Mileage	Fuel Economy (MPGGE)	Purchase Price ($/vehicle)	Maintenance & Repair ($/mi)
Gasoline	10	12,000	24.0	$28,278	$0.15
All-Electric Vehicle (EV)	10	12,000	103.0	$43,947	$0.09

Our second AFLEET calculation compared the 2022 Ford Mustang Mach-E with the 2022 Ford Explorer at 12,000 annual miles for 10 vehicles. A 2022 Ford Explorer costs $28,278, has a fuel

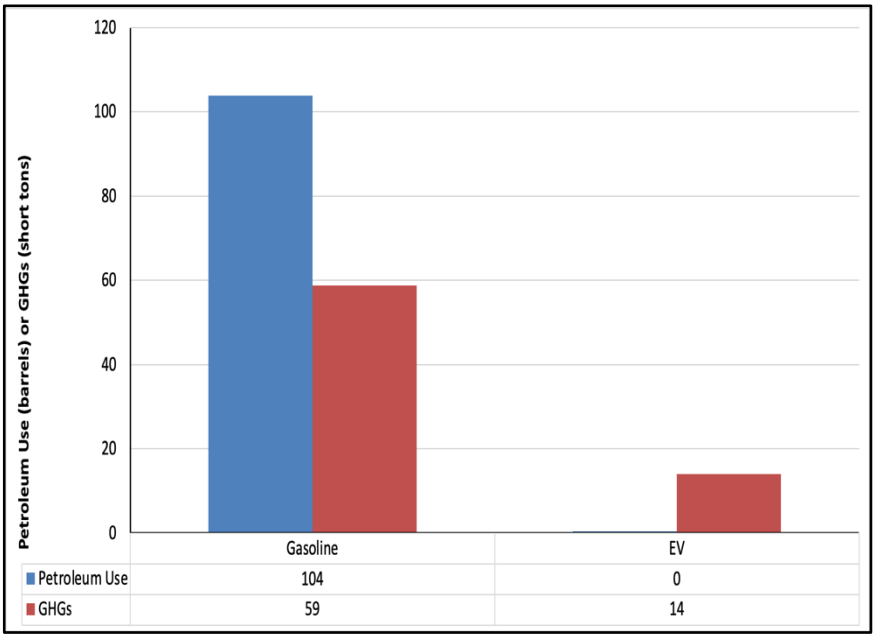
economy of 24 miles per gallon, and averages a maintenance cost per mile of .15 cents. The 2022 Ford Mustang Mach-E costs $43,947, has a fuel economy of 103 miles per gallon, and averages a maintenance cost per mile of .09 cents. The purchase prices were taken from the Virginia Sheriff's shared contract. This also provides graphics for presentations but does not provide as much narrative detail as earlier in the document.



	Gasoline	EV
Insurance	$124,360	$155,589
Maintenance and Repair	$336,489	$212,145
Diesel Exhaust Fluid	$0	$0
Fuel	$351,733	$48,465
Depreciation	$249,725	$313,099
Financing	$0	$0

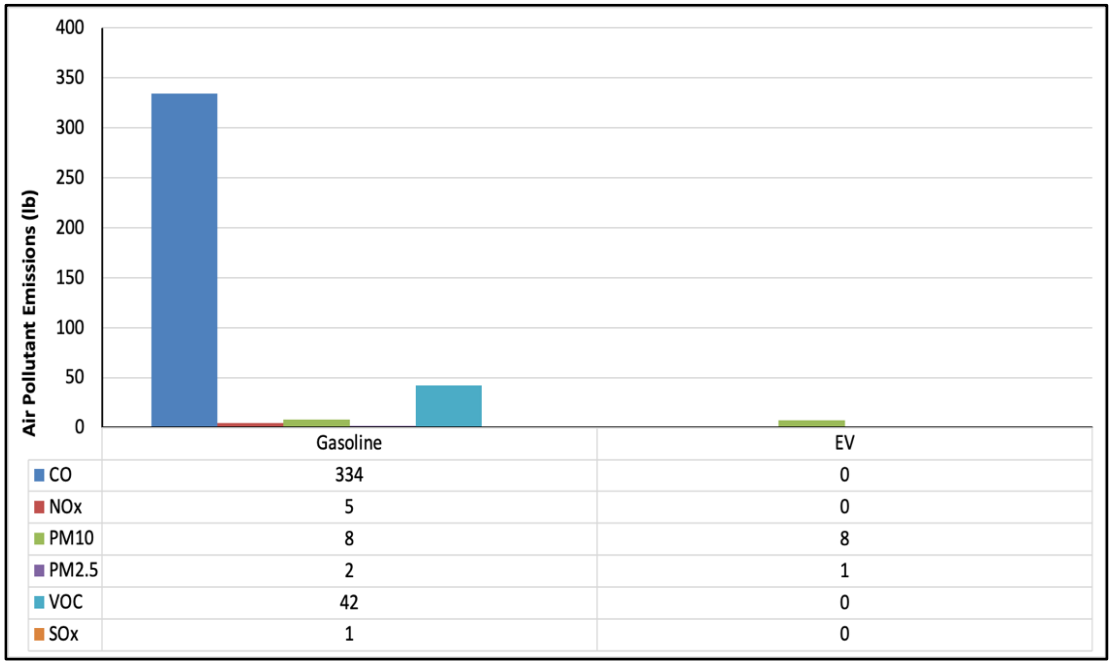
Total Cost of Ownership **$1,066,543 Gasoline** **$742,354 Electric Mustang**

Annual Well-to-Wheels Petroleum and Emissions



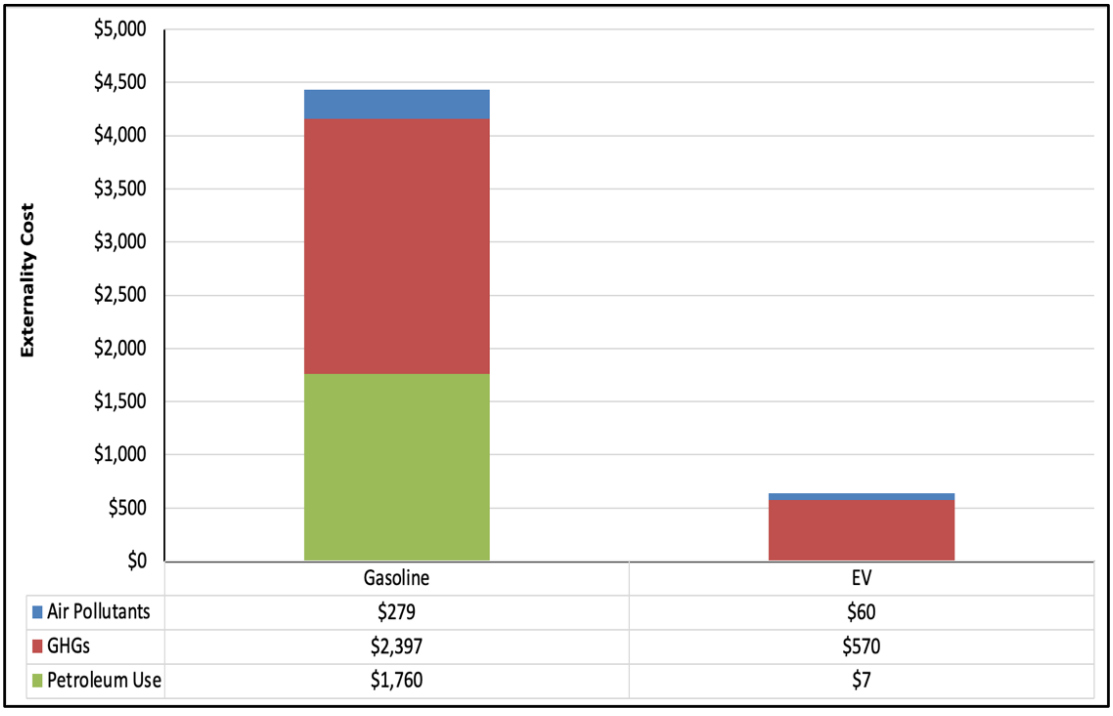
	Gasoline	EV
Petroleum Use	104	0
GHGs	59	14

Annual Vehicle Air Pollution



	Gasoline	EV
CO	334	0
NOx	5	0
PM10	8	8
PM2.5	2	1
VOC	42	0
SOx	1	0

Annual Externality Cost



	Gasoline	EV
Air Pollutants	$279	$60
GHGs	$2,397	$570
Petroleum Use	$1,760	$7

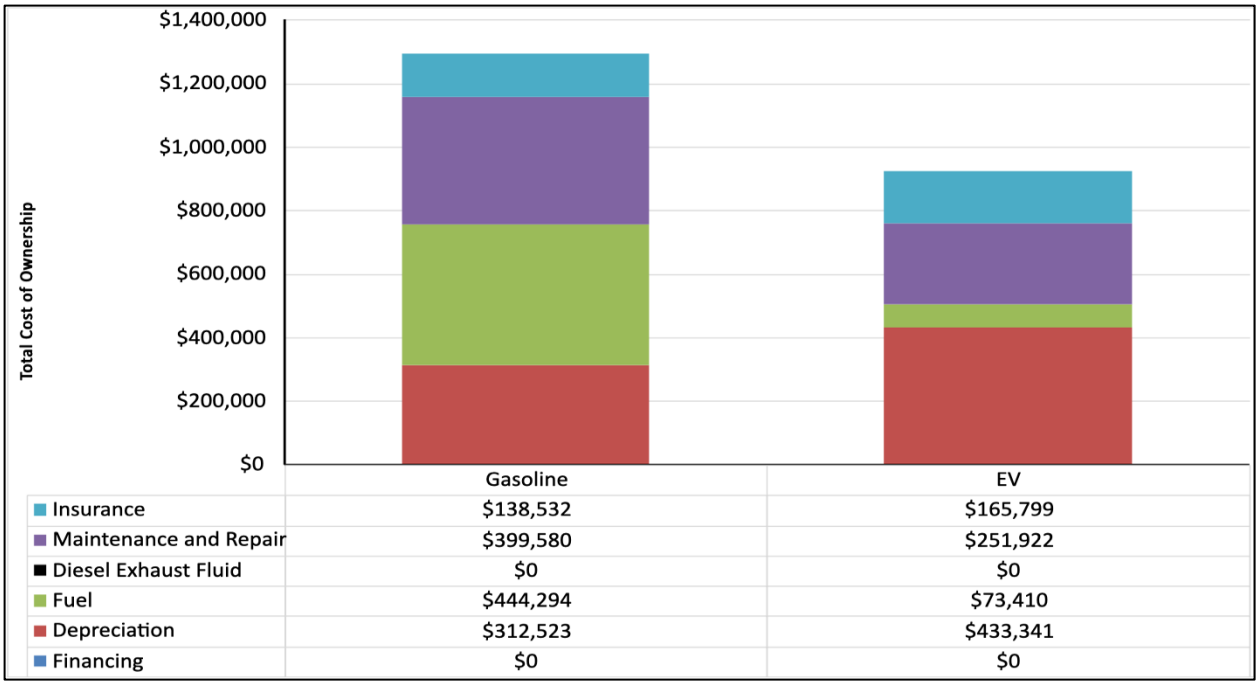
Truck Comparison – Ford F150 to Ford F150 Lightning

2022 Ford F-150 XL: Base MSRP - $35,389

2022 Ford F-150 Lightning: MSRP - $49,070

Key Vehicle and Fuel Inputs					
Primary Vehicle Location					
State	VIRGINIA				
County	VIRGINIA BEACH CITY				
Light-Duty Vehicle Information					
Vehicle Type	Passenger Truck				
Vocation Type	Light-Duty Pickup Truck				
Light-Duty Fuel Type	Number of Light-Duty Vehicles	Annual Vehicle Mileage	Fuel Economy (MPGGE)	Purchase Price ($/vehicle)	Maintenance & Repair ($/mi)
Gasoline	10	12,000	19.0	$35,389	$0.16
All-Electric Vehicle (EV)	10	12,000	68.0	$49,070	$0.10

Our third AFLEET calculation compared the 2022 Ford F-150 Lightning with the 2022 Ford F-150 Lightning at 12,000 annual miles for 10 vehicles. A 2022 Ford F-150 costs $35,389, has a fuel economy of 19 miles per gallon, and averages a maintenance cost per mile of .16 cents. The 2022 Ford F-150 Lightning costs $49,070, has a fuel economy of 68 miles per gallon, and averages a maintenance cost per mile of .10 cents. The purchase prices were taken from the Virginia Sheriff's shared contract. Depreciation a few years ago was expected to be greater on EVs however the market has reset and that depreciation value may be different now, the model continues the conservative high depreciation estimate. Due to demand, It may be difficult to purchase the F150 lightning.

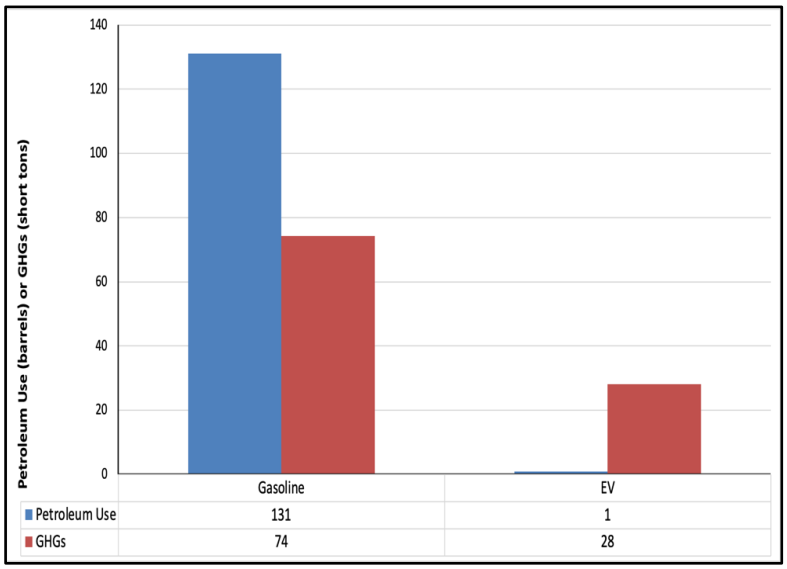


	Gasoline	EV
Insurance	$138,532	$165,799
Maintenance and Repair	$399,580	$251,922
Diesel Exhaust Fluid	$0	$0
Fuel	$444,294	$73,410
Depreciation	$312,523	$433,341
Financing	$0	$0

Total Cost of Ownership **$1,284,929 Gasoline** **$924,473 Electric**

This graph above represents the cost of ownership between the 2022 Ford F-150 and 2022 F-150 Lightning over a 15 year period.

Annual Well-to-Wheels Petroleum and Emissions

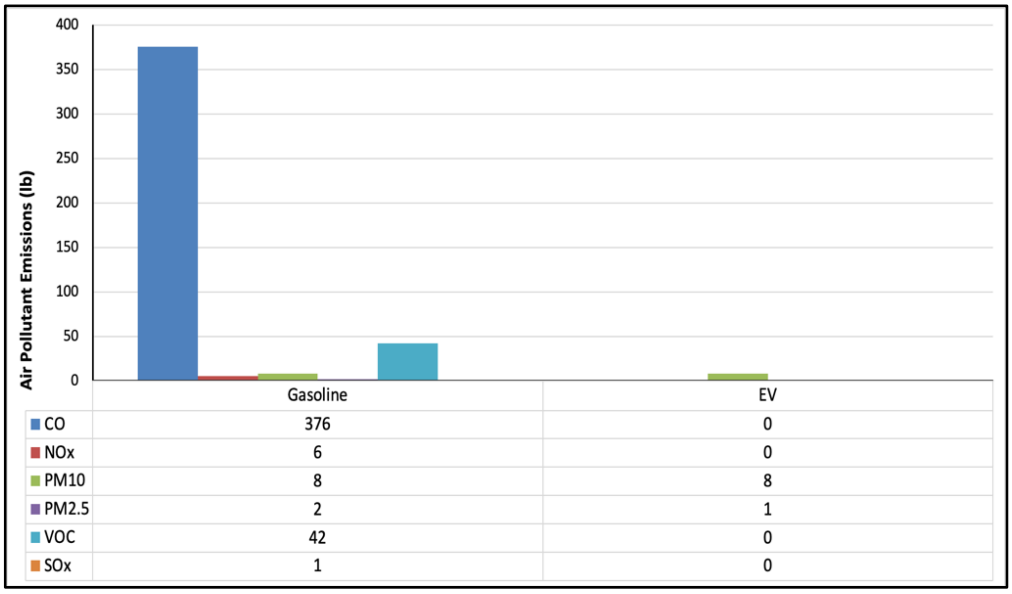


	Gasoline	EV
Petroleum Use	131	1
GHGs	74	28

The Annual Well-to-Wheels graph is showing the amount of barrels of petroleum and short tons of Green-house-gasses released during the entire lifespan of the vehicle. Well-to-Wheels refers to the involvement of the production of the vehicles before the vehicle is placed in operation.

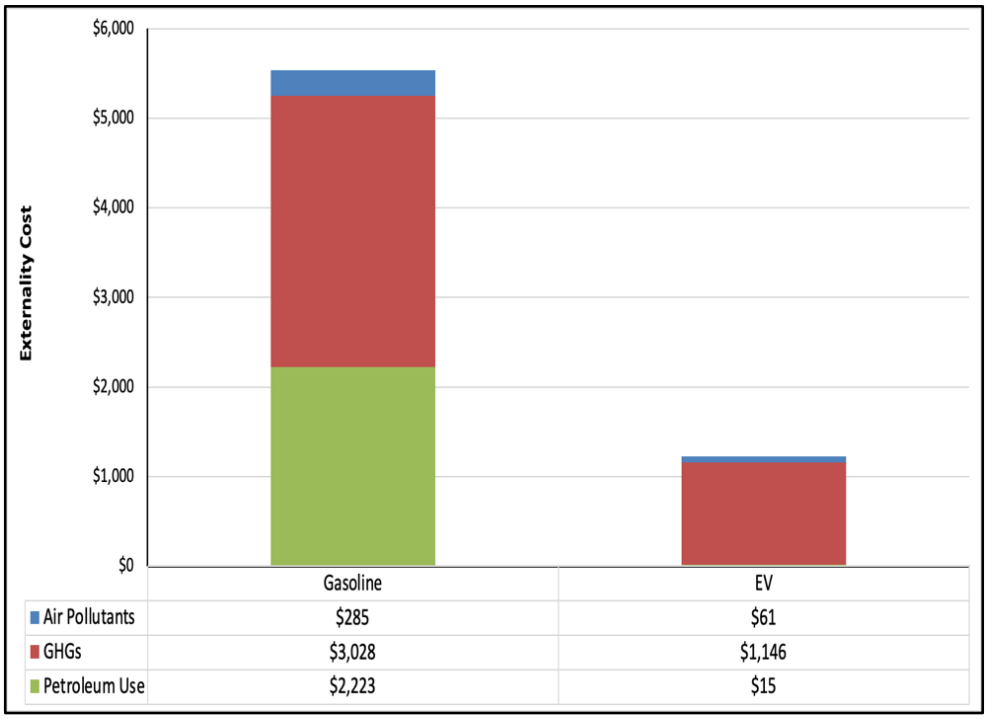
Annual Vehicle Air Pollution

This graph shows the annual air pollution produced by both the Ford F-150 and F-150 lightning.



	Gasoline	EV
CO	376	0
NOx	6	0
PM10	8	8
PM2.5	2	1
VOC	42	0
SOx	1	0

Annual Externality Cost



	Gasoline	EV
Air Pollutants	$285	$61
GHGs	$3,028	$1,146
Petroleum Use	$2,223	$15

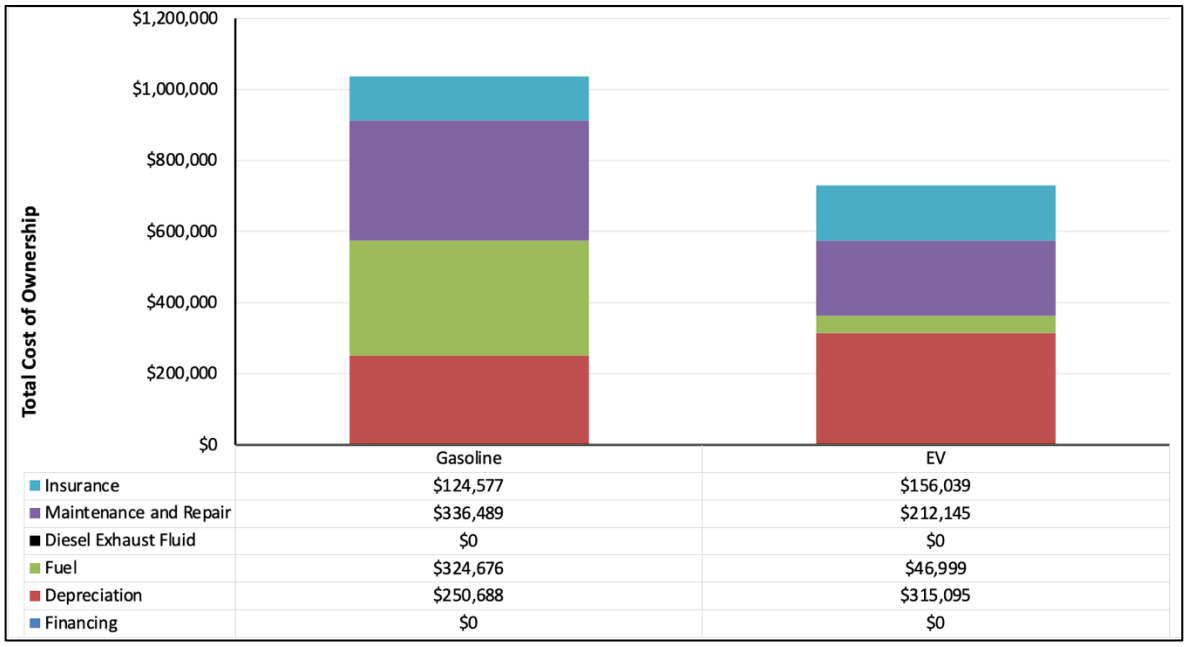
Van Comparison – Ford Transit to Ford E-Transit

2022 Ford Transit: Base MSRP - $28,378

2022 Ford E-Transit: Base MSRP - $44,173

Key Vehicle and Fuel Inputs					
Primary Vehicle Location					
State	VIRGINIA				
County	VIRGINIA BEACH CITY				
Light-Duty Vehicle Information					
Vehicle Type	Passenger Car				
Vocation Type	Car				
Light-Duty Fuel Type	Number of Light-Duty Vehicles	Annual Vehicle Mileage	Fuel Economy (MPGGE)	Purchase Price ($/vehicle)	Maintenance & Repair ($/mi)
Gasoline	10	12,000	26.0	$28,387	$0.15
All-Electric Vehicle (EV)	10	12,000	106.2	$44,173	$0.09

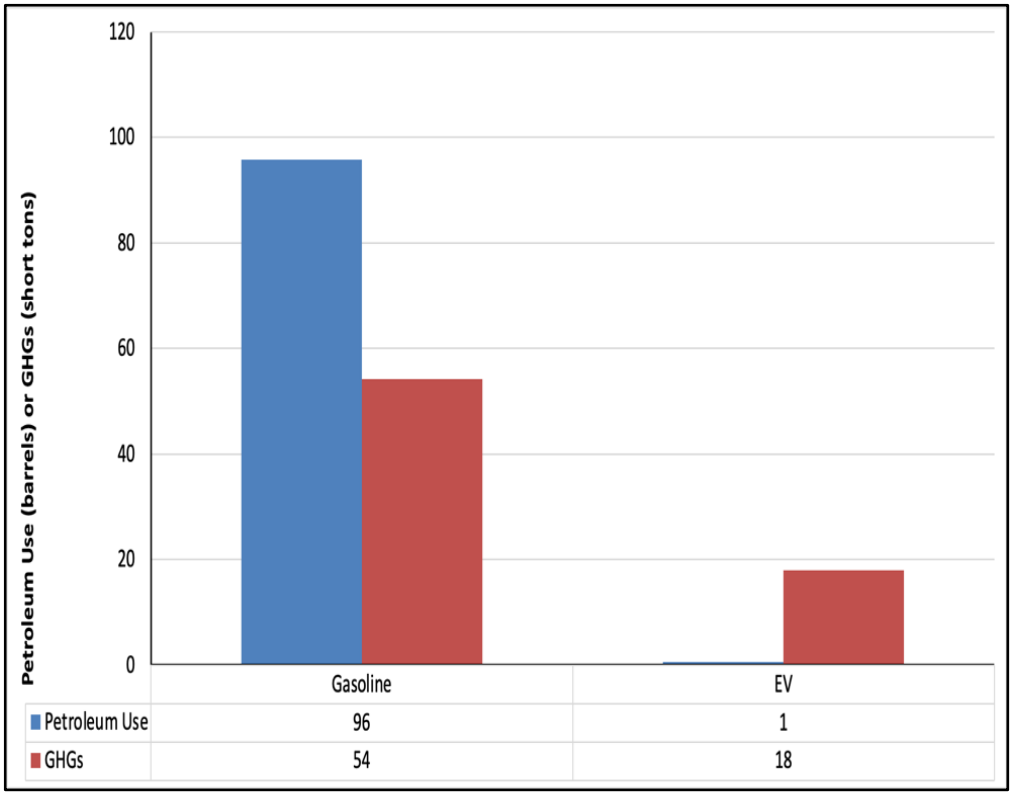
Our last AFLEET calculation compared the 2022 Ford Transit connect with the 2022 Ford E-Transit connect at 12,000 annual miles for 10 vehicles. A 2022 Ford Transit connect costs $28,378, has a fuel economy of 26 miles per gallon, and averages a maintenance cost per mile of .15 cents. The 2022 Ford E-Transit connect costs $44,173, has a fuel economy of 106 miles per gallon, and averages a maintenance cost per mile of .09 cents. The purchase prices were taken from the Virginia Sheriff's shared contract.



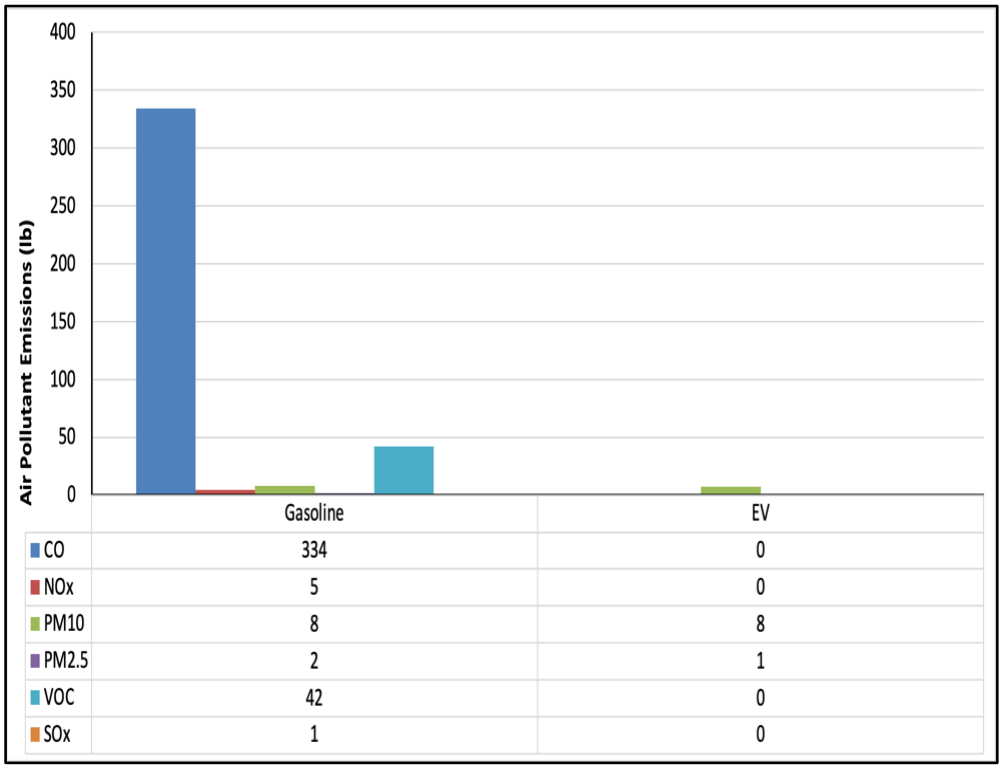
	Gasoline	EV
Insurance	$124,577	$156,039
Maintenance and Repair	$336,489	$212,145
Diesel Exhaust Fluid	$0	$0
Fuel	$324,676	$46,999
Depreciation	$250,688	$315,095
Financing	$0	$0

Total Cost of Ownership **$1,040,667** **$743,334**

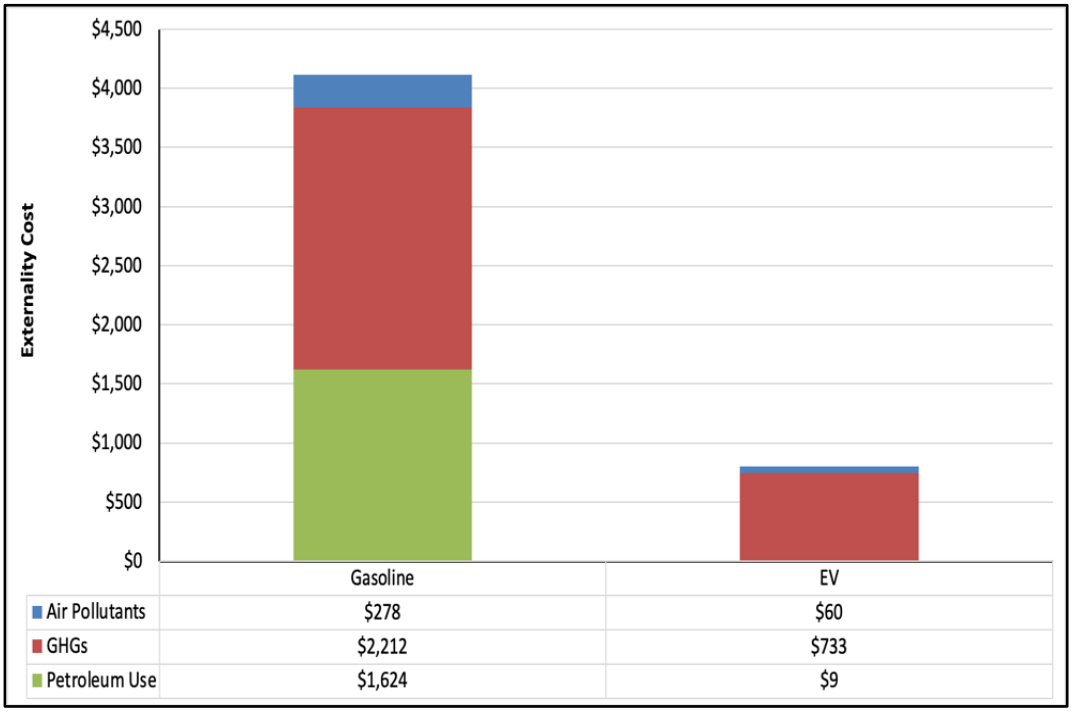
Annual Well-to-Wheels Petroleum and Emissions



Annual Vehicle Air Pollution



Annual Externality Cost



	Gasoline	EV
Air Pollutants	$278	$60
GHGs	$2,212	$733
Petroleum Use	$1,624	$9

General Benefits of EVs

Electric Vehicles offer several benefits and are able to fill the roles of light-duty, medium-/ heavy-duty, and even off-road vehicles for fleet operations. Understanding the impacts of charging multiple vehicles while maintaining fleet operations is key towards efficiency in utilizing electric vehicle technology. These benefits include lower costs, performance features, flexible charging, and the ability to meet fleet requirements.

Lower Costs

- In addition to available incentives, EVs offer high fuel economy, which translates to lower operating costs. Operation and maintenance average about 3 cents per mile for light-duty EVs. They achieve their best fuel economy during stop-and-go driving conditions typical of many fleet applications. Electricity prices have also been less volatile than those of gasoline/diesel, making it easier to estimate future fuel costs Finally, lower off-peak electric rates may be available for charging, which further reduces EV fuel costs.

Performance Features

- EVs are much quieter than conventional vehicles. They produce maximum torque and smooth acceleration from a full stop, which can be especially useful when hauling heavy

loads. Additionally, some can serve as a significant energy source for off-board equipment such as power tools or lights, providing several kilowatts of electricity through multiple electrical outlets.

Flexible Charging

- EVs can charge at fleet facilities or public stations. Facility charging enables EVs to charge overnight and during idle times. Public "fast charge" stations are increasingly available along major transportation corridors to extend EV range for longer trips. Plug-in hybrid electric vehicles (PHEVs) can fuel with gasoline/ diesel at traditional fueling stations when necessary, adding even more flexibility.

Meeting Fleet Requirements

- EVs can help fleets comply with state or local alternative transportation policies, as well as net-zero and sustainability goals.

Buying the Right EV's

Many light-duty vehicles are available for fleet applications. Although some new models are limited to certain states, many are or will soon be available nationwide. MD/ HD vehicles are also available for many fleet applications. In addition to federal and state incentives for light-duty vehicles, some MD EVs also qualify for such incentives. Electrified repowers are an option for MD/HD vehicles as well. These can be new vehicles where the original equipment manufacturer uses an authorized company to electrify the powertrain while maintaining the factory warranty. Whichever vehicle solution a fleet chooses, it's important to ensure that servicing is locally available and appropriate charging is available for all vehicle types. This report details appropriate electric vehicles considered by the Virginia Beach fleet for the Virginia market for this analysis.

Driving and Maintaining EV's

From the manufacturer, EVs are very safe and undergo rigorous testing to meet federal requirements. Their electrical systems require little maintenance, but battery life and warranties should be well-understood upfront. It's also advisable to work with fleet vehicle providers to establish a service agreement that outlines the party to perform maintenance both during and after the warranty period and how fleet service technicians will be trained. Driver training is also important to maximize vehicle availability and efficiency, and periodic "refresher" training should be included.

Medium- and Heavy-Duty Considerations

Medium and Heavy duty electrification options are available and growing. There are several MD/HD EV models ranging from school and transit buses, shuttles, delivery trucks, vocation trucks, and an increasing number of off-road equipment including forklifts, mowers, and agricultural tractors.

Idling

Idling increases our dependence on petroleum, reduces the fuel economy of a vehicle, costs money, produces pollutants, and wastes precious natural resources. Researchers estimate that idling from heavy-duty and light-duty vehicles combined wastes about 6 billion gallons of fuel annually. Reducing the amount of time fleet vehicles idle while operating is key to saving money and being able to utilize potentially wasted energy. Electric vehicles are seen as a key technology solution for reducing unnecessary idling because they do not produce tailpipe emissions. Fleet operators are able to save on money and prolong the lifetime of a vehicle if they decide to transition towards electric vehicles.

Charging Speeds

In addition to where chargers will go, it is also important to consider what type of charger will be installed and how it will be used. There are three major charger types and their price, charging speeds, and usage varies. The three types, Level 1, Level 2, and DC Fast Charging (DCFC) charging capabilities are outlined below, though standards advance and charging speed may also be limited by the vehicle.

Charger Type	Alternating or Direct Current	Amperage	Voltage	Power	Range Per Hour of Charging
Level 1	Alternating	12-16 Amps	120 Volts	1.3-1.9 kW	2-5 miles
Level 2	Alternating	20- 80 Amps	208-240 Volts	3.6kw-19.2 kW	10-75 miles
DC Fast-Charging	Direct	Up to 200 Amps	208-600 Volts	50-350 kW	60-400 miles

While DCFC is the fastest of the charging options, it is limited by equipment cost, and high speeds, high equipment failure rates, and are not necessary in every situation. DCFC can be great in instances such as along highway routes where quick top-ups are needed, but one of the great things about EV charging is that it can be done over longer periods of time at less expensive rates. Take

for instance a charger in a movie theater parking lot, where we would expect the average customer to spend about three hours inside of the establishment. In this case, many vehicles could top up their battery using a high-powered Level 2 charger. A DCFC in this instance would be able to charge the car battery quicker, but with the customer inside enjoying their movie, they would not be able to move the vehicle for other drivers to charge, meaning that DCFC could be a less efficient option. It is important to match charging with parking dwell times. Fleets often use a mix of charging from 110 to DCFC.

Additionally, it is important to consider that in many cases public infrastructure is to support and extend EV range, not to fully charge every EV battery every day. Your average internal combustion engine (ICE) vehicle owner doesn't top off their tank with gas at gasoline retailers every day and EV owners with access to home charging can top off at home.

Charging EVs for Fleets

Fleets have many options for charging at their facilities. For fleets considering PHEVs, Level 1 charging may be sufficient. Level 2 equipment can easily charge a typical EV battery overnight, making it a good fleet option. Opting for portable Level 1 or 2 units can add flexibility and reduce project costs. Instead of installing a pedestal at each EV parking location, 120/240 V receptacles may be installed to support lower-cost portable EVSEs that can be stored in fleet vehicles.

DC fast charging can add up to 400 miles of range in 20 minutes, making it an option for midday charging or scheduled overnight charging at off-peak electric rates. This type of "managed" charging is made easier by using a networked charging system.

Maximizing Electricity and Minimizing Petroleum

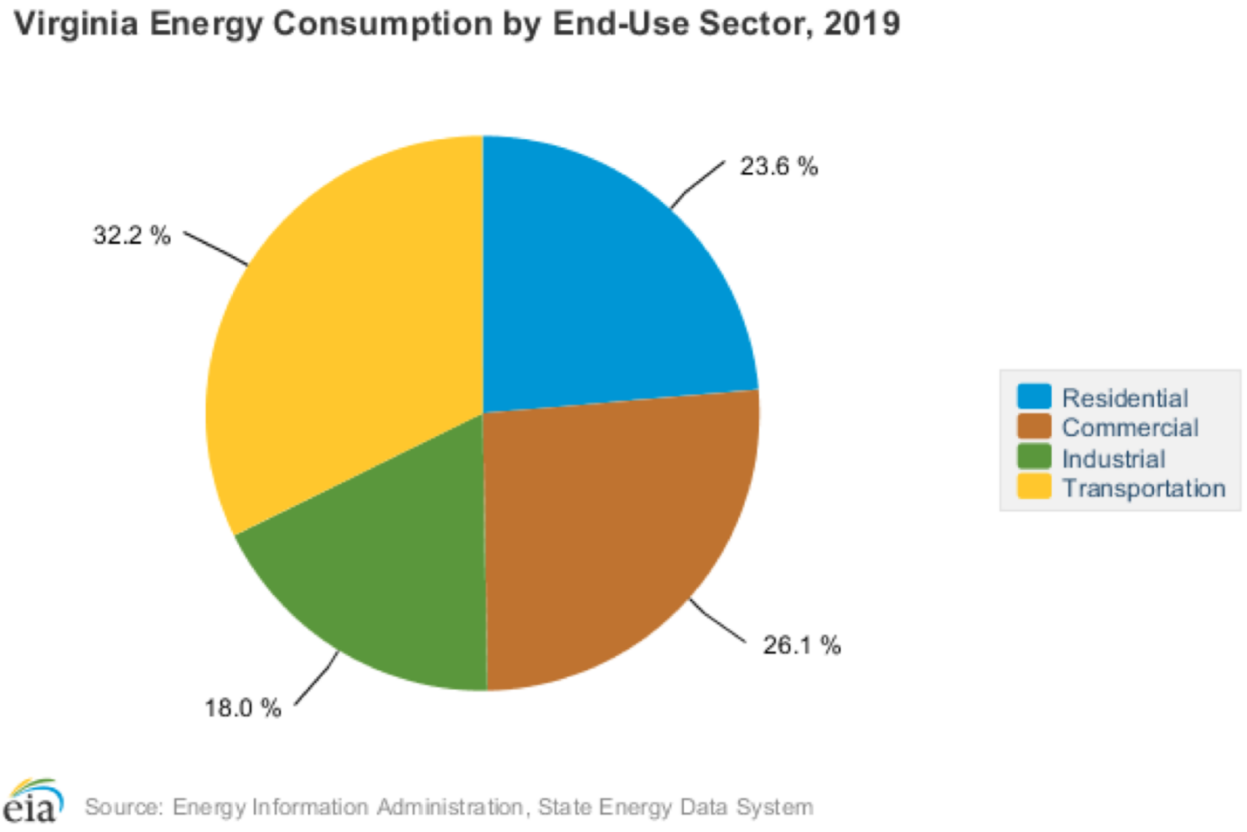


Figure 1: Virginia Energy Consumption by End-Use Sector, 2019, Energy Information Administration

A major reason for fleets in the Commonwealth make the transition from internal combustion engines to electric vehicles is their fuel and the emissions they create. According to the Energy Information Administration, the transportation industry was responsible for 32.2% of the Commonwealth's energy consumption and 47% of its CO2 emissions (EIA "Virginia - State Energy Profile Overview" and "State Carbon Dioxide Emissions Data").

To further contextualize the impact of petroleum, Virginia consumes more petroleum per capita than nearly two-thirds of the other states in the nation and almost three-fourths of the other U.S. states overall. Of this consumption, the transportation sector is responsible for close to 90% of the petroleum used in Virginia with about two-thirds being gasoline consumption. Virginia produces almost no petroleum and petroleum is our primary transportation fuel. (EIA "Virginia - State Energy Profile Analysis").

For all of the transportation energy the Commonwealth consumes through the use of petroleum, near zero percent is produced in Virginia ("Oil and petroleum products explained"). With only two small crude oil production sites and zero refineries, Virginia receives all of its petroleum through the Colonial Pipeline originating in Texas, the Plantation Pipeline originating in Louisiana and

Missouri and foreign petroleum products that arrive at Virginia's ports from overseas ("Virginia - State Energy Profile Analysis").

On the alternative, a large portion of the electricity consumed in Virginia is generated in the state. As described in the below chart, Virginia's sources for energy generation as of 2019 had less than 1% produced by oil and less than 4% by coal.

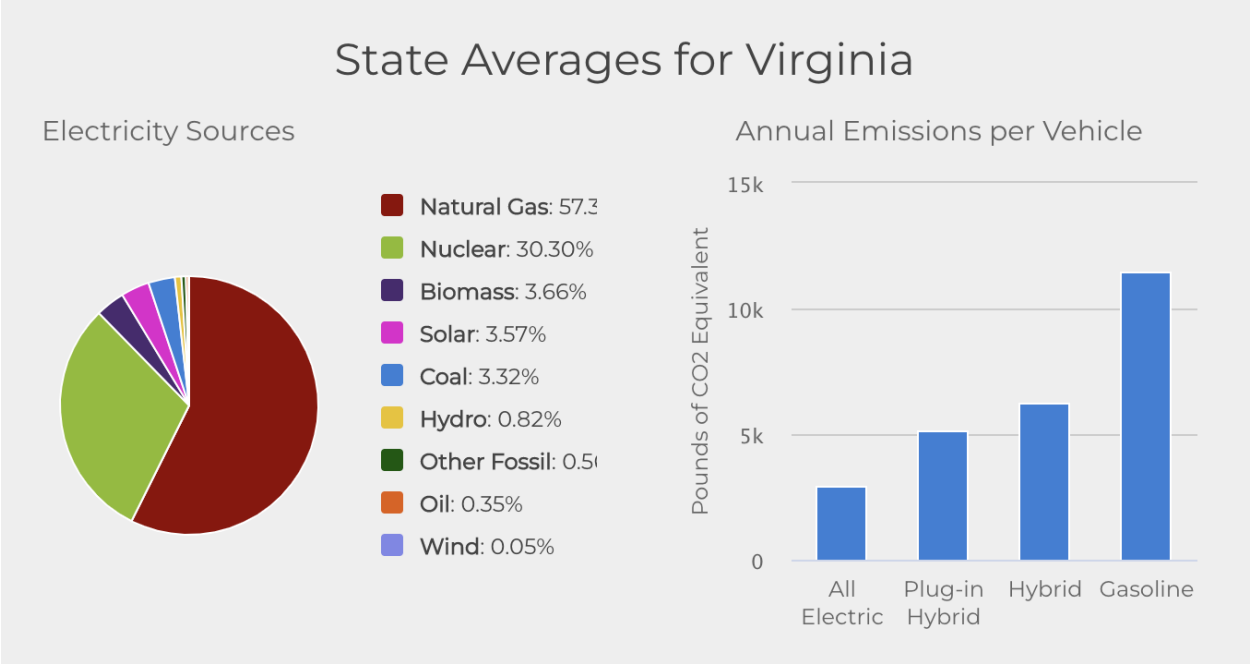


Figure 2: State Emissions Averages for Virginia from the Alternative Fuels Data Center, 2022

The largest contributors to the Commonwealth's energy mix are natural gas and nuclear, which are largely produced in the state ("Alternative Fuels Data Center: Emissions from Hybrid and Plug-In Electric Vehicles"). All of the nuclear energy consumed in Virginia is produced in the Commonwealth and a sixth of the natural gas consumed is produced in the state ("Virginia - State Energy Profile Analysis"). As demonstrated in the above chart, the CO_2 emissions produced by electric vehicles powered in Virginia is less than a third of those powered by petroleum. Additionally, transportation emissions for electric vehicles will also continue to decrease after the purchase date as the grid increases its portfolio of renewables. Virginia is rapidly closing coal-fired power plants, with the last expected to close by the end of 2024 ("Governor Northam Signs Clean Energy Legislation"). The Commonwealth also has a goal to be 100% carbon-free by 2050 ("Virginia's Progress Towards a Cleaner Electric Grid". As demonstrated in the below figure from Virginia Department of Energy and the Virginia Clean Economy Act, Dominion Energy and Appalachian Power's renewable portfolios are expected to make steady increases towards 100% renewable energy in 2050. This transformation of the grid would also decrease EV CO_2 emissions to zero over time.

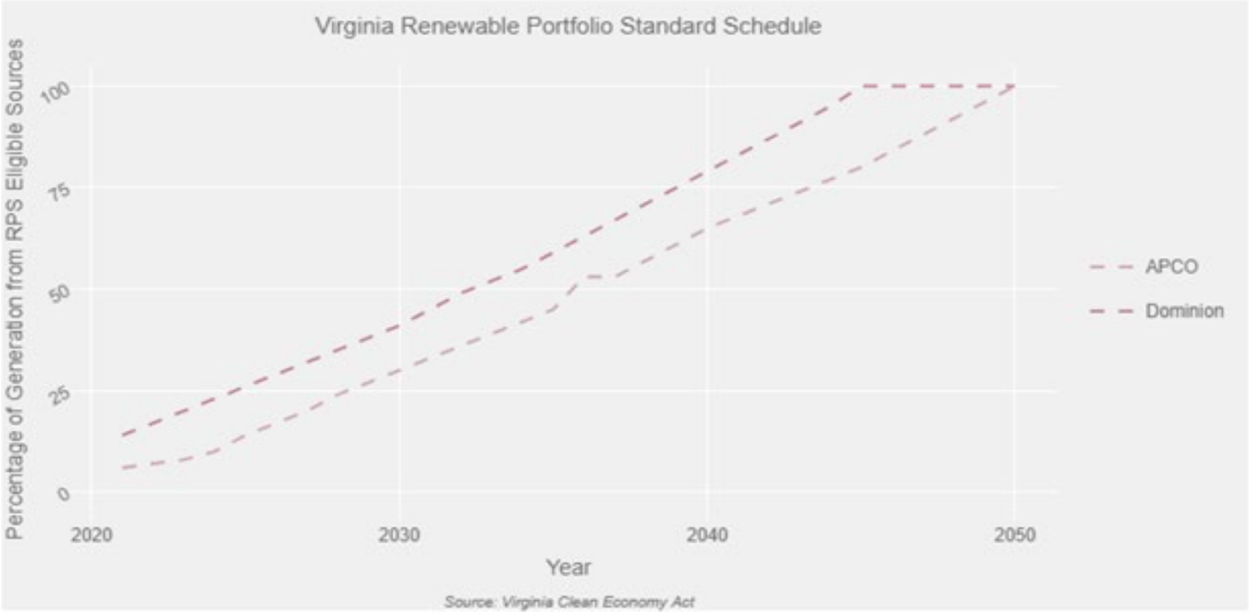


Figure 3: Virginia Renewable Portfolio Standard Schedule from the Virginia Clean Economy Act

Virginia Clean Cities
www.vacleancities.org
1401 Technology Drive, MSC 4115
Harrisonburg Virginia, 22807