Maryland Energy Administration Clean Fuels Technical Assistance Program: City of Gaithersburg

April 28, 2023

Submitted to:

Maryland Energy Administration

and

City of Gaithersburg

Submitted by:

ICF

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Executive Summary

The Maryland Energy Administration (MEA) Clean Fuels Technical Assistance (CFTA) Program has provided this fleet advisory service for the City of Gaithersburg (City), through a partnership with ICF, and support from Maryland Clean Cities. ICF analyzed the City's on-road vehicle fleet comprised of 198 vehicles, recommending 136 internal combustion engine (ICE) vehicles for electrification based on current electric vehicle (EV) make and model availability. Electrification recommendations take place over an eight-year timeframe[1], with the actual number of vehicles eligible for electrification likely increasing over time as more EV makes and models become available.

Based on our analysis, converting 136 ICE vehicles to EVs between 2024 and 2032 is estimated to produce the following impacts over 23 years[2] of vehicle ownership[3]:

$5,489,719 total cost of ownership (TCO) savings over **23** years of vehicle operations

$4,637,519 fuel cost savings over **23** years of vehicle operations

$2,810,269 maintenance savings over **23** years of vehicle operations

24,002 metric tons (MT) of greenhouse gas (GHG) eliminated over **23** years of vehicle operations

164,927 gallons of gasoline and **105,498** gallons of diesel displaced annually

Equivalent to eliminating **2,760** homes' energy use annually

[1] 2024 to 2032
[2] 2024 to 2046
[3] Based on the Assumptions and Calculations outlined in Appendix A, as then applied to the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Introduction

The State Fiscal Year 2022 (FY22) CFTA Program aims to provide eligible local government and municipal fleets with technical assistance as they consider alternative transportation fuel options. This program is a continuation of MEA's FY21 CFTA Pilot Program and complementary to FY22 Clean Fuels Incentive Program. Through CFTA, a technical assistance contractor, ICF, employed by MEA was tasked to work directly with eligible fleets, selected via an application process, for the purpose of developing potential alternative fuel fleet strategies for on-road light-, medium-, and heavy-duty vehicles. Possible alternative fuels for evaluation include electricity, ethanol, hydrogen, natural gas, propane, and other biofuels. The participating local government or municipal fleet chooses their preferred fuel for technical evaluation. The City of Gaithersburg selected fleet electrification for their technical assistance assessment.

This assessment includes vehicle replacement recommendations, an economic analysis of vehicle electrification, an emissions analysis of electrification recommendations, an overview of charging infrastructure needed to support the electrification recommendations, and a list of best practices based on the City's primary concerns.

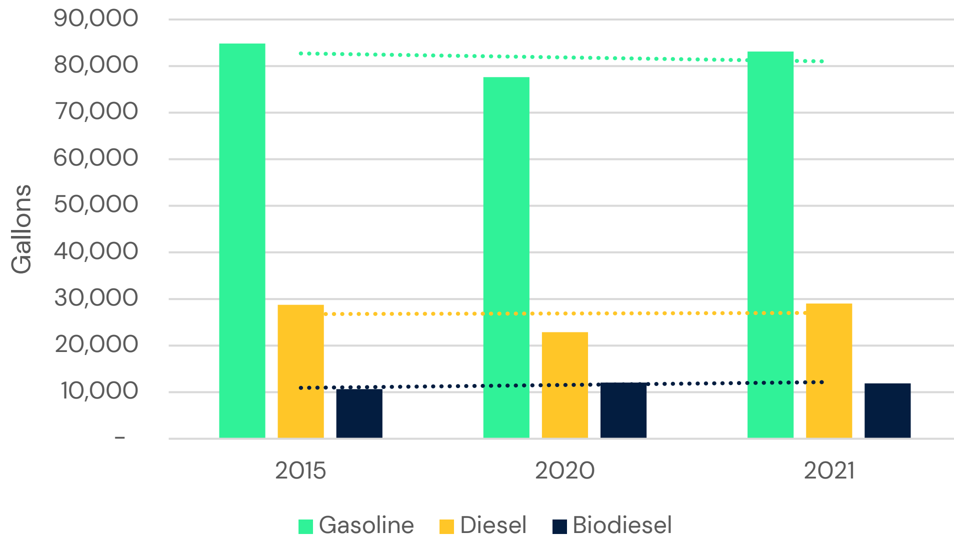
Overview of Motivations and Priorities

In 2015, the City of Gaithersburg became a Maryland Smart Energy Community (MSEC) and began working to reduce energy consumption. MEA's MSEC program helps local governments adopt energy policies that offer cost savings, reduce energy use, and support renewable energy development. Through MSEC, the City committed to meeting the following goals:

- Reduce building energy consumption by 10% compared to 2015 levels
- Reduce petroleum consumption by 20% compared to 2015 levels

Over the past 8 years, the City's petroleum consumption has remained stable (Figure 1). While petroleum consumption dropped by almost 12,000 gallons in 2020, it returned to just under 2015 levels in 2021. To meet the City's MSEC petroleum consumption goal, the City is pursuing fleet electrification and developing a fleet decarbonization plan.

Figure 1. City of Gaithersburg Fuel Consumption 2015-2021



As part of the City's fuel consumption reduction efforts, the City began purchasing hybrid electric vehicles (HEVs) in 2015. The City also explored adopting biofuels, but determined EVs and fuel-efficient vehicles are preferrable for the City's needs. In 2022, the City deployed its first two EVs in the Police Department and the Department of Public Works and recently purchased three additional EVs.

In addition to meeting their own goals, the City is also pursuing fleet electrification to help the Metropolitan Washington Council of Governments (MWCOG) meet its regional GHG emission reduction goals:

- 50% below 2005 levels by 2030; and
- 80% below 2005 levels by 2050.[4]

The City is utilizing the CFTA Program to help plan fleet electrification, summarize general charging needs, estimate TCO savings potential, and improve the environmental health of the community. Ultimately, this report will support the City of Gaithersburg in its mission to cultivate an inclusive, sustainable, and thriving community.

Current Fleet Inventory

The City provided fleet data for 198 vehicles. ICF's evaluation includes all 198 on-road light-, medium-, and heavy-duty fleet vehicles. Most vehicles operate on gasoline or diesel fuel blended with 5% biodiesel (B5). Of the gasoline vehicles, over 20 are HEVs. The City also has five EVs. To support current fleet EVs, the City has access to three government-only

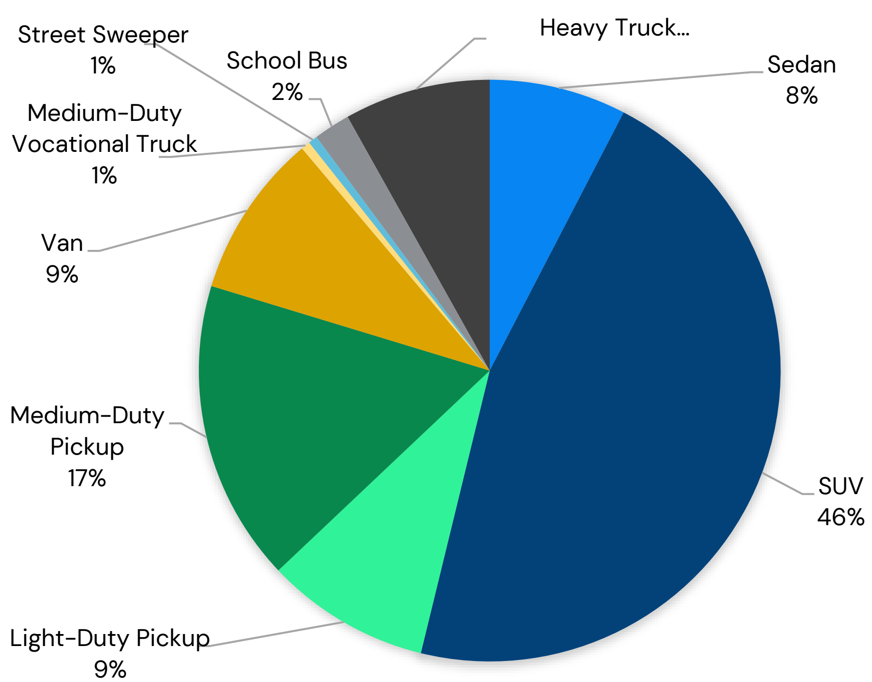
[4] MWCOG. 2020. "Metropolitan Washington 2030 Climate and Energy Action Plan." Retrieved from: https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/

Level 2 EV charging stations at the Department of Public Works. Table 1 and Figure 2 break down the City's on-road fleet by vehicle type.

Table 1. Current Fleet Inventory by Vehicle and Fuel Type

Vehicle Type	Gasoline	Diesel	BEV
Sedan	12	0	3
SUV	92	0	0
Light-Duty Pickup	10	8	0
Medium-Duty Pickup	2	31	0
Van	16	0	2
Medium-Duty Vocational Truck	0	1	0
Street Sweeper	0	1	0
School Bus	0	4	0
Heavy Truck	0	16	0
TOTAL	**132**	**61**	**5**

Figure 2. Existing Fleet by Vehicle Type



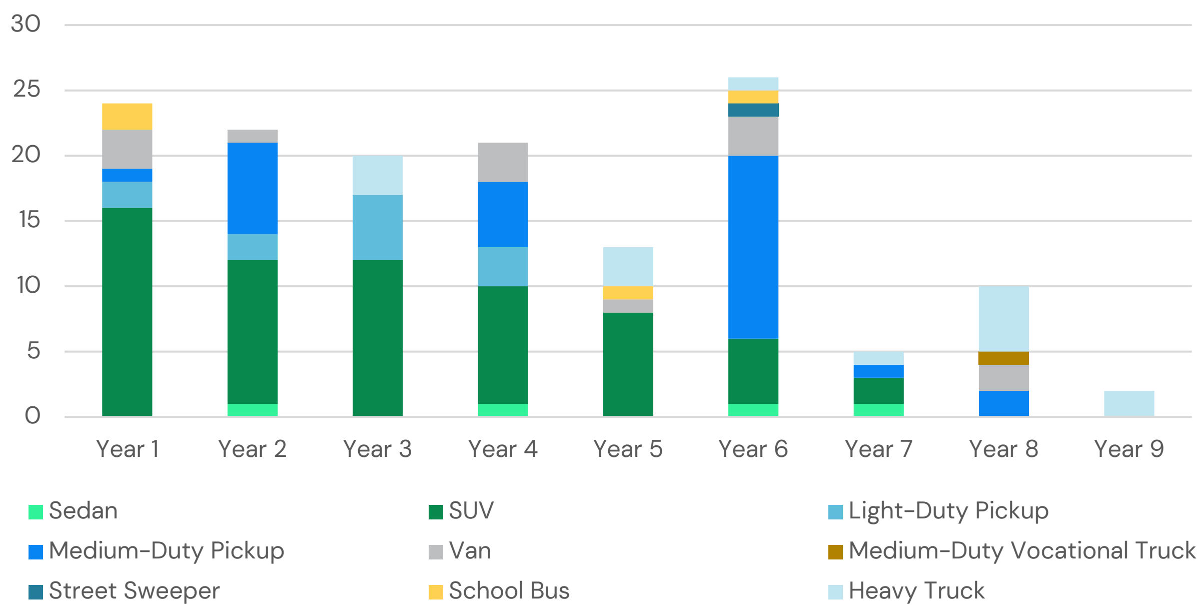
The City's evaluated fleet is primarily composed of SUVs (46%) and medium-duty pickups (17%), as seen in Figure 2. One third of the fleet (34%) consists of sedans, heavy trucks, vans, and light-duty pickups.

The fleet data also includes police vehicles, which are primarily SUVs. Most City police vehicles are domiciled, which may present a barrier to electrification without an at-home charging policy. They are included in the assessment to help the City evaluate the cost effectiveness of electrifying police vehicles. Police vehicles make up the following percentages of each vehicle type:

- SUVs: 79%
- Sedans: 27%
- Light-Duty Pickups: 11%
- Vans: 5%

This assessment assumes vehicle replacement and electrification will begin in 2024, so ICF identified all vehicles eligible for retirement beginning in 2024. Figure 3 shows the breakdown of the existing fleet's planned retirement schedule.

***Figure 3. Existing Fleet Retirement Schedule*[5]**



The vehicle retirement schedule used in this assessment is based on the assumptions identified by ICF and the City, as shown in Appendix A.[6] The exact vehicle replacement schedule is determined by the City's fleet manager. Actual vehicle retirement and replacement will likely vary considerably from the proposed retirement schedule due to use case feasibility, lead times for new vehicles, and potential financial constraints. While Gaithersburg's vehicle retirement criteria will be met in 2024, the City may not be able to feasibly take vehicles out of rotation and purchase new vehicles for a few more years, especially if the City is willing to wait for EVs with longer lead times.

[5] Year 1 is 2024
[6] Due to the timing of this report, the City may choose to wait until 2025 to begin implementing the recommended fleet retirement and electrification schedule.

Fleet Electrification Assessment

Overview

This fleet electrification assessment includes all 198 vehicles provided to MEA and ICF. ICF examined all vehicles eligible for retirement over nine years—between 2024 and 2032—and evaluated opportunities for electrification, based on EV model availability as announced through the end of October 2022. Because the assessment begins in 2024, the 54 vehicles set to retire in 2022 and 2023 are not included. For this assessment, it is assumed that the city will replace those vehicles with an equivalent ICE vehicle. Only one round of vehicle retirements and replacements is included in this assessment, and the current fleet is assumed to be entirely replaced by the end of 2032.

Recommendations are based on comparing the TCO of EVs versus ICE vehicles. The assessment considers one TCO scenario set at a 10% threshold, which means any EV with a TCO less than or up to 10% more than its ICE vehicle equivalent will be recommended for electrification. In future years, it is assumed that the City will continue to replace electrified vehicles with EVs and PHEVs. Similarly, as the EV market develops, more models will become available, vehicle purchase prices will decrease, and the City will likely be able to obtain more EVs.

This fleet electrification evaluation assumes that non-police fleet vehicles are primarily located on government property and police vehicles are domiciled at employee homes. This consideration is particularly important in determining fleet EVSE needs, as police vehicles will not be able to charge overnight. This assessment includes general charging assumptions and infrastructure costs that may be required to support electrification recommendations, which may be used to guide future EVSE siting assessments.

The City worked with ICF to set assessment assumptions, including assessment start year, fuel prices, standardizations for fleet data outliers, and financial incentives.[7] A full list of assessment assumptions are located in Appendix A. As the City fleet changes, the EV market evolves, and new financial incentive programs become available, the City should revisit the following recommendations and reevaluate electrification opportunities. For a simple approach to fleet assessments, the City can utilize Argonne National Laboratory's AFLEET Tool.[8]

Recommendations

Overall, up to 136 vehicles are eligible for electrification based on fleet data, assessment assumptions, and EV make and model availability. Table 2 shows the quantity of electrification recommendations, by vehicle type, over the next 15 years.

[7] EPA Diesel Emissions Reduction Act (DERA) funding, the U.S. Department of Transportation Low- or No-Emission Vehicle (Low-No) Program funding, and EPA Clean School Bus Funding.

[8] The AFLEET tool may be found here: https://greet.es.anl.gov/index.php?content=afleet. Additional information is available in Appendix F.

Table 2. Electrification Recommendations by Vehicle Type

Vehicle Type	Total Quantity	Electrification Recommendations
Sedan	11	1
Sedan - Police	4	1
SUV	19	9
SUV – Police	73	54
Light-Duty Pickup	18	10
Medium-Duty Pickup	33	30
Van	18	12
Medium-Duty Vocational Truck	1	1
Street Sweeper	1	1
School Bus	4	2
Heavy Truck	16	15
TOTAL	**198**	**136**

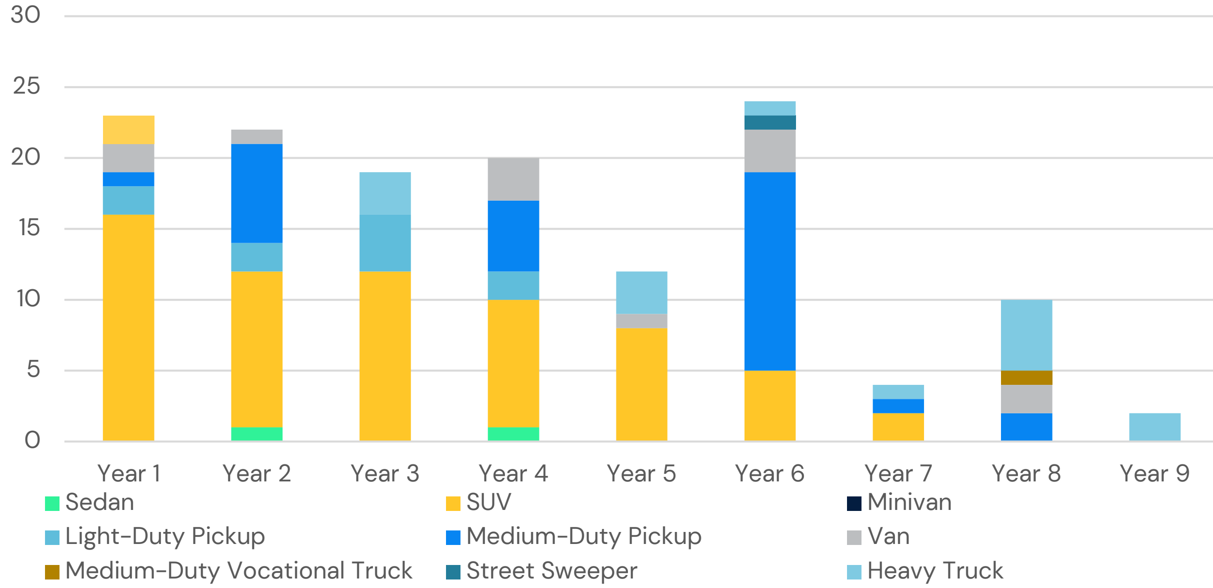
This assessment provides a list of EV make and model recommendations that the TCO analysis is based on, shown in Table 3. However, these vehicle recommendations are examples not requirements. The City may purchase similar EVs and achieve savings similar to those in the Economic Analysis and Emissions Analysis sections of this report.

Table 3. EV Recommendations by Vehicle Type

Vehicle Type	Vehicle Recommendations – Or Similar
Sedan	Chevrolet Bolt
Sedan – Police	Tesla Model 3
SUV	Chevrolet Bolt Electric Utility Vehicle
SUV – Police	Chevrolet Blazer EV PPV
Light-Duty Pickup	Ford F-150 Lightning
Medium-Duty Pickup	Ford E-Transit Chassis Cab
Van	Canoo MPDV1 Maxwell Vehicles ePro LR Passenger Van
Street Sweeper	M3 SUPERCHARGED
School Bus	Lion Electric – LionD
Heavy Truck	Peterbilt – 220EV (Class 7)

The replacement timeline for the 136 fleet vehicles recommended for electrification can be seen in more detail below in Figure 4. In Figure 4, vehicle replacements take place over 9 years due to the assumptions and data identified by ICF and the City. However, a number of barriers (e.g., financial constraints, supply chains, etc.) could extend the replacement timeline.

Figure 4. Recommended EV Replacement Timeline by Vehicle Type[9]



The electrification schedule begins predominately with SUVs, with ICF's analysis recommending 16 for replacement in 2024. SUVs represent most vehicle replacements from 2024 to 2028, with medium-duty pickups taking over as the largest replacement group in 2029. The final three years of vehicle replacements are a mix of eight heavy trucks, two vans, one medium-duty vocational truck, two medium-duty pickups, and two SUVs. This information is further broken down in Table 4 below.

Table 4. Recommended EV Replacement Timeline by Vehicle Type

Vehicle Type	2024	2025	2026	2027	2028	2029	2030	2031	2032
Sedan	–	1	–	1	–	–	–	–	–
SUV	16	11	12	9	8	5	2	–	–
Light-Duty Pickup	2	2	4	2	–	–	–	–	–
Medium-Duty Pickup	1	7	–	5	–	14	1	2	–
Van	2	1	–	3	1	3	–	2	–
Medium-Duty Vocational Truck	–	–	–	–	–	–	–	1	–
Street Sweeper	–	–	–	–	–	1	–	–	–
School Bus	2	–	–	–	–	–	–	–	–
Heavy Truck	–	–	3	–	3	1	1	5	2

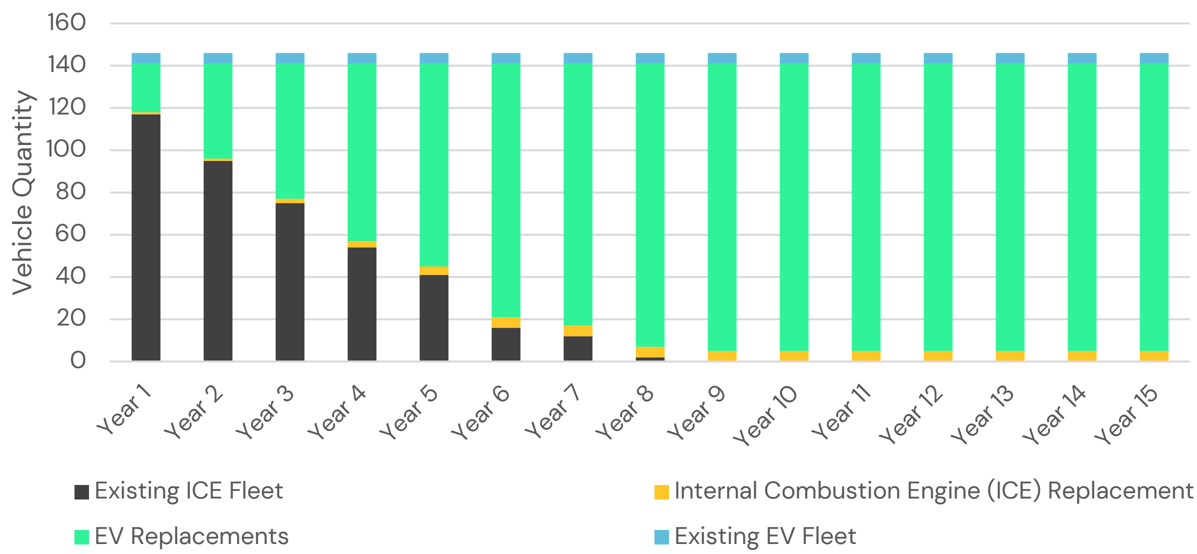
For future models, recently announced, and currently nascent EV types, electrification recommendations do not take place until price parity between EV and ICE vehicles is achieved. However, while EV TCO may be more favorable than ICE TCOs, the purchase price may still present a large barrier to adoption, limiting the City's ability to electrify in the

[9] Year 1 is 2024.

short-term. As noted above, the City is aiming to begin a larger transition to fleet electrification in 2024. If the City needs to delay electrification for any reason, it will likely result in larger first-generation electrification TCO savings for the fleet due to market gains. For example, there will be a larger number of EVs to choose from, potentially shifting or expanding vehicle replacement recommendations and saving opportunities. Similarly, as the EV market develops and continues making technological advancements, the City can expect the purchase price of EVs to drop and more favorable electricity rates (i.e., time-of-use rates, managed charging programs, etc.) for EV charging to become readily available. Any delay in the electrification timeline presented in this report means that, while the City will still see TCO savings, they would not be realized until the electrification begins.

Of the existing fleet vehicles, Figure 5 shows what fuel types are recommended to replace the existing fleet from 2023 through 2038. Most vehicle replacements will be EVs, with some fleet vehicles being replaced by ICE vehicles.

Figure 5. Recommended EV Replacement Timeline by Fuel Type[10]



A full list of vehicle recommendations is available in Appendix B.

While the recommendations listed in Table 3 and Appendix B list specific vehicle makes and models, the City is not obligated or required to purchase the exact vehicles recommended or purchase them in the year listed. Similar vehicle makes and models will offer similar opportunities for electrification as well as cost and emission savings.

[10] Year 1 is 2024.

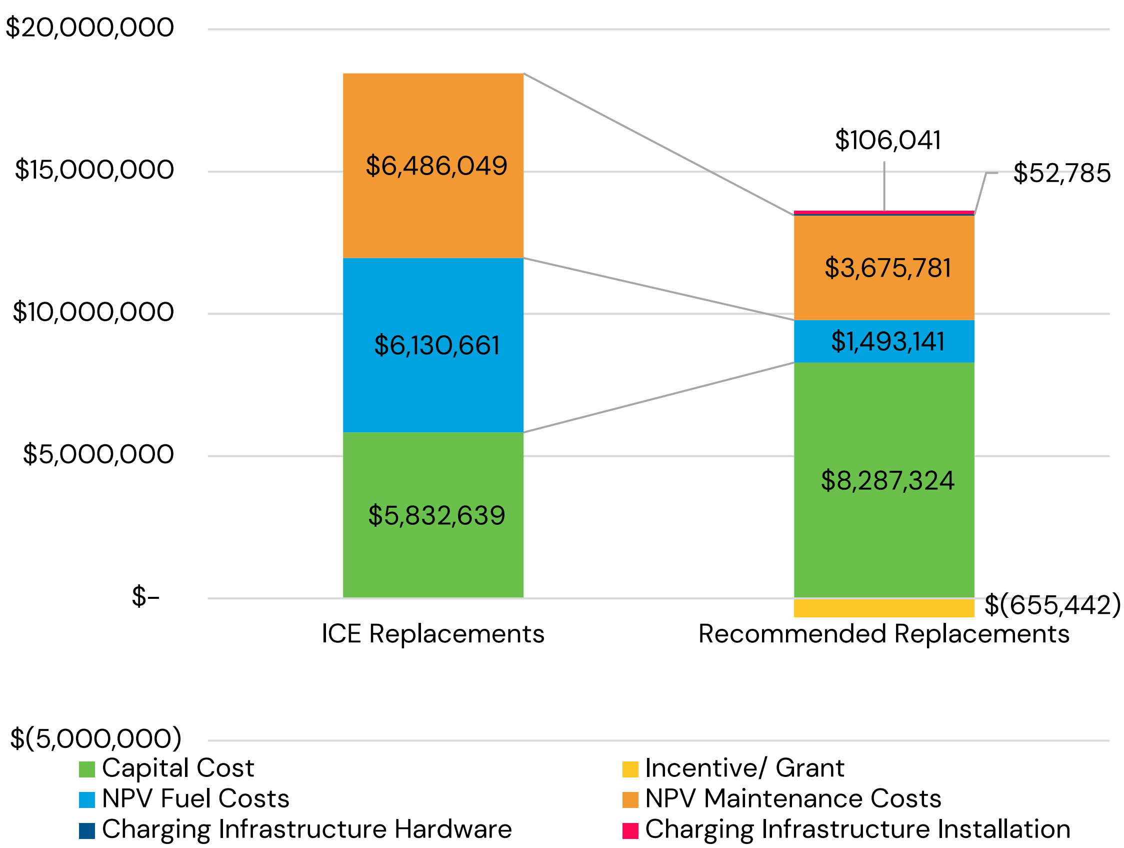
Economic Analysis

Electrification recommendations are based on a TCO assessment. City vehicles are recommended for electrification if there is an EV option available that has a TCO less than, equal to, or up to 10% more than the ICE equivalent. To determine the TCO, costs accumulated over fleet vehicle lifespans were evaluated. Beyond the cost to acquire, charge or fuel, and maintain vehicles, the TCO calculations include:

- Charging infrastructure necessary to support EVs
- Cost assumptions for EVSE purchase and installation
- Grant opportunities for fleet electrification

These cost assumptions assume installing non-networked Level 2 and direct-current fast charging (DCFC) EVSE at a ratio of four vehicles to one charging port. Figure 6 includes the cost of all 136 EVs and recommended EVSE over the entire vehicle lifespans compared to the traditional ICE vehicle replacement.

Figure 6. Fleet TCO Comparison - Net Present Value Costs Over Vehicle Lifespans



Please see U.S. Department of Energy's (DOE) Alternative Fuels Data Center for all currently available Maryland and Federal EV and EVSE incentives. Information is also available at MarylandEV.org.

Fleet advisory services provided by ICF

Different vehicle types are responsible for different average electrification TCO savings. Electric heavy-duty vehicles typically have much larger capital costs than their traditional counterparts and are less frequently available. While heavy-duty EVs typically present more opportunities for long-term cost savings, their high purchase prices present a barrier that limits electrification potential for many fleets that do not have the financial flexibility for a large upfront investment. The City of Gaithersburg's fleet consists of mostly light- and medium-duty vehicles, making the opportunity to capitalize on existing TCO savings more easily accessible. Table 5 outlines the TCO savings projected for the City of Gaithersburg by vehicle type.

Table 5. TCO Savings by Vehicle Type

Vehicle Type	TCO Savings
Sedan	$11,287
SUV	$220,801
Light-Duty Pickup	$10,488
Medium-Duty Pickup	$3,048,664
Van	$785,691
Medium-Duty Vocational Truck	$92,417
Street Sweeper	$138,964
School Bus	$373,556
Heavy Truck	$807,852
Total	**$5,489,719**

If the City of Gaithersburg decides to pursue new financial incentive programs as they become available, additional vehicles and vehicle types will become financially beneficial for electrification. Moving forward, the City should continue to monitor incentive program availability to take advantage of additional electrification opportunities.

As vehicles are replaced through 2032, lifespans extend beyond 2035 and TCO calculations extend out to 2050. The TCO comparisons in Figure 7 and Figure 8 show that TCO savings will almost always be realized annually, except for the first and third years of electrification. After the initial capital costs associated with purchasing EVs to replace existing ICE fleet vehicles, the years following 2026 will all provide operational savings.

Figure 7. Cumulative TCO Comparison From 2024 to 2046

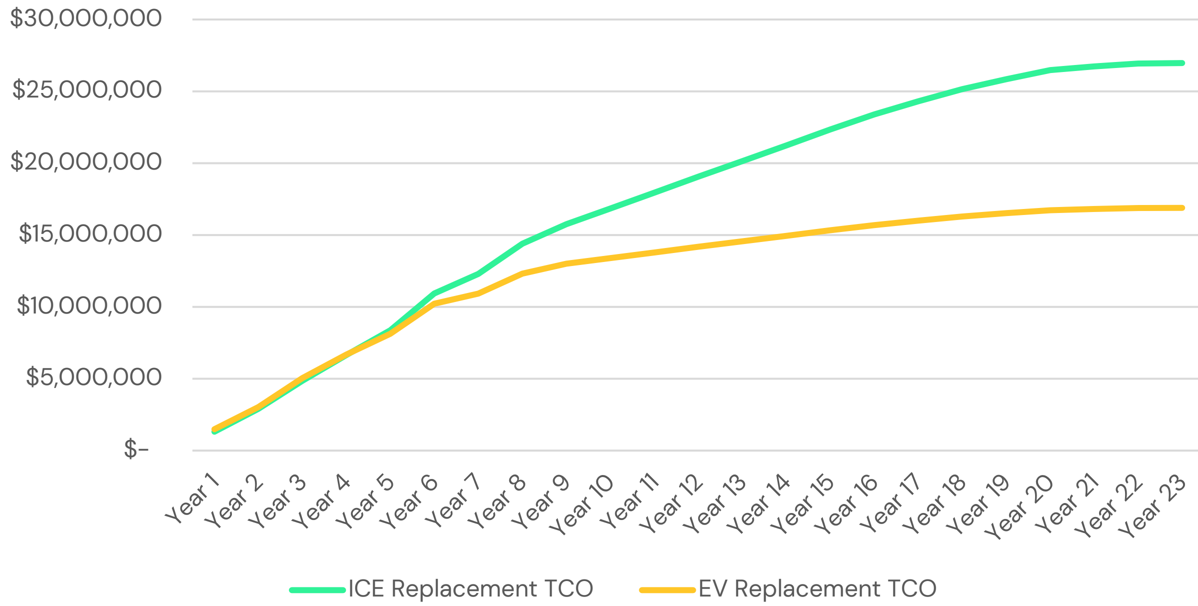
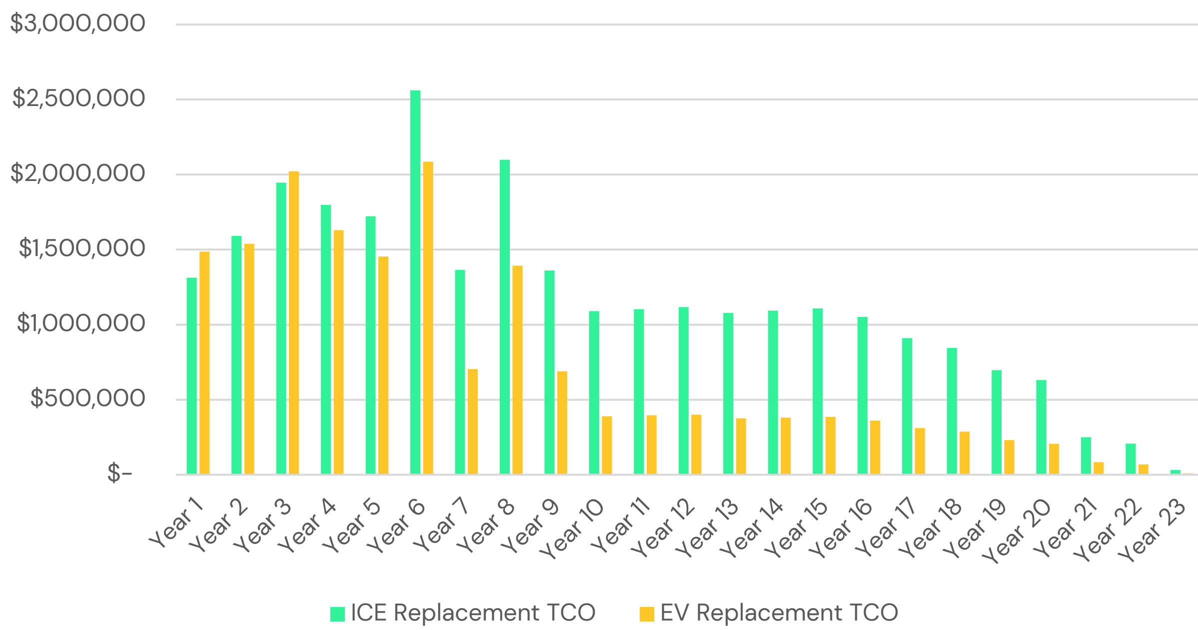


Figure 8. Annual TCO From 2024 to 2046



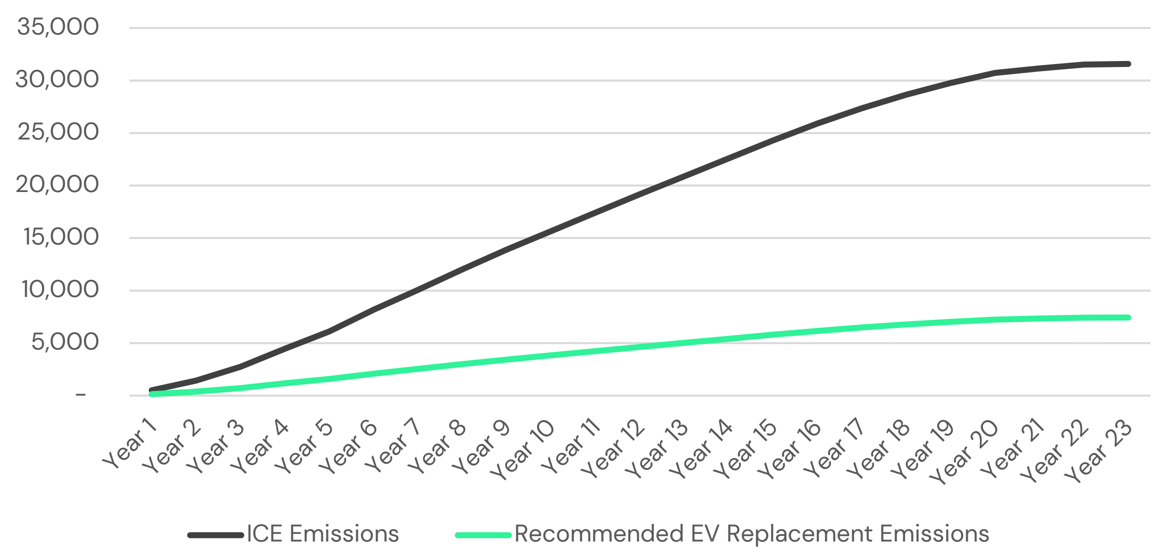
This report estimates the payback period, with incentives, for purchase fleet electrification to end in 2046, hitting breakeven in Year 4. However, the length of the payback period can be significantly influenced by the number of financial incentives the City pursues and wins as well as the exact EVs the City is able to acquire and the year the City acquires them. The more funding the City obtains for EVs and EVSE and the more favorable the purchase price, the shorter the payback period.

While the current analysis projects TCO costs to break even in 2027 (Year 4). Any delay in fleet electrification beyond 2024 will not guarantee the same results, due to changes in EV purchase prices, infrastructure costs, maintenance and training costs for employees, and more. Many vehicles not currently recommended for electrification will likely become eligible for electrification beyond 2032. As new makes and models become available and technology develops, it is expected that later and subsequent EV purchases will be less expensive due to more accessible and affordable EV options.

Emissions Analysis

Over the last few decades, improvements in ICE vehicle fuel economy have provided incremental vehicle emissions savings over the years. However, converting an ICE vehicle to an EV offers significant, immediate emissions savings at a much larger scale than choosing a more fuel-efficient ICE vehicle. Converting 136 ICE vehicles to EVs would potentially save the City of Gaithersburg 24,002 MT of GHG emissions over the lifespan of all converted EVs, through 2046. In other words, these electrification recommendations can help reduce fleet emissions by up to 76.5%. Additionally, 93,025 pounds of NOx will be reduced over the lifespan of all converted EVs, through 2046. Figure 9 shows the emissions trajectory of the replacement with new ICE vehicles versus the replacement with EVs. This includes factoring in petroleum fuel reductions, offset by a potential electricity consumption increase.

***Figure 9. Cumulative Fleet GHG Emissions*[11]**



These calculations are for wheel-to-well emissions, balancing the gasoline and diesel emissions savings with the emissions created to produce electricity, based on the City's grid generation mix. A more detailed comparison of projected annual GHG emissions levels are in Appendix C.

[11] Year 1 is 2024.

Estimated lifetime emissions savings per vehicle type for the 136 vehicles are available below, in Table 6. Actual emissions per vehicle can vary dramatically based on the vehicle being replaced, average mileage, and use case.

Table 6. Lifetime Fleet Emissions by Vehicle Type

Vehicle Type	Lifetime GHG Emissions Reductions (MT)	Lifetime NOx Emissions Reductions (MT)
Sedan	92	0
SUV	4,349	1
Light-Duty Pickup	645	0
Medium-Duty Pickup	7,301	29
Van	3,071	6
Medium-Duty Vocational Truck	191	1
Street Sweeper	1,804	0
School Bus	458	1
Heavy Truck	6,090	5
TOTAL	**24,002**	**42**

While almost half, 46%, of the electrification recommendations are for SUVs, SUVs only account for 18% of GHG emissions savings. Medium-duty pickups and heavy trucks, which represent 33% of electrification recommendations, account for 55% of GHG emissions savings potential. For NOx emissions savings, medium-duty pickups offer the largest opportunity for reduction.

The recommendations are equivalent to:

- Removing 5,148 passenger vehicles from the road for one year
- Planting 396,032 trees
- The energy use of 2,760 homes for one year
- Switching 912,074 incandescent lamps to LEDs
- Recycling 8,161 tons of waste

In addition to emissions reductions, the electrification recommendations also reduce fossil fuel consumption. As noted above, the City set a goal to reduce petroleum consumption by 20% compared to 2015 levels. In 2015, the City reported consuming 124,253 gallons of fuel. To calculate potential fuel savings, ICF set assumptions with the City to account for outliers in the fleet data.[12] By electrifying 136 vehicles, the City has the potential to reduce

[12] These calculations utilize AFLEET assumptions for annual vehicle milage and fuel economy. While this removes outliers from the fleet data and helps account for human error when entering data, it results in different actual values for gallons of fuel consumed reported by the City and calculated by ICF. To account for the differences in calculation, ICF is providing an estimated percentage of gallons of fuel saved based on the assumptions used in the electrification assessment.

petroleum consumption by an approximately 77%, which would greatly surpass the City's current goal.

EVSE Needs Assessment Overview

For the electrification assessment, basic infrastructure planning cost considerations were incorporated into the calculations and recommendations. This assessment assumes that the City will be able to assign four vehicles per EVSE for both Level 2 and DCFC. Depending on vehicle duty cycle and application, the number of vehicles per plug may fluctuate. For example, if vehicles are fully rotated throughout the day, less plugs may be needed, while more plugs may be needed for vehicles on the same duty cycle that need to charge simultaneously. Similarly, if some vehicles have higher daily mileage than others, the City can develop a charging schedule that would identify efficiencies in charging and reduce the number of plugs needed. This analysis also assumes vehicles that are not domiciled will have access to overnight charging and vehicles that are domiciled—police vehicles—will be able to fast charge during the day.

Table 7 provides a more in-depth breakdown of the EVSE infrastructure assumptions made in the TCO modeling. Using Table 7 and Table 8 as potential guides can help Gaithersburg strategically plan EVSE needs and installation.[13] This fleet electrification analysis does not include a complete EVSE needs and siting assessment, but the preliminary results can help the City begin planning for future infrastructure build out. However, charging needs should be further explored by the City before widescale electrification occurs.[14] Appendix D provides an overview of EVSE types and a breakdown of how to assess EVSE needs.

Table 7. EVSE Considerations by Charger Type

Charger Type	Number of EVSE Needed	Vehicle Types Supported
Level 2	23	Sedan, Medium-Duty Vocational Truck, School Bus, SUV, Light-Duty Pickup, Medium-Duty Pickup, Van, Heavy Truck
DCFC	15	SUV – Police, Sedan – Police, Street Sweeper

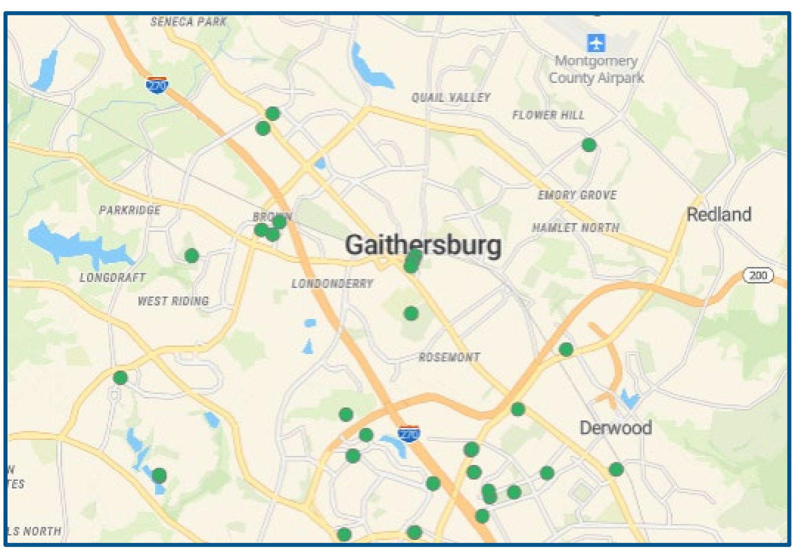
[13] Tables 7 and 8 offer projected Level 2 and DCFC EVSE needs based on current model assumptions and number of vehicles recommended for electrification.
[14] See the DOE Alternative Fuels Data Center for more information about Charging Infrastructure Procurement and Installation, including average costs.

Table 8. EVSE Considerations by Vehicle Type

<table>
<tr><th>Vehicle Type</th><th>Number of Vehicles Recommended for Electrification</th><th>L2</th><th>DCFC</th></tr>
<tr><td>Sedan</td><td>1</td><td rowspan="3">2</td><td rowspan="3">0</td></tr>
<tr><td>Medium-Duty Vocational Truck</td><td>1</td></tr>
<tr><td>School Bus</td><td>2</td></tr>
<tr><td>Sedan - Police</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>SUV</td><td>8</td><td>2</td><td>0</td></tr>
<tr><td>SUV – Police</td><td>55</td><td>0</td><td>13</td></tr>
<tr><td>Light-Duty Pickup</td><td>10</td><td>3</td><td>0</td></tr>
<tr><td>Medium-Duty Pickup</td><td>30</td><td>8</td><td>0</td></tr>
<tr><td>Van</td><td>12</td><td>3</td><td>0</td></tr>
<tr><td>Street Sweeper</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Heavy Truck</td><td>15</td><td>4</td><td>0</td></tr>
<tr><td>Total</td><td>136</td><td>23</td><td>15</td></tr>
</table>

Currently, Gaithersburg only has access to three private, government-only Level 2 EVSE located at the Department of Public Works. The City is also installing two additional government-only access Level 2 EVSE at the Police Department. Beyond these EVSE, there are several publicly accessible EVSE around the City that may be used for short-term charging needs. However, if the City uses public chargers, they will pay commercial rates, reducing fuel cost saving opportunities. Figure 10 shows the location of existing EVSE in and around Gaithersburg.[15]

Figure 10. EVSE Locations in Gaithersburg



[15] Publicly available EVSE data and locations are available here: https://afdc.energy.gov/stations/#/find/nearest

Continuing to install behind-the-fence EVSE will result in a lower cost per kilowatt-hour (kWh) to charge fleet vehicles in the future and should be prioritized long-term. When considering where to begin charging infrastructure construction, locations with the highest number of fleet vehicles should be prioritized to ensure charging demand is met. The City's fleet data indicates there are four primary locations where vehicles dwell, but actual overnight parking location may vary. Table 9 summarizes electrification recommendations by dwell location. Appendix E provides an overview of the number of vehicles at each dwell location by vehicle type.

Table 9. Electrification Recommendations by Dwell Site[16]

Dwell Address	Number of Vehicles Recommended for Electrification
800 Rabbitt Road	65
16 S Summit Avenue	55
31 S Summit Avenue	14
506 S Frederick Avenue	2

As the City begins electrifying vehicles on a larger scale and planning EVSE installations, it should assess the fleet's current and future charging needs. Recommendations on how to futureproof charging infrastructure include, but are not limited to, the following:

- Evaluating short- and long-term EV charging station needs based on current fleet makeup and future fleet makeup, based preliminarily on this assessment
- Locating the exact parking locations of all vehicles recommended for electrification
- Identifying location(s) that may be used as a hub for DCFC stations to reduce the number of construction sites
- Identifying the number of existing parking spaces at each location
- Examining the existing electrical capacity and infrastructure to determine if the parking location can support the installation of and use of EVSE without infrastructure upgrades and the number of parking spaces that will require infrastructure upgrades to support EVSE
- Developing plans for EVSE design, construction, and installation. These plans may include: panel upgrades, electrical capacity upgrades, utility-side infrastructure upgrades, trenching for electrical conduit, etc.

[16] Vehicle dwell locations are not permanent and may change. The fleet should confirm vehicle dwell locations before electrification or installing EVSE.

- Standardizing EVSE siting design (e.g., signage,[17] accessibility,[18] use requirements, parking space design, Americans with Disabilities Act requirements,[19] etc.)
- Facilitating and standardizing the permitting process for EVSE deployment
- Adopting building codes[20] that require pre-wiring compatible with EVSE installation on government property with considerations for existing and new buildings

Police Vehicle Charging Infrastructure Considerations

Of the 136 vehicles recommended for electrification, 55 are police vehicles. Police vehicles represent a challenging charging scenario for the City because the vehicles are domiciled at officers' homes and the City does not have an at-home charging policy. Without the ability to charge overnight at home, the City will need to develop alternative charging options unless an at-home policy is developed.

To address police charging needs, the City should take a closer look at the use cases for each vehicle and determine how many hours each police vehicle is on patrol versus parked at the Police Department. Any vehicles that are driven to the station and parked for the day should be prioritized for electrification first, as they can use the Level 2 EVSE currently being installed at the Police Department without impacting performance. Police vehicles that are driven, or are on patrol, for most working hours will need access to fast charging stations. DCFC will allow patrol vehicles to charge up quickly in the morning, during breaks, or at the end of the workday. Installing DCFC will require a larger upfront investment from the City but will provide officers with more optimal charging speeds until an at-home charging policy is in place. Developing a policy that allows at-home EV charging will help the City provide more charging opportunities for domiciled vehicles, reducing the dependence and need for DCFC stations for police patrol vehicles. The policy should include considerations for:

- Whether the City will support Level 1 and Level 2 charging at employee homes
- Wiring, capacity, submeters, or other electrical upgrades necessary to support EVSE at an employee home and whether the City will cover expenses
- The cost to purchase, install, and maintain EVSE at employee homes
- The cost of electricity to charge EVs at employee homes
- EVSE ownership models

Despite the current limitations, this report includes police vehicles in the assessment to demonstrate that electric police vehicles offer financial benefits. After the City conducts a more extensive review of police vehicles and EVSE siting requirements, the City may

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[17] DOE. 2023. "Signage for PEV Charging Stations." Retrieved from: https://afdc.energy.gov/fuels/electricity_charging_station_signage.html
[18] California PEV Collaborative. 2012. "Accessibility and Signage for PEV Charging Infrastructure." Retrieved from: https://www.calbo.org/sites/main/files/file-attachments/ca_accessibility_for_ev_charging.pdf?1524861081
[19] DOE. 2014. "Guidance in Complying with ADA Requirements." Retrieved from: https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf
[20] IECC. 2019. "Proposed Changes to the 2019 International Codes." Retrieved from: media.iccsafe.org/code-development/group-b/2019-Group-B-CAH-compressed.pdf

choose to delay police vehicle electrification until an at-home charging policy or a charging schedule for DCFC stations is developed. If the City delays electrifying police vehicles, the City should expect a larger number of electric police vehicles to be available and more opportunities for cost savings as the EV market continues to mature.

Additional Best Practices and Considerations

Vehicle and Battery Warranties

EV electrical systems require little maintenance, but battery life and warranties should be well understood prior to purchasing a vehicle. The batteries in EVs are generally designed to last for the expected lifetime of the vehicle, between 10 to 12 years. [21] Like engines in conventional vehicles, the advanced batteries in EVs are designed for extended life but will eventually lose efficiency and wear out.

Battery warranties vary by original equipment manufacturer (OEM), but the City should look to purchase vehicles from OEMs that offer a minimum warranty of 8-years or 100,000-miles on EV batteries. The City should also check with vehicle dealers about battery life and length of warranties in comparison with manufacturer policies. Before purchasing an EV, the City should be aware of the scenarios in which a manufacturer will and will not replace a battery under warranty. If purchasing any previously owned EVs, the City should confirm whether the warranty is transferrable between vehicle owners.

Battery Life and Performance

During vehicle life, there are several factors that influence battery health.[22] These factors include ambient temperature, driver behavior, driving terrain, cargo loads, and the use of vehicle climate control. While it is unclear how each factor can influence battery longevity, there are a few best practices the City can encourage its drivers to abide by to maintain a healthy battery life, including:

- Practicing safe driving habits (i.e., avoid speeding, aggressive driving, and heavy loads).[23]
- Minimizing vehicle exposure to extreme temperatures by parking vehicles out of the sun, snow, or wind in shaded or canopied areas or by parking vehicles indoors.
- Minimizing regularly charging batteries to 100% or leaving EVs plugged in and charging at 100% for longer than necessary.

[21] DOE. 2021. "At a Glance: Electric Vehicles." Retrieved from: https://afdc.energy.gov/files/u/publication/electric-drive_vehicles.pdf
[22] Medium- and heavy-duty vehicles may be more heavily impacted by can be more impacted by factors that reduce range.
[23] DOE. 2021. "Electric Vehicle Basics." Retrieved from: https://afdc.energy.gov/files/u/publication/electric_vehicles.pdf

- Aiming to keep batteries at a charge between 20% to 80%, as vehicles in extremely high or low states of charge put more stress on the battery.[24]
- Emphasizing to drivers that EVs should not regularly be fully discharged and that they should abide by the fleet's charging schedule.
- Using EV features like regenerative breaking or choosing vehicles with more efficient cabin heating and cooling.
- If vehicle use and duty cycle allows, using Level 2 instead of DCFC EVSE when possible.

Snow Removal

The City fleet's light-duty pickups and heavy-duty trucks are used in the winter months for snow removal. During emergency events, these vehicles need to be operational and available 24 hours per day. From a financial perspective, it is favorable to electrify many of these vehicles. However, while electric trucks are plow-capable, the City should further study the snow removal fleet to determine if EVs will meet the use case. In assessing this scenario, the City should determine if it is possible to use plow-capable EVs on a rotating schedule to allow snow removal vehicles 20-minute breaks for fast charging. If the fleet determines it is possible to develop an emergency snow removal charging schedule, the City may proceed with electrifying these vehicles. Alternatively, the City may prefer to electrify these vehicles on a slower timeline than proposed in this assessment, introducing only a few EVs at a time while primarily relying on ICE vehicles for the next several years. A slower introduction would allow the City to gradually learn best practices while still providing emergency services. Moving forward, the City should continue monitoring EV charging technology developments (e.g., faster charging times, longer ranges, etc.), snowplowing case studies, and pilot programs for opportunities to electrify in the future.

Staff Training Resources

EVs require less maintenance than ICE vehicles, but they often involve new skills, knowledge, and techniques. To ensure the fleet maintenance staff and technicians receive adequate training on EV and EVSE maintenance, the City fleet manager should hold a mandatory training for all mechanics and consider providing additional learning opportunities throughout the year. Training and educational resources for fleet mechanics include:

- The National Alternative Fuels Training Consortium Electric Drive Vehicle Automotive Technician Training. This teaches participants the difference between EV and ICE vehicle operation and appropriate maintenance techniques.
- The Electric Vehicle Infrastructure Training Program (EVITP) for EVSE provides certification for electricians on, among other things, EV battery types and

[24] Woody, et al. 2020. "Strategies to limit degradation and maximize Li-ion battery service lifetime – Critical review and guidance for stakeholders." Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2352152X19314227?dgcid=author

specifications, service-level assessments and upgrade implementation, and utility interconnection policies and requirements. To be eligible for EVITP, a participant must be a State licensed or certified electrician or if the participant works in a States that does not license or certify electricians, the participant must provide documentation of a minimum of 8,000 hours of hands-on electrical construction experience.

- The Federal Energy Management Program's fleet management training courses. This resource offers training for EV technology, EVSE power and installation requirements, EVSE site assessments, and site operations.
- The DOE's EV Training website.
- The Clean Tech Institute's Certified EV Technician Training Program, which provides training for EV repair and maintenance.

Along with the cost of vehicle acquisition, range anxiety can present barriers to EV drivers. To familiarize staff in charge of operating and maintaining EVs and EVSE, Gaithersburg can use the following EV resources, among others, to develop educational materials:

- Maryland EV
- DOE Alternative Fuels Data Center's Electricity Basics
- DOE Alternative Fuels Data Center's Developing Infrastructure to Charge PEVs
- DOE's EV Basics report
- DOE's fueleconomy.gov website for all vehicle models available
- CALSTART's Zero-Emission Technology Inventory (ZETI) tool
- National Alternative Fuels Training Consortium's Electric Drive Vehicle Automotive Technician Training

Finally, in addition to EV maintenance, the City will need to develop EVSE maintenance policies. In developing them, the City should consider the following practices:

- Evaluate the EVSE OEM's maintenance and support packages and the availability of local service options.
- Develop a service agreement that outlines who (Gaithersburg, the manufacturer, etc.) will perform EVSE maintenance both during and after the warranty period.
- Establish a schedule for the routine inspection and maintenance of EVSE to ensure high up-time (i.e., the percentage of time the EVSE is fully operational).
- Have both electrical and non-electrical maintenance staff available for servicing EVSE, as not all maintenance is electrical.
- Consider extended warranties for Level 2 and DCFC EVSE.

Conclusion

This analysis identifies 136 vehicles for electrification in Gaithersburg's fleet, with electrification beginning in 2024. If the City follows the recommended replacement schedule for transitioning from ICE vehicles to EVs, the City can expect to see operational savings following 2027, a reduction in GHG emissions up to 24,002 MT, and a reduction of up to 77% of gallons of fuel consumed. Electrification offers the City of Gaithersburg the opportunity to save money, reduce emissions, improve community and employee health and exposure to pollutants, and improve environmental health. For simpler, future electrification assessments, the City may utilize AFLEET for quick cost and emissions calculations, see Appendix F.

Appendices

Appendix A. Assumptions and Calculations

Key assumptions and data sources that were used in this analysis include the following:

- **Recommendation Threshold:** EVs are recommended only when the EV TCO is 10% of the TCO of the comparable ICE vehicle.
- **Vehicle Pricing:** The model uses manufacturer suggested retail prices (MSRPs) for EVs where available. When MSRP pricing is unavailable, the model uses average pricing based on vehicle and fuel type based on Argonne National Laboratory's Alternative Fuel Life Cycle Environmental and Economic Transportation (AFLEET) Tool and ICF's Comparison of Medium- and Heavy-Duty Technologies in California report for the California Electric Transportation Coalition. Vehicle pricing was escalated annually using the U.S. Energy Information Administration's (EIA) 2020 Annual Energy Outlook (AEO) and ICF's Comparison of Medium- and Heavy-Duty Technologies in California report for the California Electric Transportation Coalition.
- **Current Mileage:** The City of Gaithersburg provided current mileage from odometer readings, taken in July and August 2022.
- **Annual Mileage:** The City of Gaithersburg provided mileage estimates. Due to several outliers in the data, AFLEET assumptions were substituted.
- **Fuel Costs:** The existing fleet fuel costs were estimated using the vehicles' annual mileage, AFLEET fuel economy assumptions by vehicle and fuel type, and base fuel prices per gallon. The model fuel prices provided by the City of Gaithersburg for diesel and gasoline. Prices were set at: $3.60 per gallon of diesel and $3.37 per gallon of gasoline. The model escalates gasoline and diesel pricing annually using projections from the U.S. EIA's 2022 AEO Reference Case for Transportation.
- **Maintenance Costs:** Existing fleet maintenance costs were estimated using AFLEET dollar per mile assumptions by vehicle type and by fuel type. Maintenance costs were escalated 2.2% annually. Additional maintenance savings for EVs may be realized over time, however an initial capital outlay is needed to train maintenance staff and adjust operations to handle EVs.
- **Electricity Pricing:** The model uses $0.11/kWh, as provided by the City of Gaithersburg.
- **Timeframe:** The City of Gaithersburg set the start year for electrification at 2024.
- **Discount Rate:** 5% was used for net present value (NPV) calculations.
- **Temperatures:** Utilized the average annual temperatures to calculate the impact on battery performance and reduced battery range.
- **Emissions Factor:** The assessment uses eGRID Region emissions factors, set to RFCE.

Appendix B. Electrification Assessment Results and Recommendations

ID	Vehicle Type	Make	Model	Year	Retirement Year	Replacement Make/Model
V1	VAN	FORD	TRANSIT VAN	2017	2025	Maxwell Vehicles - ePro LR Passenger Van
V10	SUV	FORD	EXPLORER	2017	2025	Chevrolet - Bolt EUV LT
V100	HEAVY TRUCK	FREIGHTLINER	FL70	2018	2028	Peterbilt - 220EV (Class 7 - 141 kW)
V101	HEAVY TRUCK	FREIGHTLINER	FL70	2019	2029	Peterbilt - 220EV (Class 7 - 141 kW)
V102	HEAVY TRUCK	FREIGHTLINER	M2106	2021	2031	Peterbilt - 220EV (Class 7 - 141 kW)
V103	HEAVY TRUCK	FREIGHTLINER	TANDUM DUMP	2021	2031	Peterbilt - 220EV (Class 7 - 141 kW)
V104	HEAVY TRUCK	INTERNATIONAL	7400 HOOK TRUCK	2020	2030	Peterbilt - 220EV (Class 7 - 141 kW)
V105	STREET SWEEPER	FREIGHTLINER	SWEEPER	2019	2029	Global - M3 SUPERCHARGED
V107	HEAVY TRUCK	INTERNATIONAL	HV 507	2022	2032	Peterbilt - 220EV (Class 7 - 141 kW)
V108	HEAVY TRUCK	FREIGHTLINER	108SD	2016	2026	Peterbilt - 220EV (Class 7 - 141 kW)
V109	HEAVY TRUCK	FREIGHTLINER	HV 507	2021	2031	Peterbilt - 220EV (Class 7 - 141 kW)
V11	LIGHT-DUTY PICKUP	CHEVROLET	COLORADO	2019	2027	ZEVx - Ford F-150
V110	SCHOOL BUS	THOMAS	PUSHER BUS	2006	2024	Lion Electric - LionD - 127 kWh
V111	SCHOOL BUS	THOMAS	PUSHER BUS	2008	2024	Lion Electric - LionD - 127 kWh
V114	MEDIUM-DUTY PICKUP	FORD	F450	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V115	MEDIUM-DUTY PICKUP	FORD	F450	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V116	HEAVY TRUCK	FREIGHTLINER	M2106	2021	2031	Peterbilt - 220EV (Class 7 - 141 kW)
V117	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V118	HEAVY TRUCK	INTERNATIONAL	HV 507	2022	2032	Peterbilt - 220EV (Class 7 - 141 kW)
V12	SUV	FORD	ESCAPE HYBRID	2010	2024	Chevrolet - Bolt EUV LT
V124	SUV	DODGE	DURANGO	2020	2024	Chevrolet - Blazer EV PPV (Police)
V125	SUV	JEEP	GRAND WAGONEER	2021	2024	Chevrolet - Blazer EV PPV (Police)
V142	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V143	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V144	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V145	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V146	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V147	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V148	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V149	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V150	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V151	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V152	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V153	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V154	SUV	FORD	EXPLORER	2017	2024	Chevrolet - Blazer EV PPV (Police)
V155	SEDAN	FORD	FOCUS	2017	2025	Tesla - Model 3 (Police)
V156	SUV	CHEVROLET	TAHOE	2018	2025	Chevrolet - Blazer EV PPV (Police)
V157	SUV	CHEVROLET	TAHOE	2018	2025	Chevrolet - Blazer EV PPV (Police)
V158	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V159	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V160	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V161	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V162	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V163	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V164	SUV	FORD	EXPLORER	2018	2025	Chevrolet - Blazer EV PPV (Police)
V165	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V166	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)

ID	Vehicle Type	Make	Model	Year	Retirement Year	Replacement Make/Model
V167	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V168	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V169	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V170	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V171	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V172	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V173	SUV	FORD	EXPLORER	2019	2026	Chevrolet - Blazer EV PPV (Police)
V174	SUV	CHEVROLET	TAHOE	2019	2026	Chevrolet - Blazer EV PPV (Police)
V178	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V179	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V180	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V181	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V182	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V183	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V184	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V185	SUV	FORD	EXPLORER	2020	2027	Chevrolet - Blazer EV PPV (Police)
V186	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V187	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V188	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V189	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V190	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V191	SUV	FORD	EXPLORER	2021	2028	Chevrolet - Blazer EV PPV (Police)
V192	SUV	FORD	ESCAPE HYBRID	2020	2027	Chevrolet - Blazer EV PPV (Police)
V194	SUV	FORD	EXPLORER	2022	2029	Chevrolet - Blazer EV PPV (Police)
V195	SUV	FORD	EXPLORER	2022	2029	Chevrolet - Blazer EV PPV (Police)
V196	SUV	FORD	EXPLORER	2022	2029	Chevrolet - Blazer EV PPV (Police)
V197	SUV	FORD	EXPLORER	2022	2029	Chevrolet - Blazer EV PPV (Police)
V198	SUV	FORD	EXPLORER	2022	2029	Chevrolet - Blazer EV PPV (Police)
V21	SUV	FORD	EXPLORER	2017	2025	Chevrolet - Bolt EUV LT
V22	SEDAN	FORD	FUSION HYBRID	2019	2027	Chevrolet - Bolt EV 1LT
V3	MEDIUM-DUTY PICKUP	CHEVROLET	SILVERADO 3500	2014	2024	Atlis - XT (300 mi) (Crew Cab)
V32	LIGHT-DUTY PICKUP	DODGE	RAM	2019	2027	ZEVx - Ford F-150
V33	SUV	FORD	EXPLORER HYBRID	2022	2030	Chevrolet - Bolt EUV LT
V34	SUV	FORD	EXPLORER HYBRID	2022	2030	Chevrolet - Bolt EUV LT
V35	MEDIUM-DUTY PICKUP	CHEVROLET	SILVERADO 3500	2017	2027	Atlis - XT (300 mi) (Crew Cab)
V36	VAN	CHEVROLET	PASS. VAN	2019	2027	Maxwell Vehicles - ePro LR Passenger Van
V37	VAN	CHEVROLET	WORK VAN	2006	2024	Canoo - MPDV1
V38	VAN	DODGE	WORK VAN	2018	2028	Canoo - MPDV1
V39	VAN	CHEVROLET	WORK VAN	2021	2031	Canoo - MPDV1
V4	LIGHT-DUTY PICKUP	CHEVROLET	COLORADO	2018	2026	ZEVx - Ford F-150
V41	VAN	CHEVROLET	WORK VAN	2021	2031	Canoo - MPDV1
V43	LIGHT-DUTY PICKUP	CHEVROLET	COLORADO	2019	2026	ZEVx - Ford F-150
V44	SUV	FORD	ESCAPE HYBRID	2020	2028	Chevrolet - Bolt EUV LT
V45	VAN	CHEVROLET	WORK VAN	2021	2029	Canoo - MPDV1
V46	VAN	CHEVROLET	WORK VAN	2021	2029	Canoo - MPDV1
V48	VAN	FORD	WORK VAN	2021	2029	Canoo - MPDV1
V5	LIGHT-DUTY PICKUP	CHEVROLET	COLORADO	2018	2026	ZEVx - Ford F-150
V54	LIGHT-DUTY PICKUP	FORD	F-250	2016	2024	ZEVx - Ford F-150
V55	LIGHT-DUTY PICKUP	CHEVROLET	SILVERADO 2500	2017	2025	ZEVx - Ford F-150

ID	Vehicle Type	Make	Model	Year	Retirement Year	Replacement Make/Model
V57	LIGHT-DUTY PICKUP	CHEVROLET	SILVERADO 2500	2017	2025	ZEVx - Ford F-150
V6	LIGHT-DUTY PICKUP	CHEVROLET	COLORADO	2018	2026	ZEVx - Ford F-150
V60	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V61	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V62	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V63	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V64	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V65	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V68	MEDIUM-DUTY PICKUP	FORD	F350	2017	2027	Atlis - XT (300 mi) (Crew Cab)
V69	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V7	SUV	FORD	ESCAPE	2018	2026	Chevrolet - Bolt EUV LT
V71	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V72	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V74	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V75	MEDIUM-DUTY VOCATIONAL TRUCK	INTERNATIONAL	HV 607	2021	2031	Ford - E-Transit Chassis Cab
V76	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V77	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V78	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V79	MEDIUM-DUTY PICKUP	FORD	F350	2021	2031	Atlis - XT (300 mi) (Crew Cab)
V8	SUV	FORD	ESCAPE	2020	2028	Chevrolet - Bolt EUV LT
V80	MEDIUM-DUTY PICKUP	FORD	F350	2021	2031	Atlis - XT (300 mi) (Crew Cab)
V81	MEDIUM-DUTY PICKUP	FORD	F350	2017	2027	Atlis - XT (300 mi) (Crew Cab)
V82	MEDIUM-DUTY PICKUP	FORD	F350	2017	2027	Atlis - XT (300 mi) (Crew Cab)
V83	VAN	CHEVROLET	PASS. VAN	2014	2024	Maxwell Vehicles - ePro LR Passenger Van
V84	VAN	FORD	PASS. VAN	2017	2027	Maxwell Vehicles - ePro LR Passenger Van
V85	VAN	FORD	PASS. VAN	2017	2027	Maxwell Vehicles - ePro LR Passenger Van
V86	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V87	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V88	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V89	LIGHT-DUTY PICKUP	CHEVROLET	SILVERADO 2500	2017	2024	ZEVx - Ford F-150
V9	SUV	FORD	ESCAPE	2018	2026	Chevrolet - Bolt EUV LT

ID	Vehicle Type	Make	Model	Year	Retirement Year	Replacement Make/Model
V90	MEDIUM-DUTY PICKUP	FORD	F350	2020	2030	Atlis - XT (300 mi) (Crew Cab)
V91	MEDIUM-DUTY PICKUP	FORD	F350	2019	2029	Atlis - XT (300 mi) (Crew Cab)
V92	MEDIUM-DUTY PICKUP	FORD	F350	2017	2027	Atlis - XT (300 mi) (Crew Cab)
V94	MEDIUM-DUTY PICKUP	FORD	F350	2015	2025	Atlis - XT (300 mi) (Crew Cab)
V95	HEAVY TRUCK	INTERNATIONAL	HV 507	2021	2031	Peterbilt - 220EV (Class 7 - 141 kW)
V96	HEAVY TRUCK	FREIGHTLINER	108SD	2016	2026	Peterbilt - 220EV (Class 7 - 141 kW)
V97	HEAVY TRUCK	FREIGHTLINER	108SD	2016	2026	Peterbilt - 220EV (Class 7 - 141 kW)
V98	HEAVY TRUCK	FREIGHTLINER	108SD	2018	2028	Peterbilt - 220EV (Class 7 - 141 kW)
V99	HEAVY TRUCK	FREIGHTLINER	FL70	2018	2028	Peterbilt - 220EV (Class 7 - 141 kW)

**Note: These are vehicles used for comparison purposes, not an endorsement of any individual EV manufacturer or model. See DOE's fueleconomy.gov website for all vehicle models available.*

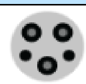
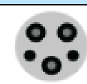
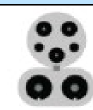
Appendix C. Projected Cumulative GHG Emissions of ICE Replacement Vehicles Versus Recommended EV Replacements

Year	ICE Emissions (MT)	EV Replacement Emissions (MT)
2024	508	141
2025	1,436	381
2026	2,752	723
2027	4,467	1,169
2028	6,108	1,591
2029	8,175	2,093
2030	10,064	2,541
2031	12,023	3,000
2032	13,904	3,435
2033	15,663	3,836
2034	17,422	4,238
2035	19,181	4,639
2036	20,888	5,027
2037	22,595	5,415
2038	24,303	5,803
2039	25,920	6,163
2040	27,356	6,489
2041	28,649	6,780
2042	29,762	7,027
2043	30,729	7,238
2044	31,153	7,337
2045	31,512	7,423
2046	31,581	7,438

Appendix D. EVSE Overview

DOE's Alternative Fuel Data Center offers resources to better understand EVSE infrastructure requirements. The following information is a primer of some of the resources available:

EVSE Charging Types

	Level 1 Alternating Current	Level 2 Alternating Current	DC Fast Charging		
Description	Uses a standard plug – 120 volt (V), single phase service with a three-prong electrical outlet at 15-20 amperage (A)	Used for both BEV and PHEV charging. 208/240 V AC split phase service that is less than or equal to 80 A.	Used specifically for BEV charging. Typically requires a dedicated circuit of 20-100 A, with a 480 V service connection.		
Connector type(s)					
	J1772 charge port	J1772 charge port	J1772 combo	CHAdeMO	Tesla combo
Use	Residential or workplace charging	Residential, workplace, or public charging	Rapid charging for transportation depots, vehicle fleets, public corridors		
Limitations	Low power delivery lengthens charging time	Requires additional infrastructure and wiring	Can only be used by BEVs currently. Higher upfront and operational costs		
Time to charge	2 to 5-mi range/1-hr charging. Depending on the vehicle battery size, PHEVs fully charge in 2-7 hours and BEVs in 14-20+ hours	10 to 25-miles range/1-hr charging. Depending on the vehicle battery size, PHEVs fully charge in 1-3 hours and BEVs in 4-8 hours	50 to 70-mi range/20-min charging. Depending on the vehicle battery size, BEVs can be fully charged in 30-60 minutes.		

Methodology for Determining Fleet EVSE Needs

Step	Description	Calculation
1. Determine Individual Vehicle Energy Use	For each vehicle, determine expected energy use in kWh by multiplying the vehicle's energy efficiency (kWh/mile) by the expected vehicle miles traveled (VMT) between charges.	Vehicle Energy Use (kWh) = Vehicle Energy Efficiency (kWh/mile) * VMT (mile)
2. Determine Fleet Energy Use	For each vehicle that requires charging within a certain window, sum their individual energy use requirements.	Fleet Energy Use (kWh) = Σ Vehicle Energy Use$_1$ + Vehicle Energy Use$_2$ + … + Vehicle Energy Use$_n$
3. Identify Daily Charging Window	Identify the period of time that fleet vehicles are available to charge (e.g., 10 p.m.– 6 a.m.).	Hours (hr)
4. Identify Average Charging Demand	Divide fleet energy use by the charging window to determine average kilowatts (kW) of charging needed for truck operations.	Average Charging Demand (kW) = Fleet Energy Use also as kWh
5. Determine Average Per Vehicle Charging Demand	Divide average charging demand by the number of vehicles that require charging	Vehicle Charging Demand (kW) = Average Charging Demand (kW) / Vehicles

Appendix E. Fleet Vehicle Dwell Locations[25]

Location	Vehicle Type	Number of Vehicles Recommended for Electrification
16 S Summit Avenue	Sedan	1
	SUV	54
31 S Summit Avenue	Light-Duty Pickup	1
	Sedan	1
	SUV	4
	Van	8
506 S Frederick Avenue	Medium-Duty Pickup	2
800 Rabbitt Road	Heavy Truck	15
	Light-Duty Pickup	9
	Medium-Duty Pickup	28
	Medium-Duty Vocational Truck	1
	School Bus	2
	Street Sweeper	1
	SUV	5
	Van	4

[25] Provided by the City of Gaithersburg. This reflects the number of vehicles assigned to each dwell location as provided by the City. This does not reflect the vehicle department assignments or other locations vehicles may have permission to dwell overnight (i.e., domiciled vehicles). The City should confirm vehicle dwell locations when they begin electrification in 2024.

Appendix F. Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool

The analysis contained within this report used assumptions and data contained within Argonne National Laboratory's (ANL) AFLEET Tool as the basis for comparison. For additional analysis, the AFLEET Tool may be used to examine the environmental and economic costs and benefits of alternative fuel and advanced vehicle technologies. AFLEET allows users to estimate vehicle and fleet petroleum use, GHG and air pollutant emissions, and TCO for light-, medium-, and heavy-duty vehicles. The tool relies on data from ANL's Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model and the Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) model.

Resources for the AFLEET Tool may be found at the following locations:

- AFLEET Tool Online
- AFLEET Tool 2020 Spreadsheet
- User Guide for the 2020 AFLEET Tool