Frederick County Alternative Fuel Vehicle Fleet Transition Plan

November 2023

DIVISION OF ENERGY AND ENVIRONMENT

Metropolitan Washington Council of Governments

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Recent federal, state, and regional initiatives demonstrate that America is working to confront the challenges posed by climate change and build more resilient communities.

Here in Frederick County, we have pledged to reduce our greenhouse gas emissions 50% by 2030 and 100% no later than 2050. In this critical moment, it is imperative that Frederick County Government do its part to make "sustainability" more than just a talking point, but a pillar upon which we base our current decision-making.

This Alternative Fuel Vehicle Fleet Transition Plan is a prime example of converting sustainability ideals into *practical* strategies. In our 2018 inventory of greenhouse gas emissions from County operations, approximately 41% of emissions came from the transportation sector. While we are determined to reduce that and achieve positive outcomes for the environment, we recognize the need to take a thoughtful approach that ensures our plan is financially sustainable and in the best interests of the County.

The plan outlined in this document assesses "rightsizing" our fleet and electrification of vehicles. It also looks at biodiesel as a transitional step for vehicles not currently recommended for electrification. In making these assessments, we balanced environmental and financial impacts, along with other practical considerations. The analysis of vehicles for electrification considered the total cost of ownership along with the status of existing vehicle technology and the kinds of tasks County vehicles must be prepared to do. By taking advantage of new technology when appropriate, it is possible to not only reduce our greenhouse gas emissions but also lower our long-term fleet costs.

I am proud of the meticulous planning and collaborative efforts staff used to ensure this plan works across all of Frederick County Government's operations. Our County Divisions are adaptable, dedicated, and prepared to face the greatest challenge of our time: climate change. In making the switch to alternate fuel vehicles, Frederick County Government is leading by example. In demonstrating the viability of our goals, we hope to encourage other jurisdictions, businesses, and individuals to act and make a difference for our environment, our community, and our future.

Jessica Fitzwater
Frederick County Executive

Acknowledgments

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Acronyms

The following acronyms are used in this report:	
A	Amperage
ADA	Americans with Disabilities Act
ADAAS	Americans with Disabilities Act Accessibility Standards
AFC	Alternative Fuel Corridor
AFDC	Alternative Fuels Data Center
AFV	Alternative Fuel Vehicle
ANL	Argonne National Laboratory
ARB	Air Resources Board
ASTM	American Society for Testing and Materials
B100	100% Biodiesel
B20	20% Biodiesel Blend
B5	5% Biodiesel Blend
B99	99% Biodiesel Blend
BGE	Baltimore Gas and Electric
BOE	Board of Education
BTM	Behind-The-Meter
CCS	Combined Charging System
CESA	Clean Energy States Alliance
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CRRR	Climate Response and Resilience Report
DCFC	Direct Current Fast Charger
DERA	Diesel Emissions Reduction Act
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
E85	Ethanol-gasoline blended fuel that contains 51%-83% ethanol
EECBG	Energy Efficiency and Conservation Block Grant
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	Electric Vehicle
EVITP	Electric Vehicle Infrastructure Training Program
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
FEMP	Federal Energy Management Program
FFV	Flex Fuel Vehicle
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GVWR	Gross Vehicle Weight Rating

The following acronyms are used in this report:	
HBIIP	Higher Blends Infrastructure Incentive Program
ICE	Internal Combustion Engine
IIJA	Infrastructure Investment and Jobs Act
INFRA	Infrastructure for Rebuilding America
IRA	Inflation Reduction Act
kW	Kilowatt
kWh	Kilowatt hour
LDV	Light-Duty Vehicle
LEED	Leadership in Energy and Environmental Design
LPG	Liquefied Petroleum Gas
MAPT	Mid-Atlantic Purchasing Team
MEA	Maryland Energy Administration
MHD	Medium- and Heavy-Duty
MT	Metric Ton
MWCOG	Metropolitan Washington Council of Governments
MUTCD	Manual on Uniform Traffic Control Devices
NEVI	National Electric Vehicle Infrastructure
NOx	Nitrogen Oxide
NPV	Net Present Value
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
PG&E	Pacific Gas and Electric
PHEV	Plug-In Hybrid Electric Vehicle
PSC	Public Service Commission
PV	Photovoltaic
QSR	Qualified System Retrofitter
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
RD	Renewable Diesel
RFID	Radio Frequency Identification
SSD	Social Security Department
SUV	Sport Utility Vehicle
TCO	Total Cost of Ownership
TTM	To-The-Meter
V2B	Vehicle-To-Building
V2G	Vehicle-To-Grid
V2L	Vehicle-To-Load
V	Volt
VEES	Virginia Energy Conservation and Environmental Standards
VIN	Vehicle Identification Number
VMT	Vehicle Miles Traveled
ZETI	Zero-Emission Technology Inventory
ZEV	Zero Emission Vehicle

Executive Summary

This is a strategic alternative fuel vehicle (AFV) fleet transition plan for Frederick County Government (County) to right-size the County fleet, deploy electric vehicles (EVs), integrate a biodiesel blend of 20% (B20), and install electric vehicle supply equipment (EVSE) and biodiesel refueling equipment at County facilities between 2024 and 2036. This transition plan helps the County follow recommendations provided by the Frederick Climate Emergency Mobilization Work Group (CEMWG), now known as Mobilize Frederick, in the 2021 Climate Response and Resilience Report (CRRR), particularly recommendations 12, 13, 15, and 16.[1] Further, in 2022, Jessica Fitzwater was elected as County Executive, and, since taking office, has named fleet electrification as a priority to help reduce County greenhouse gas (GHG) emissions.[2] If the County adopts all recommendations within this report, Table 1 shows the total cumulative emissions savings potential at benchmark years 2030, 2040, and 2050.

Table 1. Total Fleet Transition Plan Emissions Savings Potential in Metric Tons (MT)

Fuel	2030	2040	2050
Electricity	5,866 MT	16,737 MT	17,835 MT
B20	3,031 MT	7,360 MT	11,690 MT
Total	**8,897 MT**	**24,097 MT**	**29,525 MT**

The rightsizing analysis identified 48 vehicles that may be underutilized by the fleet or are no longer performing their jobs as efficiently as possible. Further research is needed involving the user departments before vehicle retirement should occur. This plan also includes a total cost of ownership (TCO) and GHG emission assessment of the transition plan through 2050 as it relates to EVs and the adoption of B20. The fleet transition plan analyzed 876 on-road vehicles in the County fleet to determine the most cost-effective options for reducing fleet emissions. Of the 876 vehicles assessed, some vehicle types have been excluded due to the ways the vehicles are used (use case).

Fleet Electrification

The fleet electrification analysis evaluates the replacement of existing on-road vehicles with EVs based on vehicle TCO, recommending EVs if they meet County-set TCO thresholds. The TCO threshold indicates the maximum amount an EV can cost compared to an internal combustion engine (ICE) vehicle. If the analysis shows an EV's TCO is equal to or below the set TCO threshold, it is recommended for EV adoption. This analysis considers two scenarios: a 5% TCO threshold and a 10% TCO threshold. The first scenario recommends vehicles for electrification if the TCO of an EV is up to 5% more than an ICE vehicle. The second scenario recommends vehicles for electrification if the TCO of an EV is up to 10% more than an ICE vehicle.

Only one round of vehicle replacements is included in this assessment. Based on the electrification analysis, each scenario recommends the following number of EVs over the next 12 years:[3]

Fleet Electrification Assessment Quick Details

- Data for 876 vehicles were provided for analysis. Due to use case and feasibility concerns, only 235 vehicles were evaluated for electrification.
- Feedback from different County stakeholders resulted in the removal of light-duty pickups, heavy straight-trucks, and police vehicles from the electrification assessment.
- Vehicles retiring before 2024 are excluded from the assessment as they will be replaced before this plan is implemented.
- Two TCO scenarios were evaluated in this assessment.
- Financial incentives are included in this assessment.

[1] CEMWG. 2021. Climate Response and Resilience. Retrieved from: https://www.mobilizefrederick.org/_files/ugd/793224_86d724fb9047489896e823edf2e1a3f6.pdf
[2] Frederick County Executive. 2023. Transition Report. Retrieved from: https://frederickcountymd.gov/DocumentCenter/View/343208/Transition-Report-032023
[3] 2024 to 2036

- **5% Scenario:** converting **183** ICE fleet vehicles to EVs
- **10% Scenario:** converting **187** ICE fleet vehicles to EVs

The quantity of vehicles recommended for electrification in each analysis scenario is detailed below in Table 2. The makes and models of vehicle recommendations are suggestions, not requirements. If possible, the County should research and test all vehicles before adoption. In 2022, after reviewing initial recommendations, the County's Fleet Services Department piloted Ford E-Transit vans and determined that specific vehicle would not meet many fleet range needs but later discovered one use case that would work. However, Fleet Services should continue exploring other vehicles that may offer similar TCO savings while still meeting the County's needs.

Table 2. Summary of Electrification Recommendations

Vehicle Type	5% Scenario	10% Scenario	EV Recommendations
Sedan	19	20	Nissan Leaf | Kia Niro
SUV	1	1	Kia Niro SUV
Minivan	22	23	Canoo Lifestyle Vehicle
Medium-Duty Pickup	19	19	Atlis XT
Van	31	33	Arrival Van H1 Passenger | ELMS Urban Delivery Van
Medium-Duty Vocational Truck	61	61	Ford E-Transit Van[4]
Street Sweeper	1	1	Global M3 Supercharged
Shuttle Bus	21	21	Ford E-Transit Van | Ford F-650
Transit Bus	6	6	Lightning eMotors Electric City Bus
School Bus	1	1	Starcraft E-Quest XL
Heavy Truck	1	1	Tesla Semi

If the County is unable to electrify all recommended vehicles in the current replacement cycle—due to costs or use case compatibility issues—electrifying in future replacement cycles is encouraged. A delay in electrification will not prevent the County from realizing the benefits of EVs long-term, but it will result in fewer shorter-term benefits detailed in this report's adoption scenarios. Each scenario is estimated to produce the following benefits over 25 years[5] of vehicle ownership:[6]

[4] Alternatives to this vehicle make and model include Arrival Van H1 and H2 Cutaway; ELMS Urban Utility; Ford F-350, F-450, or F-550; GMC 3500 or 4500 Cutaway; and others.
[5] Vehicle ownership is assumed to last from 2024 through 2050.
[6] Based on the Assumptions and Calculations outlined in Appendix B, then applied to the U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

5% Scenario	10% Scenario
$12,147,916 TCO savings over **25** years of vehicle operations	**$12,136,290** TCO savings over **25** years of vehicle operations
$6,547,344 fuel cost savings over **25** years of vehicle operations	**$6,569,596** fuel cost savings over **25** years of vehicle operations
$4,545,554 maintenance savings over **25** years of vehicle operations	**$4,556,828** maintenance savings over **25** years of vehicle operations
17,777 MT of GHG eliminated over **25** years of vehicle operations	**17,835** MT of GHG eliminated over **25** years of vehicle operations
101,933 gallons of gasoline and **98,581** gallons of diesel displaced over **25** years of vehicle operations	**102,679** gallons of gasoline and **98,581** gallons of diesel displaced over **25** years of vehicle operations
Equivalent to eliminating **2,044** homes' energy use annually	Equivalent to eliminating **2,051** homes' energy use annually

This plan is replicated within the County's Climate and Energy Action Plan with caveats to allow for the full replacement of the fleet over an expanded timeframe and three different rounds of fleet replacements. To prepare for EV deployment, the County should install Level 2 EVSE at every County department, or associated parking facility, with EV recommendations, when possible, to allow both EVs domiciled at those facilities and EVs that may not have a designated parking location to charge without experiencing range anxiety. Similarly, installing direct current fast chargers (DCFC) should be considered at locations with vehicles that have high daily mileage so that charging time does not reduce vehicle operability or efficiency. These are preliminary infrastructure recommendations. Next steps for EVSE planning and development include the County completing a detailed siting assessment. Table 3 outlines preliminary charging needs to support the electrification recommendations contained in this report, based on the 10% TCO scenario.

Table 3. EVSE Needs to Support Report Recommendations

Vehicle Type	Level 2	DCFC
Sedan	5	0
SUV	1	0
Minivan	6	0
Medium-Duty Pickup	4	1
Van	7	1
Medium-Duty Vocational Truck	7	2
Street Sweeper	0	1
Shuttle Bus	2	3
Transit Bus	0	2
School Bus	0	1
Heavy Truck	0	1
TOTAL	**32**	**12**

Biodiesel Adoption

Based on the biodiesel analysis, transitioning 116 diesel vehicles to operate on B20 is estimated to produce the following immediate benefits[7]:

$116,247 fuel cost savings annually

433 MT of GHG eliminated annually

55 homes' energy use for one year

Equivalent to planting **7,159** tree seedlings

A summary of cumulative emissions savings at benchmark years 2030, 2040, and 2050 are below:

Year	GHG Reductions (MT)
2030	3,031
2040	7,360
2050	11,690

To support B20 adoption, the County should consider transitioning one diesel pump to B20 at one of the five County fleet fueling locations and deploy fuel totes for smaller scale fueling needs at satellite locations convenient for drivers of vehicles recommended for B20. Deploying fuel totes at one or multiple stations over the next couple of years will allow County departments and drivers to adjust to using alternative fuels over a longer period. Half of the vehicles recommended for B20 adoption belong to the Department of Highway Operations. Other divisions with a larger share of B20 recommendations include Water and Sewer Utilities, Transit Services (TransIT), and Solid Waste and Recycling. Depending on where these vehicles typically fuel, accessing B20 at one primary location may increase vehicle miles traveled (VMT).

B20 is a drop-in fuel, meaning no vehicle conversions or upgrades are necessary for its use. This report outlines considerations and best practices for adopting B20, as it does have different qualities and handling requirements than diesel fuel. These considerations include biodiesel feedstocks, fuel cloud point, diesel fuel types and blending options, biodiesel suppliers and contracts, fuel additives, and seasonal blending.

Biodiesel Assessment Quick Details

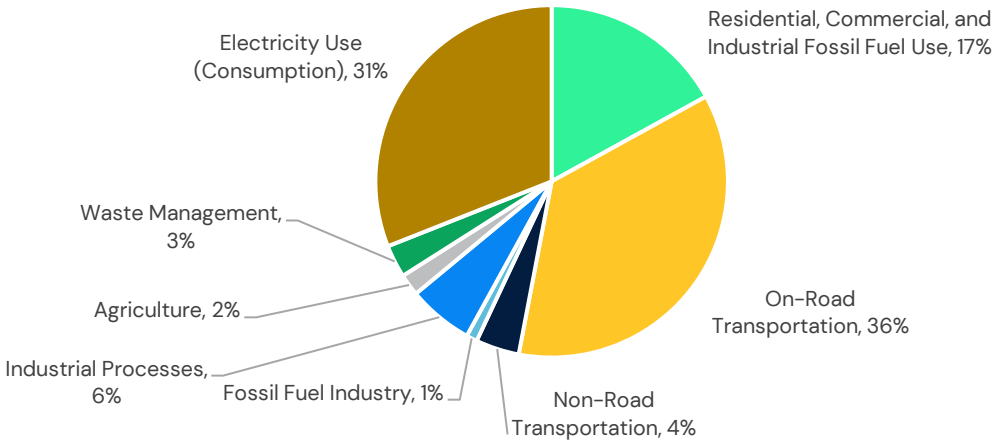
- Data for 876 vehicles was provided for electrification analysis.
- Diesel vehicles not recommended for electrification are recommended for B20 adoption.
- 116 vehicles are recommended for B20 adoption.
- If the County decides not to pursue electrification for any diesel vehicle, the County may transition the vehicle to B20 instead.
- B20 use does not require vehicle conversions or upgrades.
- Feedback from different County stakeholders resulted in the removal of Fire and Rescue vehicles from the assessment due to the nature of that department's work and operational concerns.

[7] EPA. 2022. "Greenhouse Gas Equivalencies Calculator." Retrieved from: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Introduction

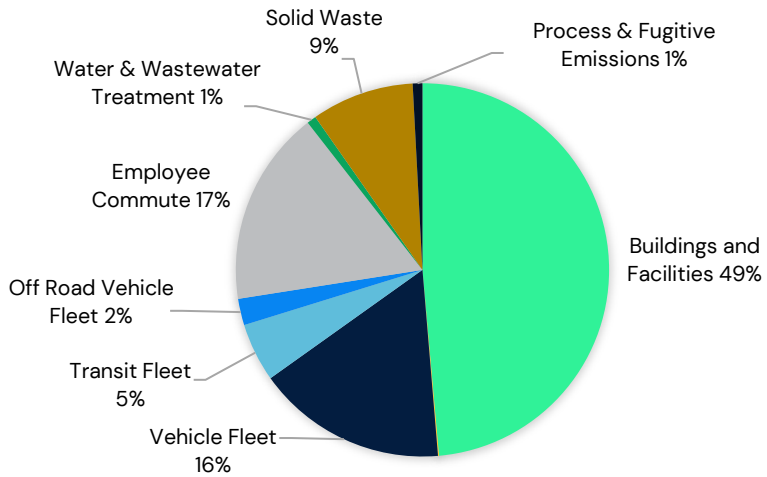
The transportation sector accounts for 29% of all GHG emissions in the United States, with on-road light-, medium-, and heavy-duty vehicles contributing 82% of those emissions.[8] In Maryland, on-road transportation is the largest generator of GHG emissions, accounting for 36% of state GHG emissions. To address these emissions, Maryland set a goal of registering 600,000 EVs by 2030 and is actively facilitating EV and EVSE deployment through state-funded incentive programs, utility programs, and educational campaigns.

Figure 1. Maryland GHG Emissions by Sector[9]



Within Frederick County, transportation accounted for 41% of GHG emissions in 2018, half of which is from the County's on-road fleet and TransIT vehicles. Figure 3 breaks down Frederick County emissions sources as reported in 2018.

Figure 2. 2018 GHG Emissions by Source in Frederick County



[8] EPA. 2021. "U.S. Transportation Sector Greenhouse Gas Emissions 1990-2019." Retrieved from: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013NR3.pdf
[9] Ibid.

Similarly, the Metropolitan Washington Council of Governments (MWCOG), which the County is part of, set a goal the following GHG emissions reductions goals:

- 50% below 2005 levels by 2030; and,
- 80% below 2005 levels by 2050.[10]

In 2020, the Frederick County Council adopted a Climate Emergency Resolution in which the County resolved to "commit to equitable climate emergency mobilization efforts to address global warming, reduce county-wide GHG emissions 50% from 2010 levels by 2030 and 100% no later than 2050,[11] and employ efforts to safely drawdown carbon from the atmosphere." [12] As an initial part of this effort, the County established the CEMWG to make recommendations to achieve emission reduction goals. In 2021, the CEMWG released a final report, Climate Response and Resilience, which includes transportation-oriented recommendations relevant to this fleet transition plan, including:

- Recommendation 12: Transition all buses to electric and enhance ridership experience.
- Recommendation 13: Transition light- and medium-duty vehicles to all electric.
- Recommendation 15: Study the feasibility of electric rapid transit.
- Recommendation 16: Facilitate the availability or renewable fuels for all vehicle types and home heating.

This report indicates where there is overlap between the County's strategies and those developed by CEMWG.

To help meet the County's, MWCOG's, and Maryland's emission reduction goals, the County plans to integrate EVs and AFVs in the County fleet and deploy the infrastructure necessary to support fleet EVs and AFVs. The County worked with ICF to develop a fleet transition plan to support the County fleet's adoption of EVs and alternative fuels. This document is a strategic transition plan for the adoption of EVs and AFVs owned and operated by the County.

The fleet transition plan focuses primarily on EVs and biodiesel, but it also includes summary assessments of other alternative fuels not recommended for the County at this time. Similarly, this plan includes a rightsizing analysis, vehicle retirement and EV replacement recommendations, infrastructure requirements for EV and B20 recommendations, economic and GHG analyses, and a discussion of other considerations and best practices for fleet EVs and B20 use. These analyses and considerations provide the County with actionable next steps and best practices to begin transitioning to a cleaner, healthier fleet and, ultimately, community.

[10] 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/
[11] The County is using 2010 as the baseline year for internal operations, but for community-wide efforts they are using 2005 as the baseline year to be consistent with MWCOG's efforts.
[12] Frederick County. 2020. "Resolution No. 20-22." Retrieved from: https://frederickcountymd.gov/DocumentCenter/View/328669/20-22-Climate-Emergency

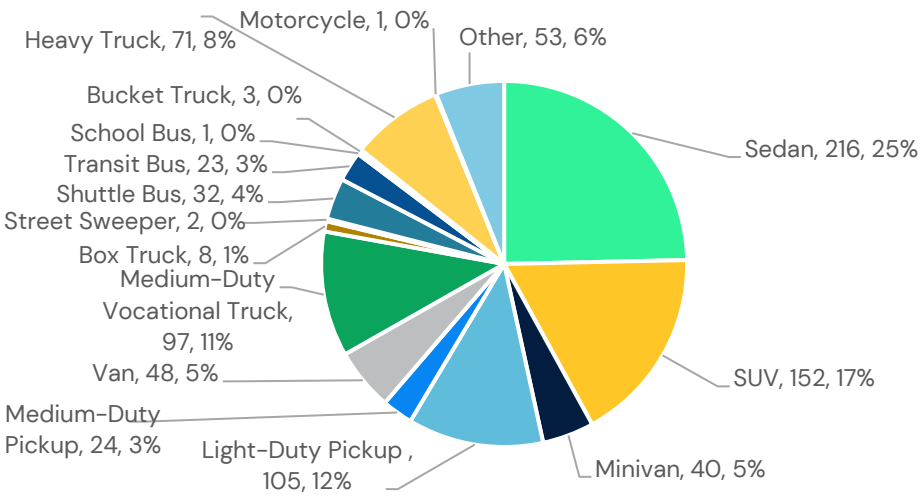
Current Fleet Inventory

At the time of this report, the County provided fleet data for 876 on-road light-, medium-, and heavy-duty vehicles and 283 non-road vehicles.[13] Most vehicles operate on gasoline or diesel fuel, but the County also owns nine electric transit buses and five plug-in hybrid electric vehicles (PHEVs). The County also completed an EV pilot program in May 2022, using the Hyundai Kona. To support existing EVs, the County owns and operates five Level 2 EVSE with nine ports total, and five DCFC stations with ten ports total. Table 4 breakdowns the County's on-road fleet by fuel type. This transition plan only evaluates on-road vehicles.[14]

Table 4. Current Fleet Inventory by Vehicle and Fuel Type

Vehicle Type	Gasoline	Diesel	PHEV	EV
Sedan	211	0	5	0
Sport Utility Vehicle (SUV)	152	0	0	0
Minivan	40	0	0	0
Light-Duty Pickup	95	10	0	0
Medium-Duty Pickup	8	16	0	0
Van	48	0	0	0
Medium-Duty Vocational Truck	27	70	0	0
Box Truck	4	4	0	0
Street Sweeper	0	2	0	0
Shuttle Bus	23	9	0	0
Transit Bus	0	14	0	9
School Bus	0	1	0	0
Bucket Truck	0	3	0	0
Heavy Truck	0	71	0	0
Motorcycle	1	0	0	0
Other[15]	1	52	0	0
TOTAL	**610**	**252**	**5**	**9**

Figure 3. Existing On-Road Fleet Composition

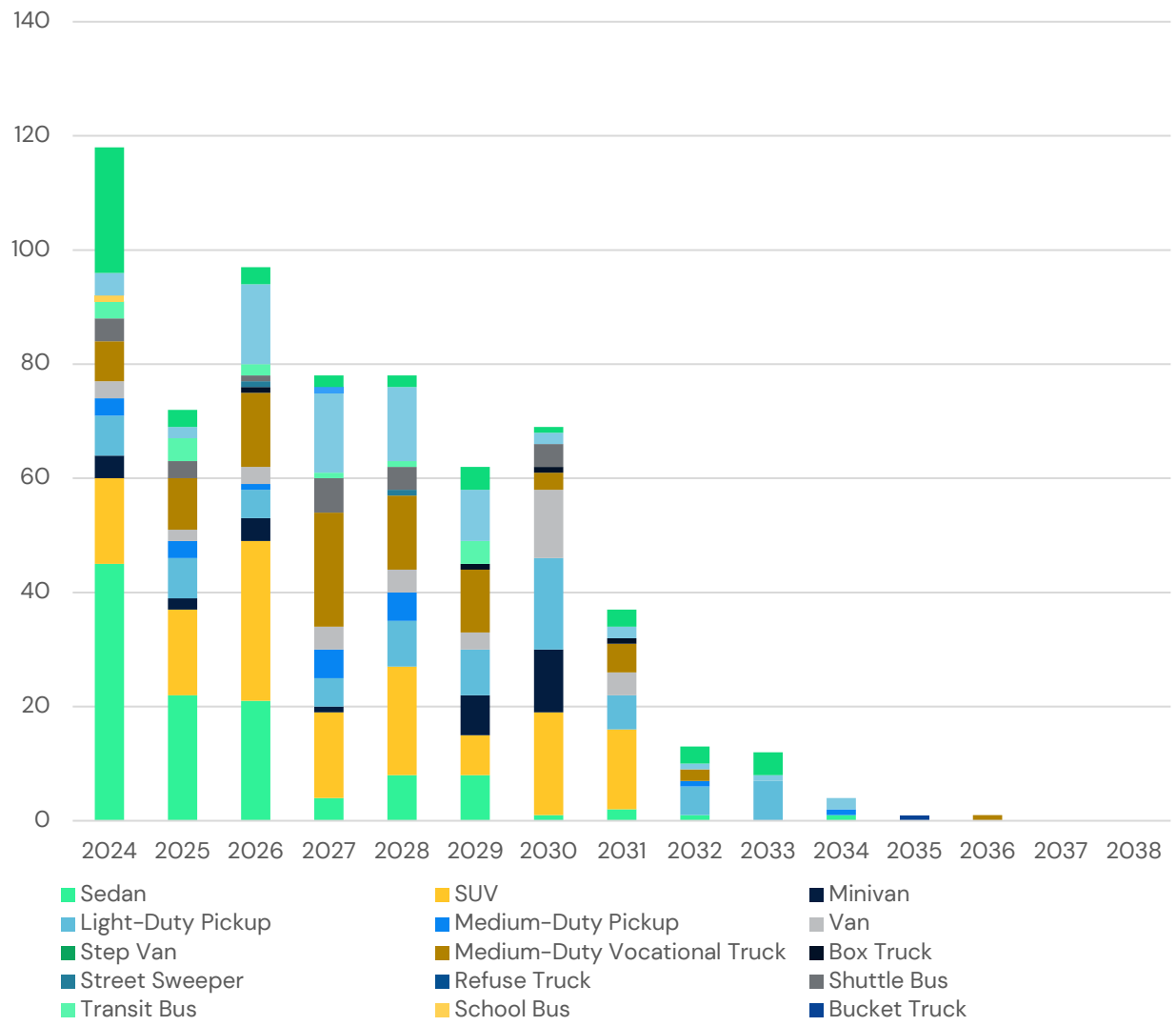


[13] This Plan does not include Frederick County Public Schools vehicles.
[14] Off-road vehicles were excluded per the fleet's request and concern that alternative fuel off-road vehicles will not be able to meet the fleet's needs.
[15] "Other" vehicle types include, but are not limited to, ambulances, fire trucks, trailers, recreational vehicles, etc.

Over half of Fredericks's evaluated fleet is primarily composed of sedans (25%), SUVs (17%), light-duty pickups (12%), and medium-duty vocational trucks (11%) as seen in Figure 3. Of the fleet's 216 sedans, 159 are police vehicles, and of the fleet's 152 SUVs, 151 are police vehicles.

The transition plan begins in 2024, excluding vehicles that are set to retire in 2022 and 2023. Vehicles retiring before 2024 already have planned vehicle replacements. For vehicles set to retire in 2024 or later, all are eligible for retirement over the following 15 years, as shown in Figure 4 and Appendix A.

Figure 4. Existing Vehicle Fleet Retirement Schedule[16]



Vehicle retirement is determined by the County fleet manager based on vehicle age and mileage. The County plans to adhere to the existing schedule as closely as possible. However, supply chain constraints, vehicle availability, use case concerns, long lead times for vehicle purchases, and financial constraints may cause actual retirement/replacement to vary considerably in the next few years. Should these constraints affect the County's implementation timeline, Fleet Services and the other relevant County stakeholders should discuss and develop a mutually agreeable replacement timeframe. Depending on how long vehicle retirements are delayed and as new vehicle models are announced, replacement options and recommendations may change.

[16] This includes all vehicles provided in the fleet data, including those excluded from the final electrification assessment.

Fleet Rightsizing and Asset Utilization

The first step in reducing County fleet vehicle emissions and improving fleet efficiency is determining whether the fleet is the correct size for County operations. A rightsizing assessment identifies which vehicles may not be fully utilized, necessary for fleet operations, or required the completion of projects or tasks. This helps fleet managers develop and maintain the ideal vehicle inventory for fleet operations by identifying vehicles that may not be necessary to own, operate, and maintain. Many fleets often expand over time to include vehicles that are overly specialized, rarely used, or no longer suitable for current fleet needs. Rightsizing helps fleet managers optimize vehicle count and use; reduce fuel consumption and expenses; lower emissions by retiring, reassigning, or replacing vehicles; and reduce operations and maintenance costs.[17]

The County provided a list of departments organized by priority for vehicle assessment, shown in Table 5. Department prioritization will help the County fleet manager determine which vehicles should be further evaluated, retired, or replaced first.

Table 5. County Government Departments by Priority for Vehicle Evaluation

Priority Tier	Department
1	Animal Control
	Health Department
	Highway Operations
	Facility Maintenance
	Frederick County Public Libraries
	Permits and Inspections
	Parks and Recreation
	Water and Sewer Utilities
2	Fire and Rescue Services
	Solid Waste and Recycling
	Sheriff's Office

To complete the rightsizing assessment, vehicle age, type, and mileage were evaluated. Vehicles with zero annual miles or with average annual mileage that is significantly lower than the average mileage for that vehicle type are flagged as potentially underutilized and recommended for further evaluation. Several fleet vehicles are recorded as having zero annual miles. Vehicles listed in Table 6 have current odometer readings above zero miles, but zero annual miles for 2022.

[17] U.S. Department of Energy (DOE). 2022. "Rightsizing Your Vehicle Fleet to Conserve Fuel." Retrieved from: https://afdc.energy.gov/conserve/rightsizing.html#:~:text=Fleet%20rightsizing%20is%20a%20management,or%20unsuitable%20for%20current%20applications.

Table 6. Fleet Vehicles with Zero Annual Miles[18]

Asset Number	Vehicle Type	Make	Model	County Department
5049	Shuttle Bus	GMC	C5500	Independent Hose Company
7021	Sedan	Ford	Focus	Social Services
7024	Sedan	Ford	Focus	Social Services
7027	Sedan	Ford	Focus	Social Services
7028	Sedan	Ford	Focus	Social Services
7031	Sedan	Ford	Focus	Social Services
39585	Sedan	Dodge	Charger	Sheriff
38847	SUV	Jeep	Patriot	Water and Sewer Utilities
5057	SUV	Chevrolet	Suburban	Dive Team
39728	Light-Duty Pickup	Ford	F150	Solid Waste and Recycling
WC11	Light-Duty Pickup	Chevrolet	Silverado 1500	Weed Control
39729	Light-Duty Pickup	Ford	F150	Animal Control

While readings of zero annual miles may be due to driver error, the fleet considers these vehicles inactive.[19] Next steps include:

- Evaluating whether these vehicles were in use in 2022.[20]
- Evaluating whether these vehicles have been in use, or will be in use, in 2023.
- Determining if these vehicles are expected to have a future use.

If the vehicles in Table 6 actually have zero annual miles, the County should consider removing these vehicles from the fleet unless they serve a unique, low frequency yet high priority purpose that results in low use. Removing vehicles with zero annual miles would reduce the fleet size by 12 vehicles. Additional information on these vehicles can be found in Appendix B.

The vehicles in Table 7 have an average annual mileage that is that is less than 10% of the average annual mileage (i.e., are at or below the 10th percentile) for that vehicle type, according to AFLEET assumptions.[21] There are 36 fleet vehicles that have mileage below the 10% threshold. Due to the high number of vehicles below this threshold, vehicles belonging to a priority one department (Table 5) are listed below in Table 7.

[18] Some of these vehicles are owned by County agencies and the State of Maryland. These vehicles may be harder to retire without further agency or state consultation.
[19] Vehicle drivers are responsible for reporting this value in the fleet data.
[20] The year this data was provided.
[21] Argonne National Laboratory (ANL). 2022. "AFLEET Tool 2020." Retrieved from: https://greet.es.anl.gov/index.php?content=afleet

Table 7. Vehicles with Annual Mileage Under 10% of the Average for that Vehicle Type (Priority Departments)

Asset Number	Vehicle Type	Make	Model	Annual Mileage	Department
37049	Straight Truck	Freightliner	M2	2,885	Water and Sewer Utilities
37389	Straight Truck	Freightliner	M2	2,999	Water and Sewer Utilities
39199	Straight Truck	Freightliner	108 SD	3,944	Highway Operations
39578	Straight Truck	Freightliner	108 SD	6,250	Highway Operations
39469	Straight Truck	Freightliner	Utility	762	Water and Sewer Utilities
27058	Straight Truck	Ford	F8000	2,331	Water and Sewer Utilities
39346	Straight Truck	Freightliner	114 SD	4,161	Highway Operations
37230	Straight Truck	International	7400	2,032	Water and Sewer Utilities
38900	Straight Truck	Kenworth	T-800	2,013	Water and Sewer Utilities
37121	Straight Truck	International	4000 Series	233	Water and Sewer Utilities
39428	Passenger Van	Dodge	Caravan	979	Library Operations
38944	Passenger Van	Dodge	Grand Caravan	2,690	Health
39296	Cargo Van	Dodge	Ram Promaster	2,283	Health
5159	Cargo Van	Chevrolet	Express 2500	1,093	Health
39615	SUV	Ford	Escape	997	Water and Sewer Utilities

The vehicles in Table 7, while utilized more than the vehicles in Table 6, are still significantly underutilized compared to the average vehicle of that type. A full list of vehicles can be found in Appendix B. If the County determines that all 36 vehicles identified are not necessary for fleet operations, retiring these vehicles from the fleet may help the fleet displace over 8,450 gallons of gasoline and 4,360 gallons of diesel fuel.[22] Reducing that level of fuel consumption can help reduce 115.5 MT of GHG from fleet vehicles. Actual fuel displacement may vary, depending on if other fleet vehicles take on any additional mileage to accommodate the retirement of these vehicles.

As the County fleet manager reviews the vehicles identified by the rightsizing assessment and continues to evaluate the fleet in future years, the following considerations should be involved in assessing whether vehicles are necessary for fleet operations:

- What tasks are accomplished by each vehicle? Are there any tasks this vehicle completes that cannot be completed by another fleet vehicle?
- What is the vehicle's drive cycle?
- What is the daily, weekly, or monthly mileage of each vehicle (i.e., what is the vehicle's duty cycle)? Is it used rarely, regularly, or frequently?
- Is the vehicle beyond its useful, efficient, or cost-effective life?
- Is the vehicle of the optimal type, class, and size for its assigned job?
- What is the vehicle's fuel consumption? Can it be replaced by a newer or lighter vehicle with better fuel economy?
- If the vehicle cannot be eliminated from the fleet, should the vehicle be replaced by a newer model?

[22] Calculated using fleet provided annual mileage and fuel economy data. Actual vehicle retirement decisions will require collaboration between the County fleet manager, the County Chief Administrative Officer, and all impacted departments and divisions.

- To minimize the number of vehicles in the fleet, are there any opportunities to consolidate vehicle uses or purposes (e.g., motor pools, short-term rentals or vehicle sharing between departments, etc.)? Are there any efficiencies that the fleet can gain by combining vehicle jobs or duties? Can one vehicle do the job of two vehicles?
- Would removing this vehicle compromise the fleet's ability to support County government needs or operations?

The County fleet manager should also engage the County departments that will be impacted by the decision to remove a vehicle. For example, the County should confirm with the Social Services Department (SSD) that their vehicles listed in Table 6 are inactive. Similarly, the fleet manager should reach out to the Health Department to determine whether one vehicle could do the work of two low-mileage vehicles. Otherwise, removing these vehicles from the fleet without that confirmation could prevent the SSD and Health Department from completing work. Additional recommendations and considerations for the fleet include:

- Confirm that vehicles with zero annual miles are inactive and that reported mileage is not the result of inaccurate data reporting by drivers or departments. If the fleet finds that annual mileage reports are a result of driver error, the fleet manager should conduct a training on why accurate data collection is important and how to correctly collect vehicle mileage data.
- Check in with the departments that will be impacted by the retirement of these vehicles to ensure department operations will not be adversely affected. This will also give the fleet an opportunity to understand any specialized roles these vehicles may play in County operations.
- The fleet should regularly engage vehicle drivers for input on vehicle use and operation. Engaging with drivers can help provide the fleet manager with detailed vehicle use information that may otherwise be unavailable in routine data collection (e.g., the vehicle is used for services or activities that may be sporadic or rare in nature).
- The fleet manager should plan annual or bi-annual check-ins with drivers or develop a short survey to gather information on underutilized vehicles to keep the fleet from expanding beyond its most efficient and useful makeup.

Alternative Fuels Overview

This fleet transition plan primarily evaluates opportunities for electrification and B20 adoption. In general, all alternative fuels typically offer a variety of benefits for fleets, each offering different levels of:

- GHG emissions reductions.
- Air quality improvements (e.g., carbon monoxide, particulate matter, hydrocarbons, etc.).
- Vehicle performance.
- TCO savings.
- Fuel cost reductions.

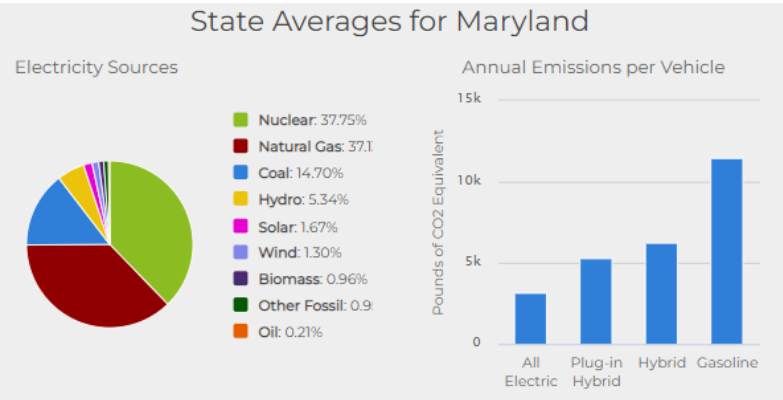
The plan considers the financial, environmental, and operational impacts of each alternative fuel to make appropriate vehicle and fuel adoption recommendations for the County.

Electric Vehicles

EVs present a unique opportunity for individuals and fleets to improve air quality and substantially reduce GHG emissions, fuel costs, maintenance and repair costs, and vehicle TCO. For these reasons, EV market share has grown substantially over the past five years, with EVs making up 4.5% of the United States' market—more than doubling from 2020 to 2021—and 8.57% of the global market.[23]

There are two types of EVs; PHEVs, which are powered by both gasoline and electricity, and all-electric vehicles, which are powered solely by electricity. By running partially or entirely on electricity, EVs have much lower emission levels than ICE vehicles. Emissions savings are realized even when including the emissions produced through utility-side electricity generation. In the United States, EVs can reduce average total vehicle lifecycle emissions by 66% compared to ICE vehicles and PHEVs can reduce average total vehicle lifecycle emissions by 49%. At the state level, Maryland's electricity production emissions are lower than the national average, resulting in greater emissions savings for EVs and PHEVs compared to ICE vehicles, up to 72% and 54% respectively. Figure 5 provides a summary of Maryland's electricity sources and annual emissions savings per vehicle type.[24]

Figure 5. Maryland Annual Vehicle Emissions by Fuel Type[25]



[23] International Energy Agency. 2022. "Electric cars fend off supply challenges to more than double global sales." Retrieved from: https://www.iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales

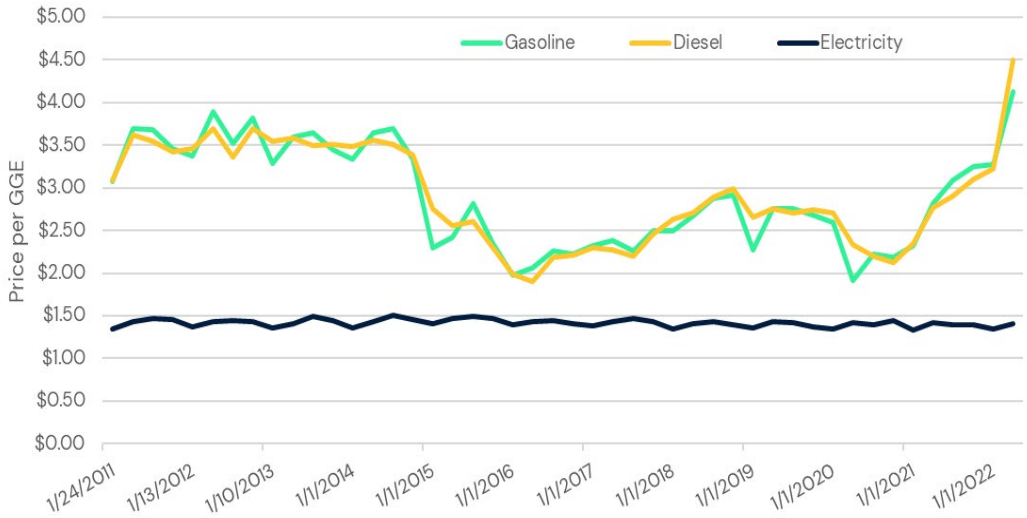
[24] This report differs from the Climate and Energy Action Plan. GHG emissions by vehicle type are determined by state and eGrid region.

[25] Alternative Fuels Data Center (AFDC). 2022. "Emissions from Electric Vehicles." Retrieved from: https://afdc.energy.gov/vehicles/electric_emissions.html

EVs are also often more affordable to own and operate than ICE vehicles. In 2021, the average price of electricity was less than half the price of gasoline, resulting in fuel costs approximately 55% lower per gasoline gallon equivalent (GGE).[26] Similarly, the price of electricity per GGE has remained reliably below the price of gasoline and diesel over the last ten years, making operation costs and fuel savings more predictable. Figure 6 shows historic prices of gasoline, diesel, and electricity in the United States from 2011 to 2022.[27]

GGE is the amount of alternative fuel it takes to equal the energy content of one gallon of gasoline.

Figure 6. Average Fuel Prices in the United States 2011-2022



In addition to lower fuel costs, EVs also offer maintenance and repair savings. EVs have fewer moving parts than ICE vehicles, which means EVs breakdown and need repairs or replacements less frequently. Over the lifespan of a passenger vehicle, EVs can save an average of $4,600 in maintenance and repair costs compared to their ICE vehicle equivalent.[28] Compared to heavy-duty diesel vehicles, these lifetime savings average approximately $120,000 per vehicle.[29] Maintenance and repair savings along with fuel savings are two of the main reasons why EVs typically have a lower TCO than ICE vehicles. However, savings will vary by fleet and vehicle use case. Similarly, fleets new to EVs will need to invest in new charging infrastructure, maintenance technician training, purchase lifts capable of supporting heavy-duty EVs, and integrate new maintenance schedules.

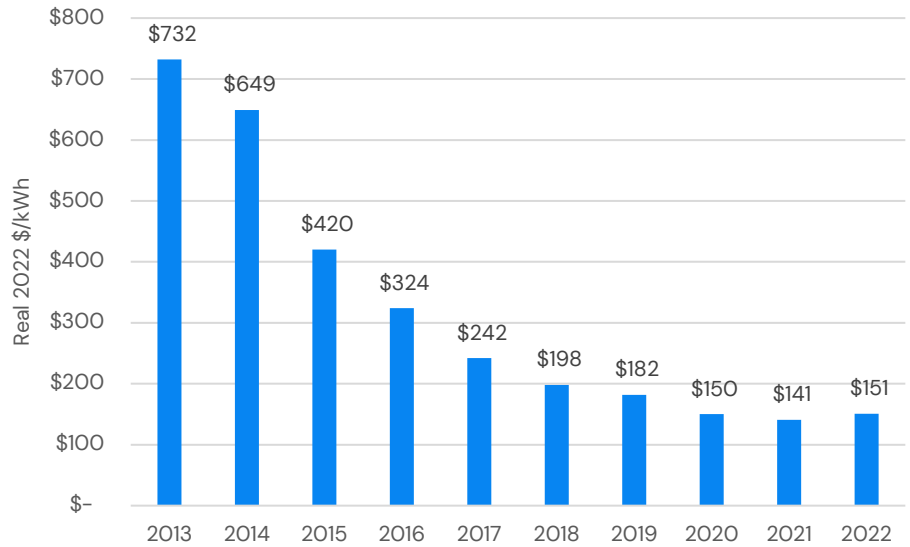
While EVs offer many short- and long-term environmental benefits as well as long-term financial savings, initial purchase price remains a hurdle for many fleets. This is particularly true for fleets with a high number of medium- and heavy-duty (MHD) vehicles, as those EV equivalents can be unattainable without the assistance of financial incentives. However, many fleets are still able to invest in MHD EVs, due to a variety of federal and state financial incentive programs making EVs more affordable for fleets.

EV purchase prices are oftentimes higher than ICE vehicles due to the cost of vehicle battery packs. Battery packs are the largest driver in vehicle purchase prices and market expansion; technological advancements are steadily bringing prices down. As the price of lithium ion (Li-ion) battery packs continues to fall, the price of EVs will decrease. In 2020, battery pack prices averaged $150 per kilowatt

[26] AFDC. 2022. "Fuel Prices." Retrieved from: https://afdc.energy.gov/fuels/prices.html
[27] Ibid.
[28] Consumer Reports. 2020. "EV Ownership Costs: Today's EVs Offer Big Savings for Consumers." Retrieved from: https://advocacy.consumerreports.org/wp-content/uploads/2020/10/EV-Ownership-Cost-Final-Report-1.pdf
[29] ANL. 2020. AFLEET Tool 2020. Retrieved from: https://greet.es.anl.gov/index.php?content=afleet

hour (kWh); in 2021, prices fell to $141 per kWh.[30] In 2022, battery prices increased for the first time in a decade by approximately 7% to $151 per kWh. Battery price forecasts originally suggested that EV prices will become competitive—when battery prices fall below $100 per kWh—in 2024. However, battery prices will likely continue to increase in 2023, due to market pressure outpacing technology improvements, before beginning to decline again in 2024, with EV price parity expected in 2026.[31] Figure 7 shows battery prices since 2013. The County plans to begin adopting EVs on a larger scale in 2024, but the electrification assessment is considering 2021 and 2022 prices when EVs are still, on average, more expensive than ICE vehicles. The County should routinely evaluate EV and ICE purchase prices to fully capitalize on all opportunities for cost savings.

Figure 7. Volume-Weighted Average Battery Pack and Cell Price Split[32]



To achieve both environmental and financial benefits, the County will need to plan, purchase, and introduce these vehicles into the fleet over a series of years and ensure adequate charging infrastructure is available throughout the County. Additional information on charging infrastructure may be found in the Infrastructure Needs Assessment and Considerations section of this report.

Biodiesel

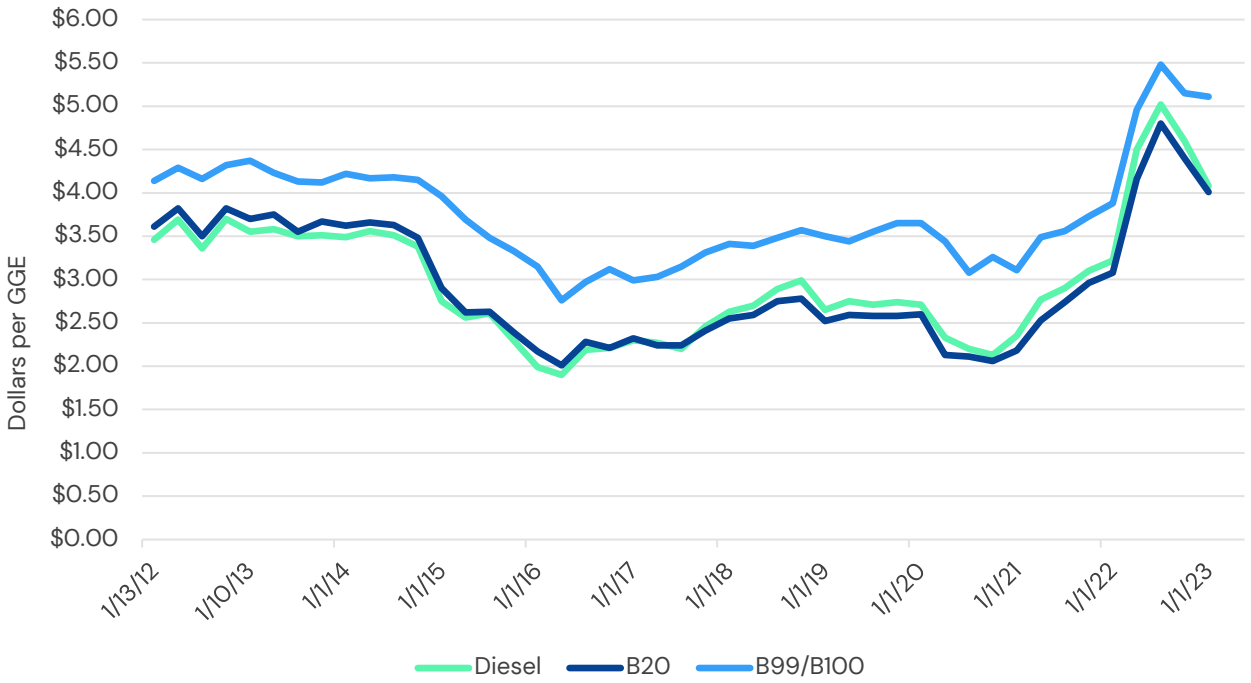
Biodiesel is a readily available, affordable diesel fuel alternative. This fuel can provide short-term reductions in GHG emissions and, at certain blend levels, is easy to integrate into existing fleet vehicles and operations. While EVs offer a viable alternative to many of the County's fleet vehicles, biodiesel offers an immediate solution to diesel-powered vehicles that are not yet cost effective to electrify. Particularly, B20 may be used as a drop-in fuel, meaning no changes to the vehicle engine are necessary for the vehicle to properly operate using this fuel. B20's drop-in nature makes it an excellent choice for individuals and fleets looking to make quick, affordable reductions in their emissions output.

Since 2018, the average price of B20 has been more favorable than diesel. At the national level, in January 2023, B20 was $4.01 per gallon and diesel was $4.08 per gallon. In the Central Atlantic region, these prices

[30] Pricing by kWh is the dollar amount the battery costs in terms of battery capacity, or how much electricity can be stored in a battery pack. The larger the battery pack, the more expensive the battery pack.
[31] BloombergNEF. 2022. "Lithium-ion Battery Pack Prices Rise for First Time to an Average of $151/kWh." Retrieved from: https://about.bnef.com/blog/lithium-ion-battery-pack-prices-rise-for-first-time-to-an-average-of-151-kwh/
[32] Ibid.

were even more favorable, with B20 at $4.26 per gallon and diesel at $4.60 per gallon.[33] However, fuel cost savings are unlikely with biodiesel blends above B20. Biodiesel blends of 99% (B99) and 100% (B100) have had prices that are historically higher than diesel.[34] Figure 8 shows fuel prices over the past 10 years. Fuel prices that the County may secure in a fuel contract will likely differ significantly from the regional prices. Fleet Services receives daily price reports from the Oil Price Information Service. In March 2023, Fleet Services reported biodiesel was $0.01 per gallon more expensive than diesel. A list of several biodiesel fuel suppliers is available in Appendix C.

Figure 8. Average Diesel and Biodiesel Prices in the United States, 2012-2023[35]



In addition to higher costs, incentives for B100 are less common than for other alternative fuels and B100 has more operational issues than lower biodiesel blends or other alternative fuels, including:

- Lower energy per gallon than petroleum diesel and B20.
- Higher cloud point than diesel and lower biodiesel blends, meaning there is a larger chance of the fuel gelling in cooler temperatures. Gelling will result in vehicle and infrastructure operational issues that can be expensive to fix.
- Few diesel manufacturers approve B100 for use in diesel vehicles.
- B100 will likely require special handling, vehicle modifications, and fueling infrastructure modifications.

Transitioning to biodiesel offers GHG emissions reductions of approximately 15% for B20 and 74% for B100.[36,37] Biodiesel blends can also reduce hydrocarbon, carbon monoxide (CO), and particulate matter

[33] At the time the biodiesel assessment was completed, this report relied on October 2022 prices. The January 2023 prices are reported here for reference of continued general price favorability.
[34] AFDC. 2023. "Fuel Prices." Retrieved from: https://afdc.energy.gov/fuels/prices.html
[35] Ibid.
[36] AFDC. 2022. "Biodiesel Vehicle Emissions." Retrieved from: https://afdc.energy.gov/vehicles/diesels_emissions.html
[37] DOE. 2011. "Biodiesel Basics." Retrieved from: https://www.nrel.gov/docs/fy11osti/47504.pdf

emissions, but increase NO_x emissions. Total emissions reductions that biodiesel can achieve depends heavily on the blend level, feedstock, and additives included in the blend. While there are variations across biodiesel blends, fleets can still expect to see emissions benefits from introducing biodiesel. Emissions savings estimates for biodiesel are outlined in Table 8.

Table 8. Average Emissions Reductions for B20 Compared to Diesel[38]

Pollutant	B20 Emissions Savings
CO_2	15%
Hydrocarbons	21%
CO	11%
Particulate Matter	10%

Biodiesel can be created with several different feedstocks manufactured from plant oils and animal fats. The most common feedstocks in the United States are soybean oil, corn oil, white grease, yellow grease, tallow, and canola oil, with soybean oil accounting for 72% of feedstock in 2020.[39] Tallow and grease feedstocks are common in warmer regions or used only in summer months due to their high cloud points. This is because the number of fatty acids in a feedstock influences the cloud point of the final fuel blend, making them more compatible with warmer climates. In the future, to achieve even lower emissions, the County should pursue biodiesel blended with renewable diesel (RD) once RD becomes more readily available beyond California. Additional information and detailed recommendations for B20 adoption are available in the Biodiesel Considerations and Best Practices section of the plan.

Other Alternative Fuels

The County is interested in pursuing EVs and biodiesel, but this study also evaluated compressed natural gas (CNG), hydrogen, E85, and propane fuels for integration into the fleet. Fuel costs, infrastructure availability and costs, financial saving opportunities, and environmental benefits were considered in all fuel evaluations. Hydrogen, propane, and CNG offer environmental benefits, but analysis of existing infrastructure, economic impacts, and total emissions savings indicate these fuels do not provide the County with enough benefits to justify the cost of their implementation. However, the County may consider integrating these fuels into the fleet in the future, should favorable prices, infrastructure expansion, or technological advancements occur. Summary assessments of the aforementioned alternative fuels are below.

E85

Ethanol is a domestically produced alternative fuel. Currently, ethanol is blended into most gasoline at 10%. Once the ethanol blend increases beyond 10% in gasoline (e.g., E15 and above), vehicles must be model year 2001 or newer to safely use ethanol blends. E85 is an ethanol-gasoline blended fuel that contains 51%–83% ethanol, varying by location and season. Any vehicle that is a flex fuel vehicle (FFV) can use E85 as a drop-in fuel, meaning no vehicle replacements or equipment upgrades are required, but the use of lubricants may be required to prevent maintenance issues.[40] Due to its drop-in nature, E85 may become an appropriate short-term alternative fuel option for County-owned FFVs. However, E85 is not currently recommended for the County due to higher fuel prices and lack of fueling infrastructure.

[38] Ibid.
[39] U.S. Energy Information Agency (EIA). 2021. "Monthly Biodiesel Production Report." Retrieved from: https://www.eia.gov/biofuels/biodiesel/production/
[40] Examples of FFVs include Chevrolet Silverado, Ford F150, GMC Sierra, and Ford Explorer.

At the time of this assessment, the price per gallon of E85 was cheaper than gasoline, but the price per GGE of E85 was $0.53 more than gasoline.[41] This is because one gallon of E85 only contains about 73% of the equivalent energy of one gallon of gasoline[42], which impacts fuel economy, the operational cost per mile, and overall emissions savings. If the County can secure a fueling contract with favorable E85 prices, it may be a viable alternative fuel to integrate into the fleet.

There are currently only five public stations that offer E85 within 5 miles of Frederick County, Maryland.[43] If the County were to pursue E85 in the future, additional fueling infrastructure would be necessary. This infrastructure could take the form of additional non-County owned fueling locations that are accessible to County vehicles, the addition of a new fuel tank dedicated to E85, or the repurposing of an existing fuel tank for E85.

E85 can reduce emissions from both CO_2 and harmful toxins created by burning gasoline.[44] Depending on feedstock and blend level, ethanol can achieve over 40% emissions reductions compared to gasoline.[45] However, there is some debate surrounding the exact emissions savings potential. GHG calculations are highly dependent on feedstock and whether fuel production emissions and emission offset credits are taken into consideration.[46,47] If the County is interested in pursuing E85 in the future, the County should pursue ethanol with cellulosic feedstocks for the largest emissions reductions.

Many FFV owners, including fleets, use gasoline due to a lack of awareness that they can use E85 instead. If the County determines they would like to pursue E85, the fleet manager will need to determine which vehicles are FFVs, which can be done by checking the vehicle's VIN, identifying a yellow gas cap or fuel filler ring, locating a fuel label on the vehicle's fuel door, reviewing the owner's manual, or identifying badges on the vehicle's body that say "E85", "FFV", or "Flex-Fuel".[48]

Future Considerations for E85:

- Fuel prices
- E85 fueling locations and infrastructure
- Prioritize cellulosic feedstock, if possible
- Identify FFVs and inform drivers

Compressed Natural Gas

CNG vehicles may be used in light-, medium-, and heavy-duty applications and achieve a similar fuel economy to conventional gasoline vehicles. CNG vehicles are available from original equipment manufacturers (OEMs) and qualified system retrofitters (QSR), who convert gasoline or diesel vehicles to operate on CNG. Historically, the price of CNG has generally been more favorable than gasoline and diesel. At the time of this assessment, the price of CNG was $2.81 per gallon and gasoline was $4.57 per gallon.[49] However, CNG is not recommended at this time due to vehicle costs, minimal emissions reductions, and infrastructure costs and availability.

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[41] AFDC. 2022. "Fuel Prices." Retrieved from: https://afdc.energy.gov/fuels/prices.html
[42] AFDC. Fuel Properties Comparison. Retrieved from: https://afdc.energy.gov/fuels/properties
[43] AFDC. Alternative Fueling Station Locator: https://afdc.energy.gov/stations/#/find/nearest
[44]EPA. 2010. E85 and Flex Fuel Vehicles - Technical Highlights. Retrieved from: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100BOSY.pdf
[45] AFDC. 2022. "Ethanol Benefits and Considerations." Retrieved from: https://afdc.energy.gov/fuels/ethanol_benefits.html
[46] Wang et al. 2012. "Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane, and cellulosic biomass for US use." *Environmental Research Letters*. Retrieved from: https://iopscience.iop.org/article/10.1088/1748-9326/7/4/045905
[47] Emissions calculations can include land use change, displacement of electricity from electricity co-produced at ethanol plants, soil organic carbon changes from farming practices. In some calculations, if biogenic CO_2—carbon offset by sequestration in new feedstocks—ethanol can have higher lifecycle emissions than gasoline.
[48] DOE. "Flex-fuel Vehicles." Retrieved from: https://www.fueleconomy.gov/feg/flextech.shtml
[49] AFDC. 2022. "Fuel Prices." Retrieved from: https://afdc.energy.gov/fuels/prices.html

CNG vehicles have a higher purchase price than their equivalents. The incremental price for CNG vehicles can be $7,000 more for passenger cars, or more than $60,000 for heavy-duty CNG trucks.[50] The payback period primarily depends on vehicle lifespan, average distance traveled, fueling infrastructure costs, fuel prices, and maintenance costs. The potential fuel cost savings of CNG may be enough to offset the higher purchase price of the vehicle, assuming CNG prices remain favorable, and the vehicle is in operation for its entire useful life. Alternatively, conversion prices vary significantly, ranging anywhere from $1,000 to over $30,000. Financial incentives for CNG vehicle purchases may be necessary to guarantee vehicle cost savings at this time.

In addition to higher purchase prices, CNG vehicles offer minimal emission reduction opportunities. Tailpipe emissions are comparable to gasoline and diesel vehicles, even when equipped with emissions control systems. However, light-duty vehicles can achieve up to 15% emission reductions. Actual reductions will depend on both the relative fuel economy, as well as upstream and vehicle methane leakage.[51] Notably, CNG produced via renewable pathways offer larger emissions savings, but there is minimal supply available beyond current demand.

While there is a natural gas distribution system in place in the United States, actual fueling infrastructure is limited. This lack of infrastructure leads many fleets to install their own CNG fueling stations, which can be prohibitively expensive. In Maryland, there are 15 CNG fueling stations, only one of which is in Frederick County. Due to the lack of fueling stations in the County, a fleet transition to CNG would require installing CNG infrastructure and securing a CNG fuel supplier contract. Costs to install CNG fueling stations can range from $10,000 for a small unit, to $1.8 million for a fast-fill station.[52]

Future Considerations for CNG:

- Fueling infrastructure prices and availability
- Vehicle purchase prices and conversion costs
- Financial incentives for vehicles and infrastructure
- Technological advancements in emissions savings

Propane

Propane, or liquefied petroleum gas (LPG), is an alternative fuel produced as a by-product of natural gas processing and crude oil refining. LPG can be used in light-, medium-, and heavy-duty propane vehicles. However, propane is not currently recommended for the County due to vehicle cost, fuel prices and economy, and limited emissions reduction potential.

Propane vehicles can be several thousand dollars more expensive than comparable gasoline vehicles, but heavy-duty propane vehicle purchase prices can be comparable to diesel equivalents (i.e., propane and diesel school buses).[53] Higher purchase prices require lower fuel or maintenance costs to make a return on investment and prevent propane vehicles from having a larger TCO. On a per gallon basis, propane is cheaper than gasoline fuel, at $3.26 and $4.57, respectively.[54] However, propane prices become unfavorable when converted to GGE, increasing to $4.46 per gallon.[55] While propane fuel price per gallon is favorable, it has lower fuel economy, requiring more fuel to drive the same distance.

[50] ANL. 2020. AFLEET Tool 2020. Retrieved from: https://greet.es.anl.gov/index.php?content=afleet
[51] DOE. 2022. "Natural Gas Benefits and Considerations." Retrieved from: https://afdc.energy.gov/fuels/natural_gas_benefits.html
[52] DOE. 2014. "Costs Associated with Compressed Natural Gas Vehicle Fueling Infrastructure." Retrieved from: https://afdc.energy.gov/files/u/publication/cng_infrastructure_costs.pdf
[53] AFDC. 2022. "Propane Benefits and Considerations." Retrieved from: https://afdc.energy.gov/fuels/propane_benefits.html
[54] AFDC. 2022. "Fuel Prices." Retrieved from: https://afdc.energy.gov/fuels/prices.html
[55] Ibid; Propane has a GGE factor of 1.37.

In addition to vehicle and fuel costs, there are only 18 public LPG stations in Maryland, only one of which is located in the County. The lack of fueling infrastructure would require the County to install new fueling stations capable of storing and dispensing LPG. Propane stations can range from $48,000 to $350,000, depending on station size and fleet needs.[56]

Future Considerations for LPG:
- Fueling infrastructure prices and availability
- Vehicle purchase prices and conversion costs
- Financial incentives for vehicles anc infrastructure
- Technological advancements in emissions savings

Finally, propane vehicles typically emit similar levels of tailpipe emissions but less lifecycle GHG than comparable ICE vehicles. Propane vehicles can emit up to 13% less GHG emissions than gasoline equivalents over the course of vehicle lifespans. However, actual lifecycle emissions depend heavily on vehicle size, age, and drive cycle.

Hydrogen

Hydrogen as a transportation fuel is relatively new. It can be produced from fossil fuels, biomass, and water electrolysis. Similar to EVs, hydrogen fuel cell electric vehicles (FCEVs) produce zero tailpipe emissions. However, hydrogen feedstocks and production methods heavily influence total lifecycle emissions. For example, while an FCEV may not produce tailpipe emissions, if the FCEV uses grey hydrogen, or hydrogen produced from natural gas, it will have much higher total lifetime emissions than hydrogen produced from renewable sources. FCEVs can eliminate tailpipe emissions, are more efficient than conventional vehicles, and have similar refueling times and driving range. However, due to limited vehicle availability, high purchase prices, lack of refueling infrastructure, and high infrastructure costs, hydrogen is not recommended for the fleet at this time.

There are few light-duty FCEVs on the market and some heavy-duty hydrogen trucks in development and entering the market. Light-duty vehicle manufacturers currently only offer these vehicles for sale or lease in markets where hydrogen fuel is available, primarily in California.[57] Similarly, FCEVs are currently more expensive than conventional vehicles; the Toyota Mirai is over $20,000 more expensive than many of the manufacturer's equivalent ICE vehicles. To help offset incremental vehicle costs, FCEVs typically have lower maintenance and repair costs. However, savings may be difficult to achieve due to high fuel costs. Hydrogen can cost approximately $15 per GGE and is expected to fall to $8 per GGE in the coming decade.[58]

Another roadblock to adopting hydrogen is the lack of existing hydrogen infrastructure in the United States. There are currently only 54 public stations, none of which are located in Maryland. This would require the County to invest in the entirely new infrastructure that is expensive and not yet widely available. A medium capacity station requires approximately $1.9 million in capital investments. To make this investment feasible, the County would need to secure substantial financial assistance from the federal and state government.[59]

Future Considerations for Hydrogen:
- Infrastructure and vehicle model availability
- Vehicle, fuel, and infrastructure prices
- Financial incentives for vehicles and infrastructure
- Hydrogen inputs and production method

[56] DOE. 2014. "Costs Associated with Propane Vehicle Fueling Infrastructure." Retrieved from: https://afdc.energy.gov/files/u/publication/propane_costs.pdf
[57] DOE. 2022. "Hydrogen Fueling Stations." Retrieved from: https://afdc.energy.gov/fuels/hydrogen_stations.html
[58] MarylandEV. 2022. "Introduction to Hydrogen." Retrieved from: https://marylandev.org/hydrogen-101/
[59] DOE. 2020. "Hydrogen Fueling Stations Cost." Retrieved from: https://www.hydrogen.energy.gov/pdfs/21002-hydrogen-fueling-station-cost.pdf

Alternative Fuel Vehicles: Fleet Assessment and Vehicle Replacement Opportunities

Assessment Overview

ICF's fleet electrification evaluation included the review of the County's 876 on-road light-, medium-, and heavy-duty fleet vehicles. ICF looked at all on-road vehicles eligible for retirement over 12 years—between 2024 and 2036—and evaluated opportunities for electrification, based on EV model availability as announced through the end of October 2022, and B20 adoption.[60] Electrification recommendations are based on comparing ICE vehicle and EV TCOs. Diesel vehicles not recommended for electrification were evaluated for B20 adoption. Similarly, the electrification and B20 assessments compare the emissions output of a business-as-usual scenario and assumes that the County adopts all recommendations.

This assessment provides the County with recommendations for the fleet as it exists at the time of completion. Only one round of vehicle replacements was evaluated for this assessment, and the entire fleet will be replaced by 2036.[61] In future years, it is assumed that EVs and PHEVs will continue to replace electrified vehicles. It is important for the Fleet Services to provide input in the future as the fleet evolves, new vehicle models become available, and technological advancements impact fuel, vehicle, infrastructure, and maintenance costs.

Fleet Electrification

ICF considered existing fleet vehicles and the current market mix of existing and future available EVs models[62] for the County's fleet electrification analysis. As the EV market develops, more models will become available, vehicle purchase prices will decrease, and the County will likely be able to obtain more EVs. Of the 876 on-road vehicles, the following vehicles were not considered for electrification:

Table 9. Vehicle Types Excluded from Electrification Analysis

Vehicle Type	Number of Vehicles Excluded	Reason for Exclusion
Light-Duty Pickups	105	Removed due to concerns about vehicle use case. These vehicles are used for snow removal and in emergency scenarios must have long range and be available for constant use with minimal interruptions. These vehicles were evaluated for B20 instead.
Heavy Straight-Trucks	68	Removed due to concerns about vehicle use case. These vehicles must also be capable of providing constant support in emergency snow removal events. These vehicles were evaluated for B20 instead. Tractor trucks are still considered for electrification.
Police Vehicles[63]	312	Removed due to concerns about vehicle use case, charging domiciled vehicles, and vehicle outfitting for police use. Police sedans account for 74% of fleet sedans, and almost 100% of fleet SUVs.

Similarly, because the assessment begins in 2024, the 234 vehicles that are set to retire and be replaced before 2024 are not included in this assessment.[64] It is assumed that Fleet Services will replace the vehicle

[60] Non-road vehicles were not evaluated in this study at the fleet's request due to concerns related to equipment performance. Low mileage vehicles are included.
[61] One round of replacements means one complete replacement cycle of the existing fleet. Each vehicle is assumed to be replaced once and evaluated for its useful life. Results are aggregated for a wholistic view of one fleet replacement cycle.
[62] The analysis model considers 545 EV models.
[63] While police vehicles are not included in the assessment, vehicles that the County may consider for future adoption include the Chevrolet Bolt, Ford Mustang Mach-E, Zero Motorcycles Zero FXP, or similar vehicles. The TCO of these EVs may already be favorable.
[64] The County has 173 vehicles set to retire in 2022 and 61 in 2023. This includes low mileage vehicles.

with an equivalent ICE vehicle. Between the excluded vehicle types and retirement years between 2022 and 2023, a total of 641 vehicles were excluded from the electrification assessment. Beyond the next replacement cycle, it is assumed that it will be cost-effective to electrify many vehicles not currently up for replacement and, for the vehicles not evaluated for electrification due to use case concerns, it will likely be feasible to electrify more vehicles with complicated use cases.

There are two scenarios evaluated within this TCO assessment:

- Opportunities to adopt EVs using a 5% TCO threshold.
- Opportunities to adopt EVs using a 10% TCO threshold.

The 10% scenario is included to highlight the additional electrification opportunities available to the County, assuming the increased TCO will be bridged by falling vehicle prices and future financial incentive availability. The scenario may be particularly useful for identifying electrification opportunities made possible by the establishment of financial incentive programs through the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA). Many financial incentive programs created by IIJA and IRA are still being clarified and finalized, making the 10% TCO threshold scenario a simpler approach to exploring additional opportunities for electrification. However, the 10% scenario only applies to the 235 vehicles being evaluated for electrification and does not assess light-duty pickups, heavy straight-trucks, police vehicles, or vehicles that are set to retire before 2024, limiting recommendation results.

The electrification assessment incorporates incentive programs, considering those that are available at the time of the assessment, namely EPA Diesel Emissions Reduction Act (DERA) funding, U.S. Department of Transportation (DOT) Low- or No-Emission Vehicle Program funding, and EPA Clean School Bus funding. The assessment also utilizes a combination of fleet provided data and AFLEET assumptions. A list of data inputs and model assumptions used in this analysis are available in Appendix D.

As the fleet changes, new EV models enter the market, and new financial incentive programs become available, the County will need to revisit these recommendations and evaluate new vehicles. The County can utilize Argonne National Laboratory's AFLEET Tool for a simpler approach to future fleet assessments.

Fleet Electrification Assessment Results

Overall, for the 5% TCO scenario, 183 vehicles are eligible for electrification, and 187 vehicles are eligible for electrification in the 10% TCO scenario. These results are based on the County's existing fleet and current and announced EV make and model availability. Table 10 shows the recommended quantities, by vehicle type, to be replaced by EVs over the next 12 years.

Table 10. 12-Year Electrification Recommendations

Vehicle Type	Existing Fleet	Vehicles Evaluated[65]	Quantity Recommended for Electrification (5% Scenario)	Quantity Recommended for Electrification (10% Scenario)	EV Recommendations[66]
Sedan	216	26	19	20	Nissan Leaf | Kia Niro
SUV	152	1	1	1	Kia Niro SUV
Minivan	40	29	22	23	Canoo Lifestyle Vehicle
Medium-Duty Pickup	24	19	19	19	Atlis XT
Van	48	35	31	33	Arrival Van H1 Passenger | ELMS Urban Delivery Van
Medium-Duty Vocational Truck	97	84	61	61	Ford E-Transit Van[67]
Street Sweeper	2	2	1	1	Global M3 Supercharged
Shuttle Bus	32	22	21	21	Ford E-Transit Van | Ford F-650
Transit Bus	23	15	6	6	Lightning eMotors Electric City Bus
School Bus[68]	1	1	1	1	Starcraft E-Quest XL
Heavy Truck	71	1	1	1	Tesla Semi[69]
Other[70]	170	0	0	0	N/A
TOTAL	**876**	**235**	**183**	**187**	

While vehicle data indicates these vehicles should meet County needs based on TCO, range, and vehicle type, Fleet Services will need to confirm EVs meet use case requirements before adopting vehicle recommendations and purchasing new EVs. Not all use cases are identical and EVs may be more appropriate for some County uses than others. For example, within sedan recommendations, the Nissan Leaf may be a viable replacement for some vehicles and not for others. Additional discussions with the vehicle's owning department are warranted.

There is a small difference between the 5% and 10% scenarios. This is primarily the result of vehicle retirement year and the removal of certain vehicle types from the assessment. Examples from the assessment are:

[65] The number of vehicles that meet all assessment parameters. This excludes light-duty pickup trucks, heavy straight-trucks, police vehicles, and vehicles that retire before 2024.

[66] Additional investigation of the listed makes and models may be necessary before purchase. The fleet may find a similar vehicle of different make may be better suited for County needs while still offering similar TCO and emissions savings.

[67] Alternatives to this vehicle make and model include Arrival Van H1 and H2 Cutaway; ELMS Urban Utility; Ford F-350, F-450, or F-550; GMC 3500 or 4500 Cutaway; and others.

[68] This vehicle is set for retirement, but Fire and Rescue Services may not replace the vehicle.

[69] The Tesla Semi may not have a maximum load capacity required to meet Solid Waste's needs. Fleet reports a load capacity of 100,000 pounds is ideal, but the Tesla Semi specifications list a load capacity of 81,000 pounds). Further review may be necessary before adoption occurs.

[70] "Other" vehicle types include, but are not limited to, light-duty pickup trucks, box trucks, bucket trucks, motorcycles, ambulances, fire trucks, trailers, recreational vehicles, etc.

Sedans: The fleet has 216 sedans, of which 159 are police vehicles and only 26 non-police sedans retire after 2024. This limits the evaluation to 26 vehicles. Of those 26 vehicles, a maximum of 20 vehicles, or 77%, are recommended for electrification.

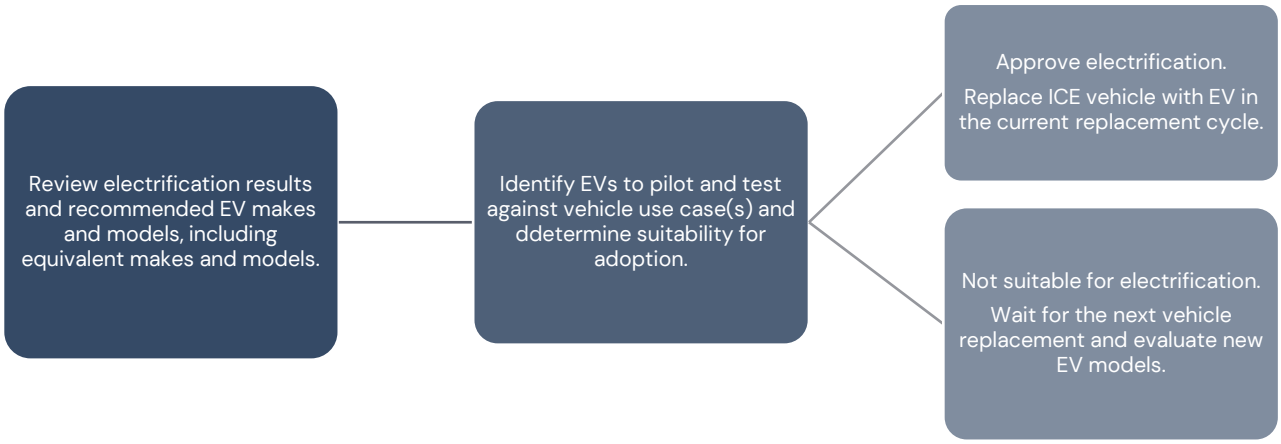
SUVs: Only one SUV is not a police vehicle, limiting the assessment of SUVs to one vehicle. In both the 5% and 10% scenario, the SUV is recommended for electrification.

Minivans: While the fleet has 40 minivans total, only 29 have retirements beyond 2024. Of those 29 minivans, up to 25, or 86%, are recommended for electrification.

If these vehicles had been incorporated into the assessment, it is expected that a much larger number would be recommended for electrification. In the future, if the County revisits electrifying the excluded vehicles, it is likely that prices, costs, and incentive programs will be even more favorable for EVs.

Table 10 also includes example EV makes and models for adoption. However, these vehicles are recommendations, not requirements. Fleet Services should pilot all new vehicles and technology to ensure EVs meet current use cases before adopting at a larger scale.[71] Figure 9 offers a high-level decision tree for determining whether to adopt EV recommendations immediately or in future replacement cycles.

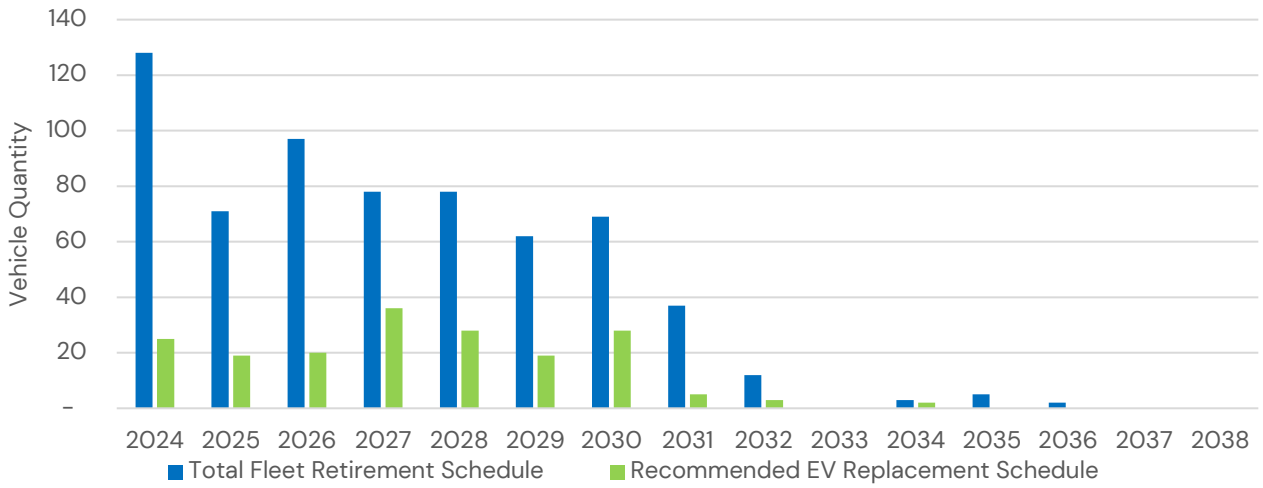
Figure 9. Decision Tree for EV Adoption



The replacement timeline for the vehicles recommended for electrification can be seen in more detail below in Figure 10. Vehicle replacements occur over 15 years due to assumptions identified by ICF and the County's planned vehicle retirement schedule. Most vehicles are scheduled for retirement and replacement within the first five years, but replacements may be delayed depending on vehicle lead times, funding opportunities, and supply chain issues. The 10% scenario adds EV replacements in years 2024, 2026, 2030, and 2031.

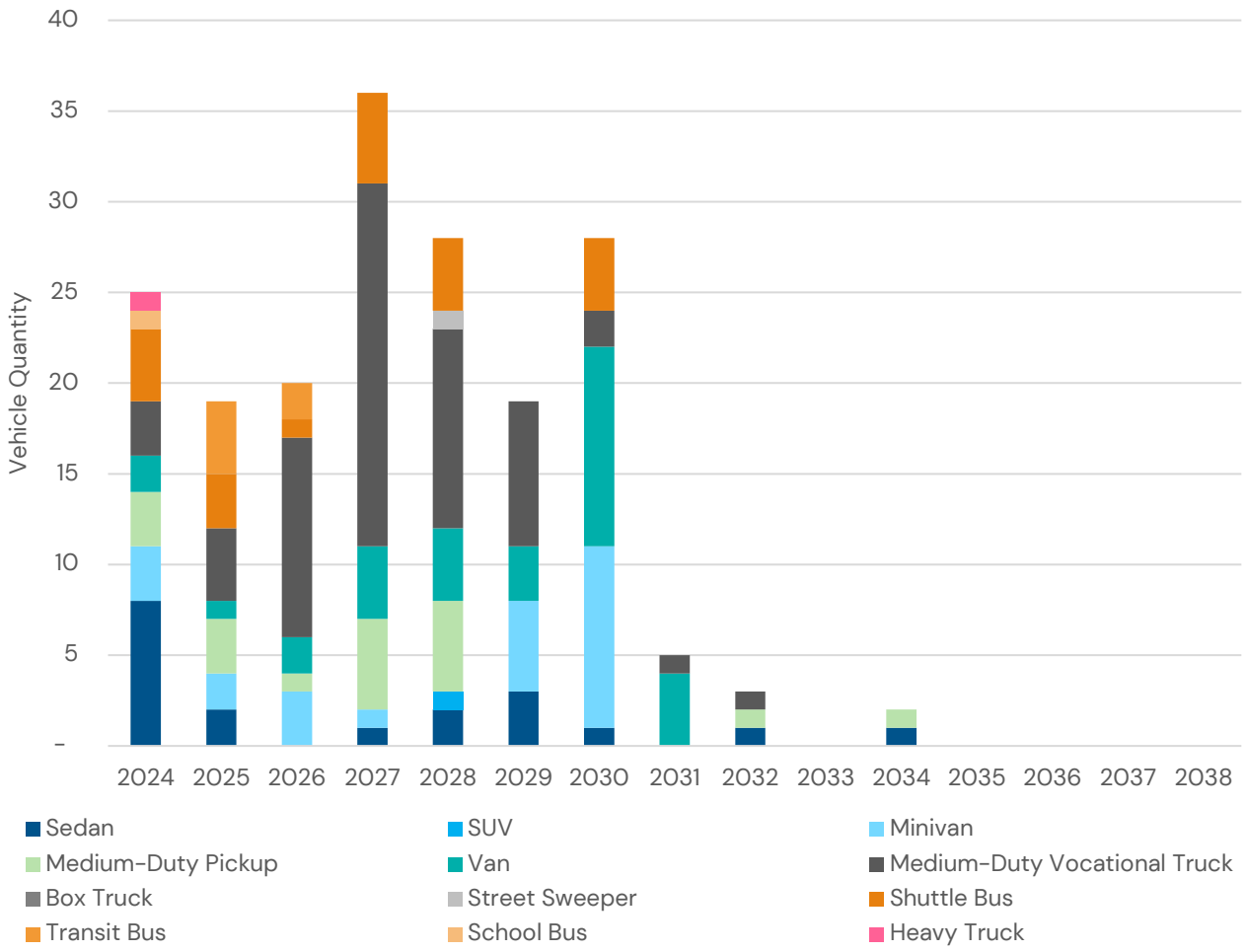
[71] During the fleet assessment process, Fleet reviewed the electrification recommendations and were able to pilot the Ford E-Transit. Fleet found that the Ford E-Transit will not meet medium-duty vocational truck use case requirements. Alternative vehicles that Fleet should explore include Arrival Van H1 and H2 Cutaway; ELMS Urban Utility; Ford F-350, F-450, or F-550; GMC 3500 or 4500 Cutaway; and others.

Figure 10. Fleet Vehicle Retirement and Recommended EV Replacement Schedules (5% Scenario)



A further breakdown of vehicle replacement recommendations can be seen in Figure 11, which outlines the recommended EV replacement timeline by year, quantity, and vehicle type. Actual acquisition timeline may vary based on funding available to purchase EVs with higher prices than ICE vehicle equivalents and supply chain issues that lead to long lead times before purchased vehicles are able to enter the fleet.

Figure 11. Recommended EV Replacement Timeline by Vehicle Type (5% Scenario)



The electrification schedule begins with a mix of vehicle types, mostly consisting of sedans (8), shuttle buses (4), minivans (3), medium-duty pickups (3), and medium-duty vocational trucks (3). In 2025, medium-duty vocational trucks and transit buses make up the two largest replacement groups. From 2026 to 2029, medium-duty vocational trucks are the largest replacement group. In 2030, the largest replacement group shifts to minivans (10) and vans (11). Replacements slow dramatically after 2030, with five or fewer replacements annually from 2031 until 2034, with one sedan and one medium-duty pickup as the final replacements.

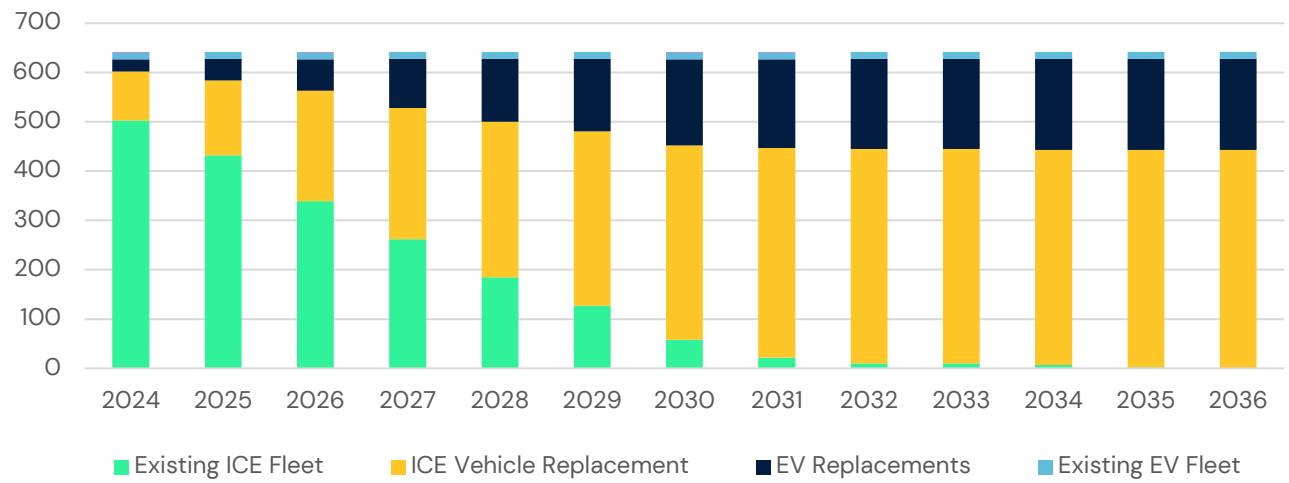
> The 10% scenario follows the same replacement timeline as seen in Figure 8 and Figure 11, but includes an EV replacement for a minivan in 2024, an EV replacement for a van in 2026, an EV replacement for a van in 2030, and a PHEV replacement for a sedan in 2031.

Over 20 medium-duty vocational trucks and nine transit buses are not recommended for electrification at this time. If funding becomes available for these specific types of medium- and heavy-duty vehicles in the future, more vehicles may be recommended for electrification.

When the County begins electrifying vehicles in 2024, there will be a larger number of EVs on the market than at the time of this assessment, potentially shifting electrification and replacement recommendations. Similarly, battery pack prices will have an opportunity to fall and potentially reduce EV purchase prices, offering the County more opportunities for financial savings through electrification. However, electrifying in calendar year 2024 means the County will not begin to realize savings until late 2024 and beyond.

Of the existing fleet vehicles, Figure 10 shows which fuel types could replace the existing fleet from 2024 through 2036. While 42% are optimal for electrification, the remaining vehicles will be replaced by ICE vehicles. A full list of EV replacement recommendations is available in Appendix E. Before purchasing EVs, Fleet Services should test or pilot each vehicle they are interested in adopting. Of the ICE replacements, 116 diesel vehicles will be recommended for B20 use, which is discussed in further detail later in this report.

Figure 12. Recommended EV Replacement Timeline by Fuel Types



This plan helps the County implement CRRR Recommendation 13. The electrification assessment sets the foundation for light-, medium-, and heavy-duty vehicle electrification using TCO as the criteria for adoption. This plan also explores opportunities to electrify heavy-duty vehicles when feasible. Similarly, this plan helps the County plan for near-term EVSE needs to support vehicle electrification.

Transit and Heavy-Duty Fleet Electrification Considerations

Of the fleet vehicles evaluated, Table 11 outlines the transit and shuttle buses and heavy-duty vehicles selected for electrification. Additional details on transit and heavy-duty fleet vehicles recommended for electrification may be found in Appendix E.

Table 11. Electrification Recommendations for Buses and Heavy Trucks

Vehicle Type	Quantity Recommended for Electrification
Transit Bus	6
Shuttle Bus	21
School Bus	1
Heavy Truck	1
TOTAL	**29**

When electrifying these vehicles, the County should keep in mind the following considerations:

- Federal Transit Agency (FTA) spare ratio requirements. TransIT may not acquire new vehicles if it will result in exceeding the maximum number of spare vehicles TransIT may keep in their fleet per FTA guidelines.[72]
- When upgrading electrical capacity to install charging, the County should add conduit and capacity for fleet and public charging as well. This is particularly true for locations that are easily accessible to other fleet vehicles or the public.
- Proprietary charging networks[73] will lock the County into one manufacturer. Proprietary charging is best used along routes and not in fleet yards. Fleet yard charging should be accessible to all vehicle makes and models.
- Utilize fleet EV deployment marketing as a low-cost way to market all the County electrification efforts. This could take the form of detailing or stickers on vehicles regularly seen or used by the public.
- Vehicle range. TransIT's primary concern with EVs is their ability to operate efficiently and without long delays for charging. TransIT should work with Fleet Services to confirm EVs of interest will meet range requirements. As noted above, Fleet Services was able to pilot and road test the Ford E-Transit and determined that specific make and model would not meet range requirements. However, other vehicle makes and models should still be investigated for potential adoption, especially as more models become available.

The FTA spare ratio requirements pose an immediate barrier to electrifying TransIT vehicles. These requirements limit the number of spare buses that can exist in a transit fleet. The number of spare buses in an active fleet operating 50 or more fixed-route vehicles cannot exceed 20% of the number of vehicles operated. Buses delivered for future expansion and buses that have been replaced, but are in the process of being disposed of, are not included in the calculation of spare ratio. Recipients of buses recently procured may temporarily exceed their spare ratio thresholds by up to two years. In addition to active vehicles, FTA recognizes contingency vehicles. FTA will permit agencies to include vehicles that have met

[72] FTA. 2023. Spares Ratio. Retrieved from: https://www.transit.dot.gov/funding/procurement/third-party-procurement/spares-ratio
[73] Non-universal chargers that fuel select EVs or require select memberships.

their minimum useful life in their contingency fleet if an agency is introducing zero emission vehicles (ZEVs) into its fleet.

TransIT's current spare ratio is 24%, exceeding the FTA requirement. FTA has given TransIT permission to maintain a 24% spare ratio, but TransIT may not further exceed that threshold. Before purchasing new EVs, TransIT should examine their spare ratio and determine whether they can stay in compliance with FTA requirements, or if they will need to delay electrification.

> These recommendations help the County implement CRRR Recommendation 12 and 15. This plan contributes to the County completing a plan to transition to electric transit and shuttle buses, increasing electric transit buses from nine (existing electric buses) to 15. Similarly, this plan helps the County plan for near-term facility upgrades to support the recommended transit buses.

Biodiesel

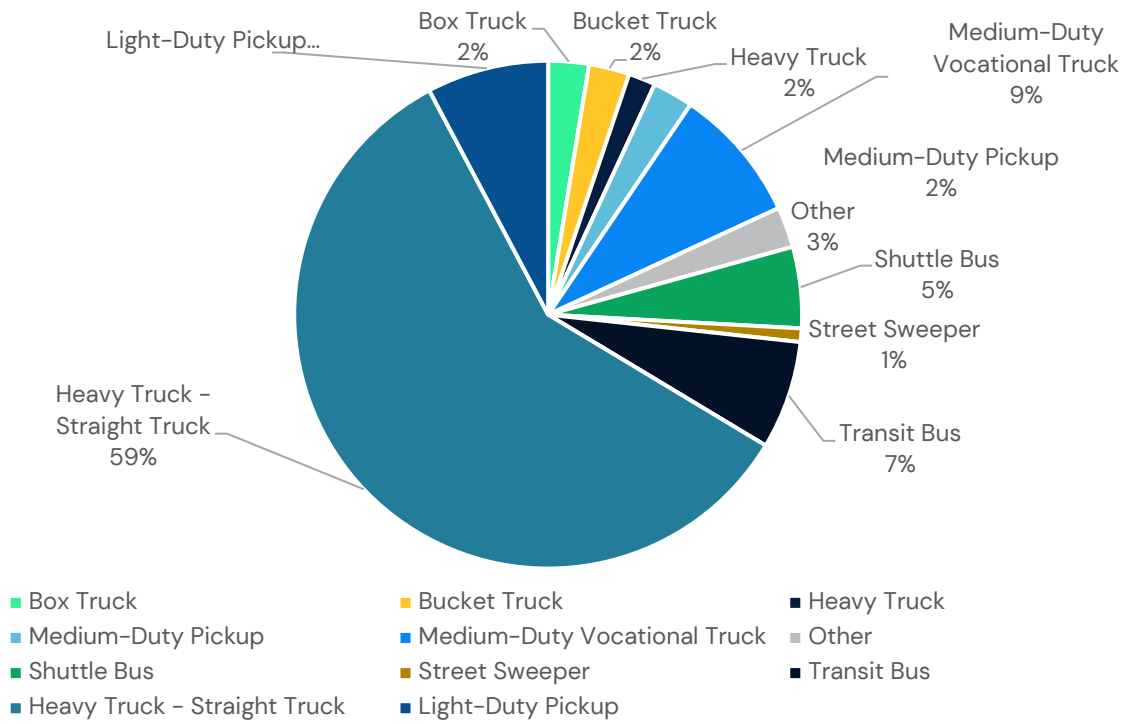
After completing the electrification assessment, diesel vehicles that were not recommended for electrification were evaluated for B20 adoption. Department of Fire and Rescue Services vehicles were excluded from this analysis per the County's request. Of the 876 on-road vehicles assessed, a total of 116 diesel vehicles are recommended for B20 beginning in 2024. Table 12 outlines a summary of the vehicles recommended for B20.

Table 12. B20 Recommendations by Vehicle Type

Vehicle Type	Quantity Recommended for B20
Box Truck	3
Bucket Truck	3
Heavy Truck – Straight Truck	68
Heavy Truck – Truck Tractor	2
Light-Duty Pickup	9
Medium-Duty Pickup	3
Medium-Duty Vocational Truck	10
Shuttle Bus	6
Street Sweeper	1
Transit Bus	8
Other	3
TOTAL	**116**

Most vehicles recommended for B20 adoption are heavy-duty vehicles, specifically heavy trucks. Figure 13 shows a breakdown of the vehicles recommended for B20 by type. Heavy-duty vehicles often have EV equivalents with high purchase prices or there are no EVs on the market yet that meet vehicle drive and duty cycles. As the EV market continues to develop and more heavy-duty EVs and associated charging infrastructure become available and affordable, these recommendations may shift to EVs instead of B20. More details on vehicles recommended for B20 are available in Appendix F.

Figure 13. B20 Recommendations by Vehicle Type



Because B20 is a drop-in fuel, the fleet will be able to implement these recommendations immediately, even for vehicles retiring before 2024. Similarly, diesel vehicles recommended for electrification can transition to B20 prior to their retirement and replacement date.

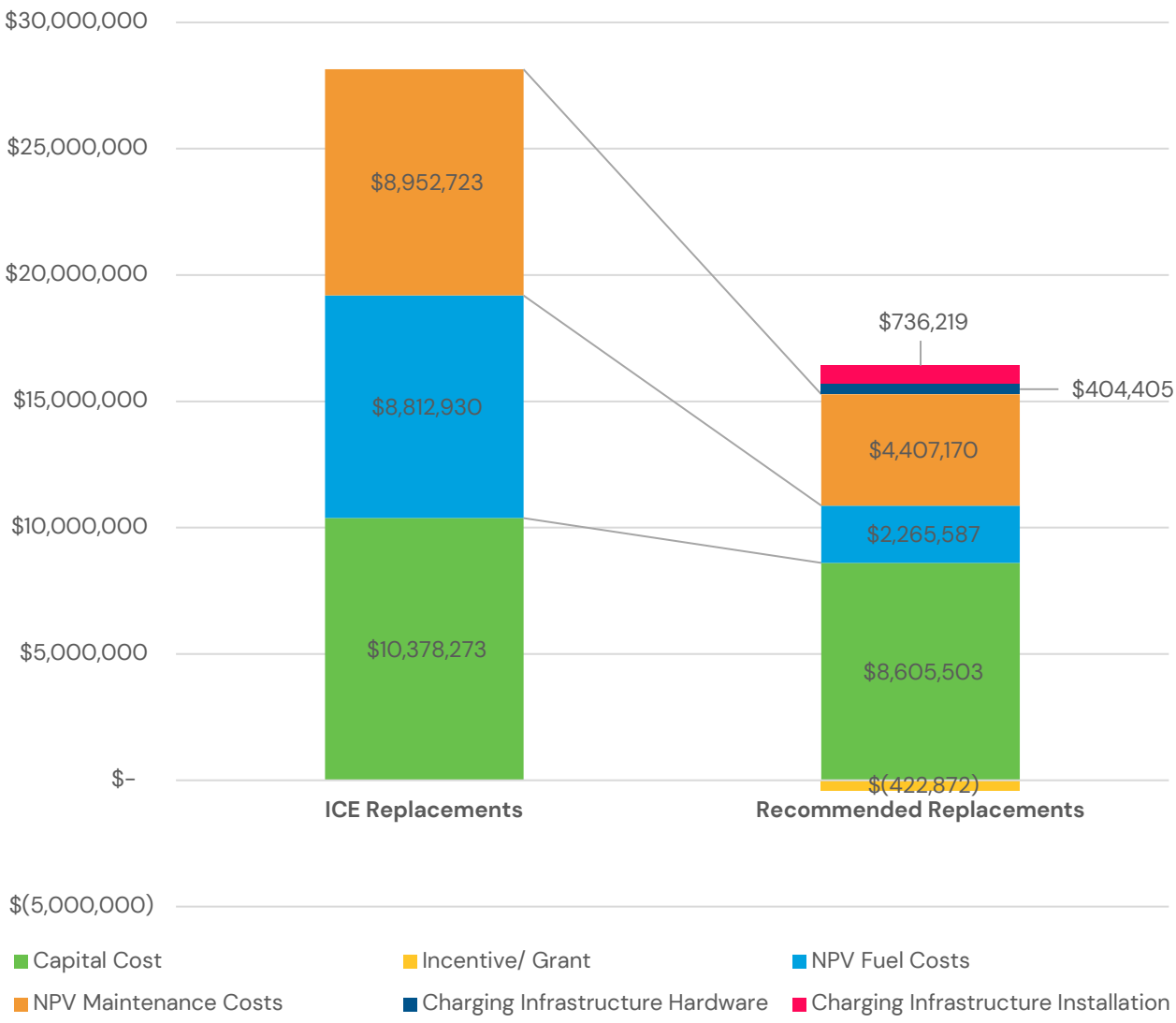
These recommendations help the County implement CRRR Recommendation 16. This plan contributes to the County facilitating the availability and use of alternative fuel in the fleet through B20. In addition to best practices for B20, this report also provides an overview of other alternative fuels for potential future consideration and adoption by the County.

Economic Analysis

Electrification

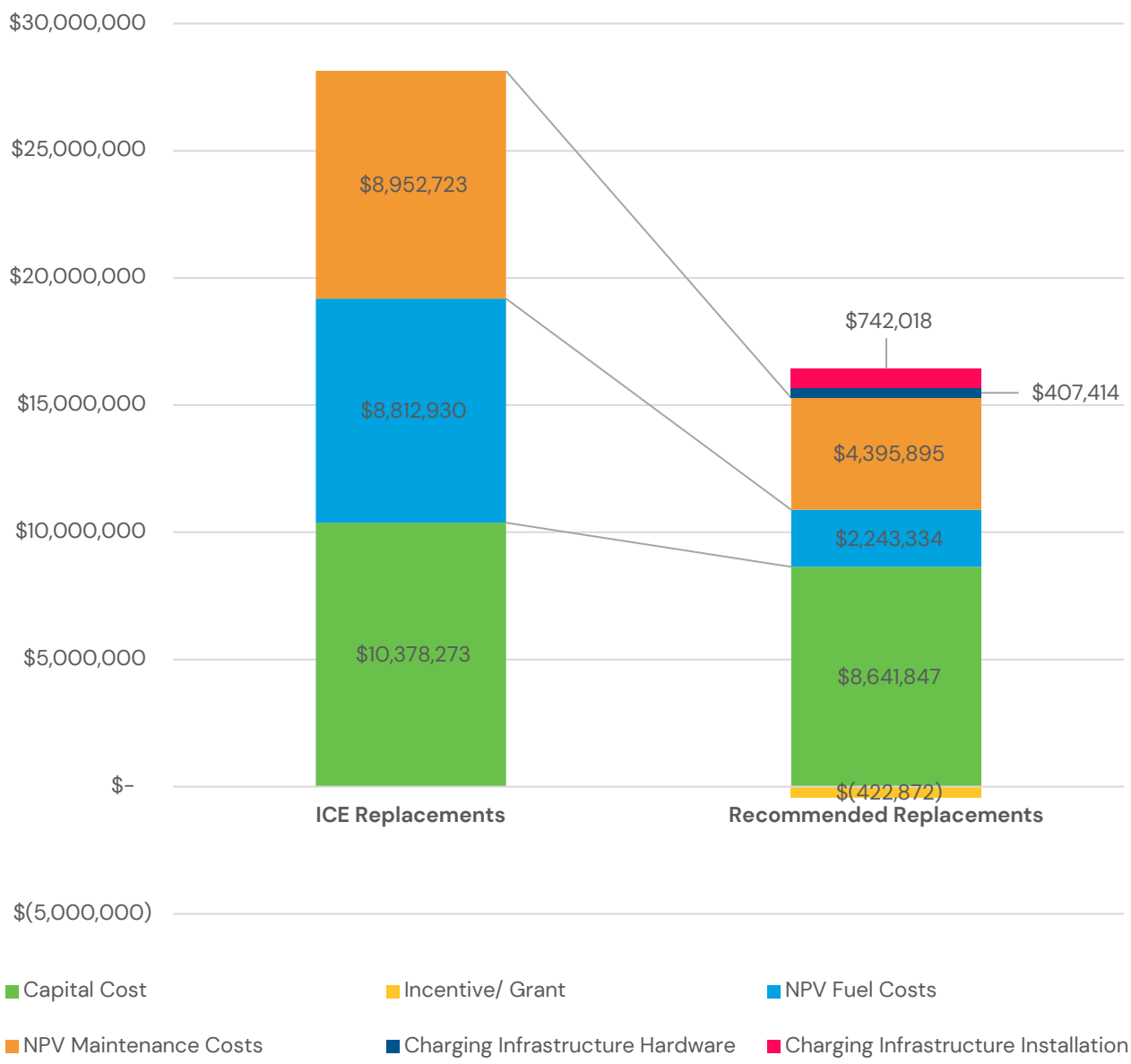
The economic analysis compares two scenarios: business as usual (i.e., continuing to replace the fleet with ICE vehicles) and the recommended EV replacements for both the 5% and 10% TCO scenarios. To calculate the TCO, all predicted costs throughout the lifespans of the vehicles recommended for electrification were evaluated. This includes vehicle purchase prices, operation and maintenance costs, and fuel costs, as well as the cost to purchase, install, and operate EVSE required to support the recommended EVs. Active grant opportunities were also included in this analysis; it assumes the County will receive $422,872 in financial incentives for both the 5% and 10% TCO scenario.[74] The County should continue to monitor the availability of financial incentive programs and apply for all grants or rebates for which eligibility is met. A further discussion of funding opportunities is available in the Funding Options and Opportunities section.

Figure 14. Fleet TCO Comparison – Net Present Value (NPV) Costs Over Vehicle Lifespans (5% Scenario)



[74] EPA DERA funding, DOT Low- or No-Emission Vehicle Program funding, and EPA Clean School Bus funding.

Figure 15. Fleet TCO Comparison - NPV Costs Over Vehicle Lifespans (10% Scenario)



Different vehicle types are responsible for different average electrification TCO savings, with some providing more opportunities financial savings than others. The County fleet consists of mostly light- and medium-duty vehicles, but almost one-third of the fleet is heavy-duty vehicles. While light-duty vehicles are oftentimes easier to acquire and easier to capitalize on opportunities for financial savings, significant TCO savings can be achieved with medium- and heavy-duty vehicles if the primary barrier, purchase price, can be overcome. Through the electrification of sedans, SUVs, and minivans, the County may achieve TCO savings of $308,557. Medium-duty pickups, medium-duty vocational trucks, transit buses, and shuttle buses offer a combined TCO savings of approximately $10,438,367. Heavy trucks, shuttle buses, and medium-duty vocational trucks offer a combined TCO savings of $11.3 million. Table 13 outlines the TCO savings projected for the County by vehicle type.

Table 13. TCO Savings by Vehicle Type

	5% Scenario		10% Scenario	
	Quantity Recommended to Convert to Electric	**Financial Savings**	**Quantity Recommended to Convert to Electric**	**Financial Savings**
Sedan	19	$100,227	20	$98,398
SUV	1	$4,038	1	$4,038
Minivan	22	$204,292	23	$201,326
Medium-Duty Pickup	19	$994,630	19	$994,630
Van	31	$844,246	33	$837,416
Medium-Duty Vocational Truck	61	$3,385,297	61	$3,385,297
Street Sweeper	1	$255,498	1	$255,498
Shuttle Bus	21	$3,252,651	21	$3,252,651
Transit Bus	6	$2,805,789	6	$2,805,789
School Bus	1	$207,588	1	$207,588
Heavy Truck	1	$93,659	1	$93,659
TOTAL	**183**	**$12,147,916**	**187**	**$12,136,290**

As vehicles are replaced through 2036, lifespans and TCO calculations extend out to 2050. The TCO comparisons in Figure 16 and Figure 17 show that TCO savings will begin to be realized after 2024, the breakeven year. After the initial capital costs associated with purchasing EVs to replace existing ICE fleet vehicles, the years following 2024 will all provide operational savings.

Figure 16. Cumulative TCO Comparison from 2024 to 2050

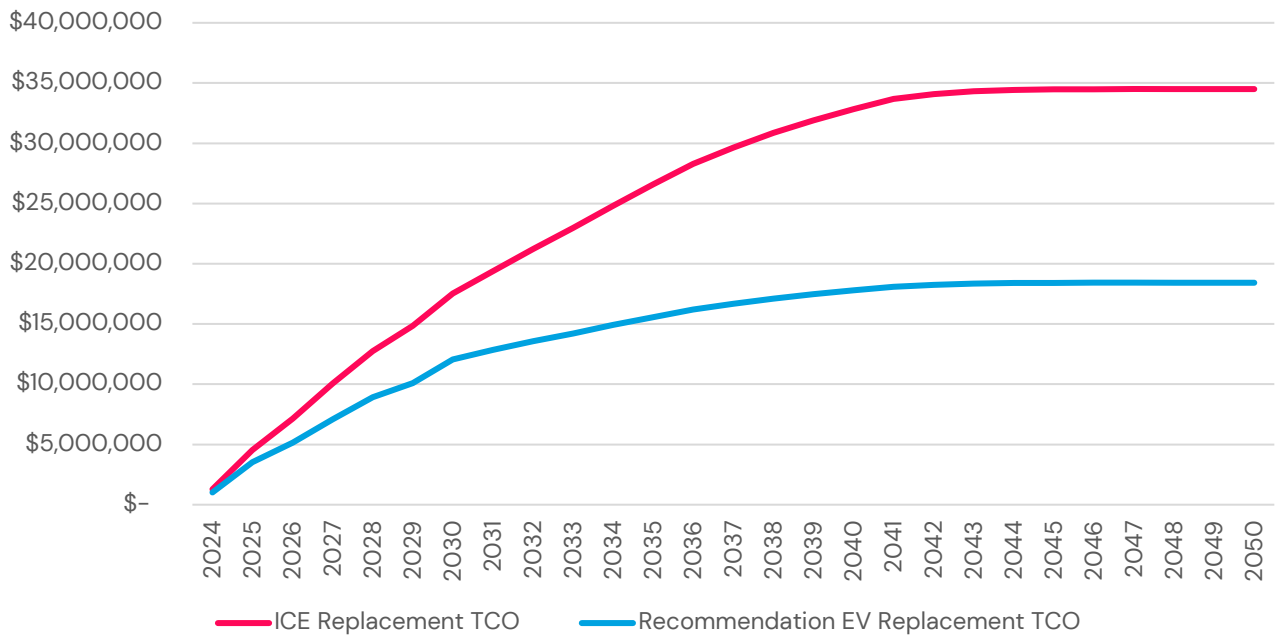
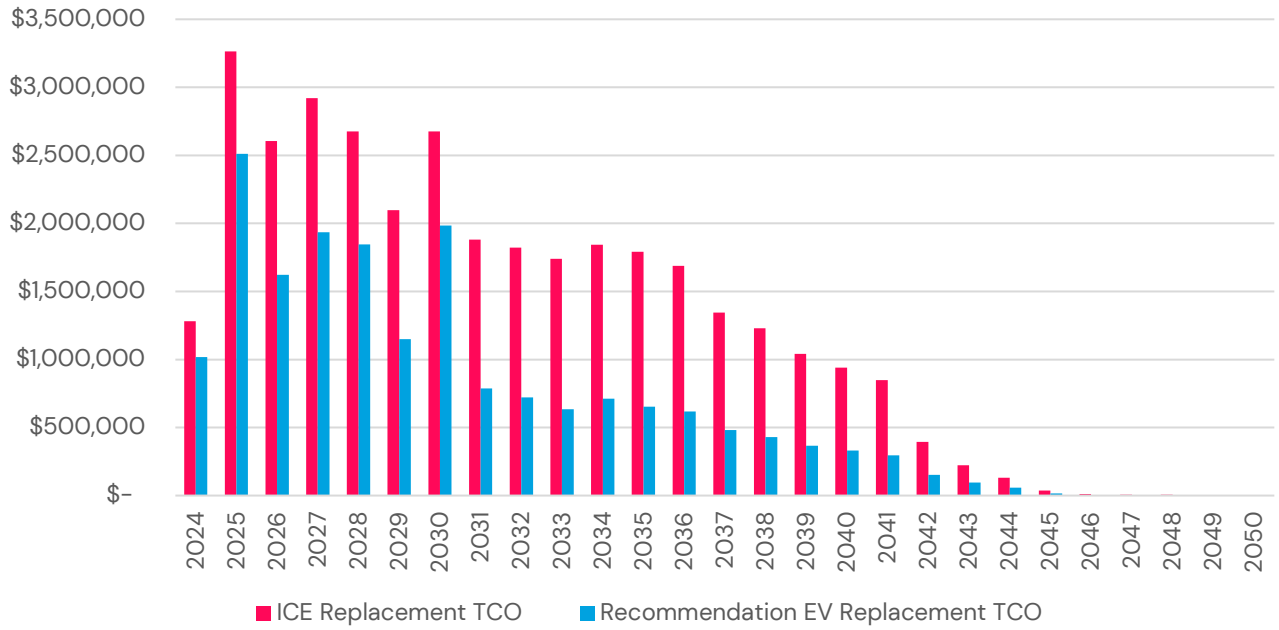


Figure 17. TCO Comparison by Year



If the County pursues and wins financial incentives, including future program offerings at the federal and state level, additional vehicles will also be financially beneficial for electrification. A list of existing financial incentives, as of April 2023, can be found in the Funding Options and Opportunities section below.

What if the County receives no financial incentives?

If the County receives no financial incentives, the TCO assessment still recommends 184 vehicles for electrification at the 5% and 10% TCO thresholds. The only vehicle not recommended for conversion in this case is the school bus. With the loss of financial incentives, the County's total TCO savings drop, but are still significant:

- 5% scenario: $11,820,517 in TCO savings
- 10% scenario: $11,808,992 in TCO savings

Biodiesel

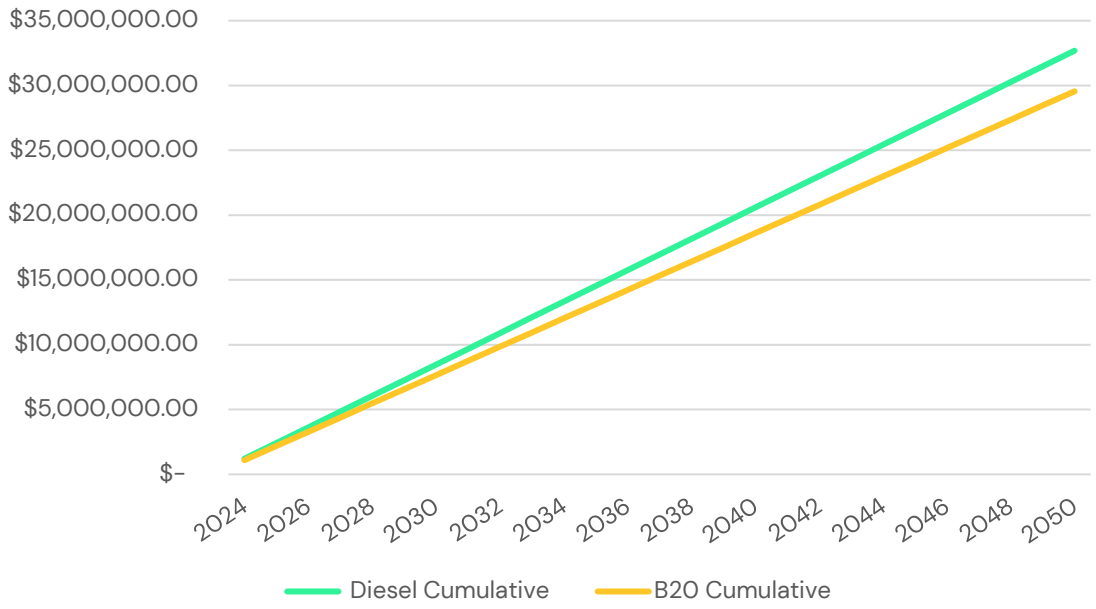
If the County implements B20 in the fleet, they should work to secure a purchase contract with a supplier that offers pricing favorable in comparison to their diesel fuel. Under the County's current diesel contract, a favorable price for B20 would need to be less than $4.27 per gallon. This economic analysis assumes that the County will be able to secure a B20 fuel contract with fuel pricing equal to the average price of B20 in the Central Atlantic region, or $3.86 per gallon.[75] Based on fleet fuel consumption, the first year using B20 in the 116 vehicles recommended for B20 adoption could result in $116,247 savings, which could be used to help bridge the purchase price barrier of EVs.

In fuel costs alone, over the next 5 years the transition to B20 could save $581,236 in fuel costs, and over the next 10 years it could save $1.16 million in fuel costs. Longer-term, assuming a stable fuel price ratio between diesel and biodiesel, between 2024 and 2050 the County could save approximately $3.1 million in

[75] AFDC. 2022. "Alternative Fuel Price Report." Retrieved from: https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_october_2022.pdf

fuel costs. This estimate does not include any costs to evaluate, clean, or otherwise prepare existing diesel infrastructure or purchase new fueling infrastructure.

Figure 18. Cumulative Fleet Fuel Price Comparison Between Diesel and B20



Infrastructure Needs Assessment and Considerations

Electric Vehicle Charging Stations

Overview of Charging Technology

There are three types of EVSE that are typically differentiated by the maximum amount of power that can be delivered to the vehicle's battery. Over 70 EVSE manufacturers are available domestically, although they vary by offering and connectivity.[76] Table 10 below provides a summary of the three types of EVSE: Level 1, Level 2, and DCFC EVSE. Each EVSE has at least one, oftentimes two, charging ports. The number of ports that an EVSE has determines the number of vehicles that can charge simultaneously.

Table 14. EVSE Technology Overview

	Level 1 Alternating Current	Level 2 Alternating Current	DCFC		
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 EV and PHEV charging 208/240 V AC split phase service that is less than or equal to 80 A.	Used specifically for battery EV 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	Combined Charging System (CCS)[77]	CHAdeMO	Tesla combo
Use	Residential or workplace charging	Residential, workplace, or public charging	Rapid charging for transportation depots, vehicle fleets, public transportation corridors		
Limitations	Low power delivery lengthens charging time	Requires additional infrastructure and wiring	Can only be used by EVs currently. Higher upfront and operational costs		
Time to charge	2 to 5-mi range/1-hr charging Depending on the vehicle battery size, PHEVs can be fully charged in 2-7 hours and EVs in 14-20+ hours	10 to 25-miles range/1-hr charging Depending on the vehicle battery size, PHEVs can be fully charged in 1-3 hours and EVs in 4-8 hours	50 to 70-mi range/20-min charging Depending on the vehicle battery size, EVs can be fully charged in 30-60 minutes.		

EV charging can occur at a variety of locations—anywhere where there is electrical infrastructure available that can support EVSE. The use of EVSE and charging demand is based on driver needs. For publicly accessible Level 2 charging, which currently accounts for most local government funded deployments, typical charging times range from 1-2 hours during the daytime. DCFC EVSE requires significantly less charging time and are usually sited along interstate highways or in depots for fleet use. Most public stations have both CHAdeMO and CCS standard ports available to charge any vehicle. As more EVs and EVSE are deployed, interoperability has become increasingly important to ensure all EVs can access all

[76] Go Electric Drive. 2022. "EVSE Products, Charging Network, and Service Providers." Retrieved from: https://www.goelectricdrive.org/charging-ev/charging-equipment-showroom

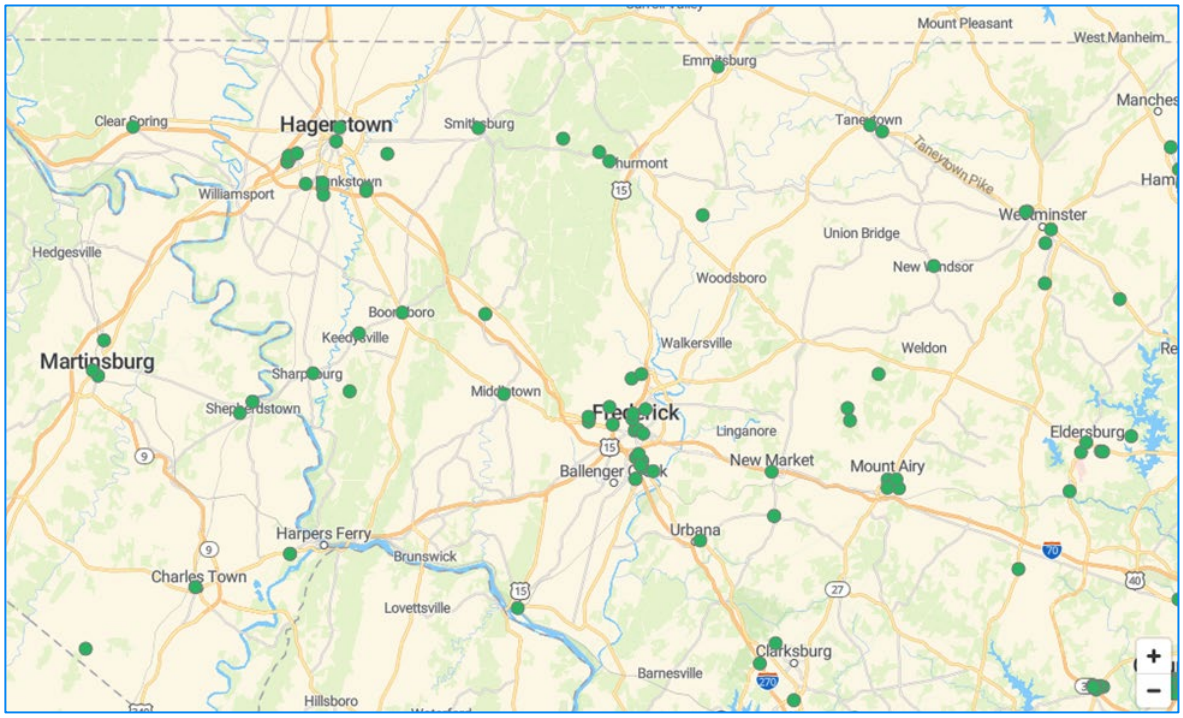
[77] Previously known as J1772 combo.

EVSE. While slower than its Level 2 and DCFC counterparts, Level 1 EVSE may be a good option for some workplaces and fleets. Level 1 EVSE are easy and cost-efficient to install, but EVs need to be parked for several hours to get a significant charge. Level 1 EVSE is typically best suited for employee-owned vehicles that remain in the same parking spot during an eight-hour shift or fleet vehicles that are parked overnight, only used for short periods of time once per day or have low weekly mileage and can charge over the weekend.

Existing Infrastructure

Data from the AFDC was used to identify, analyze, and map EV charging stations currently available across the region. There are 106 public EV charging stations located in Frederick County; 72 Level 2 and 34 DCFC, pictured in Figure 19.[78] Many of these ports belong to specific networks and may not be accessible to all drivers, including County fleet drivers.

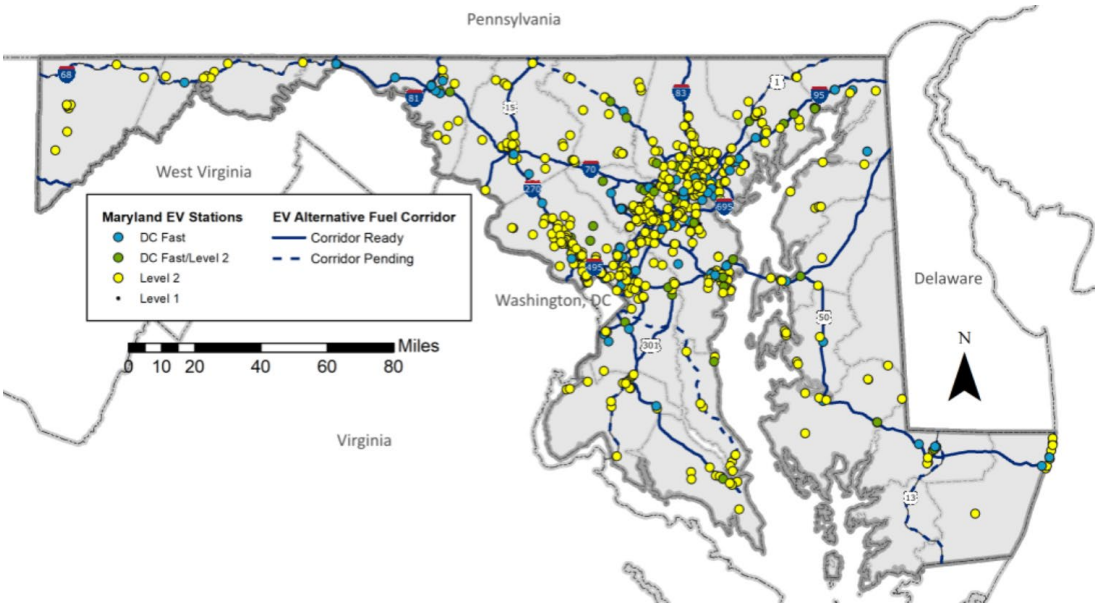
Figure 19. Existing EVSE in the County[79]



Maryland is in the process of building a robust network of alternative fuel corridors (AFCs) along highways. This EVSE deployment initiative will help provide the County with DCFC EVSE that fleet vehicles can use if they are unable to charge at their designated charging location or if they need to recharge while traveling along highways. AFCs that run through the County include I-70, I-270, and US-15, shown in Figure 20. While these EVSE may not be the primary charging source for fleet EVs, they can help the County meet short-term charging needs and serve as additional charging support in the future.

[78] The 2023 Frederick County Community-wide EV Readiness Plan further details existing public, community EVSE locations.
[79] AFDC. 2022. "Station Locator." Retrieved from: https://afdc.energy.gov/stations/

Figure 20. Electric AFCs and EVSE in Maryland



Similarly, it is important to note that The DOT Federal Highway Administration (FHWA) National Electric Vehicle Infrastructure (NEVI) Formula Grant Program will provide funding to strategically deploy EVSE. The charging stations must be located along designated FHWA AFC and include at least four 150 kilowatt (kW) DCFC EVSE with Combined Charging System ports capable of simultaneously DC charging four EVs. NEVI funding will not only spur development of DCFC along AFCs, but future NEVI funding will also provide grants to local governments for EVSE deployment in communities through the Discretionary Grant Program for Charging and Fueling Infrastructure. The County should continue to monitor funding announcements through NEVI and other federal- and state-level programs. A list of existing funding opportunities is available later in this plan.

On a more granular scale, the County already has three active EVSE: installations on government property, totaling 10 SemaConnect Level 2 ports. Table 15 provides an overview of existing EVSE infrastructure available to the fleet. These stations will serve as the foundation for the County's short-term electrification needs as the fleet begins electrifying in future years.

Table 15. Existing County-Owned EVSE

Location	Address	EVSE Level	Number of Ports
Winchester Hall	12 Church Street	Level 2	1
Frederick County TransIT	1040 Rocky Springs Road	DCFC	10
Frederick County Courthouse	100 W Patrick Street	Level 2	2
Frederick County Parks and Recreation	355 Montevue Lane #100	Level 2	6

Infrastructure Required for Recommendations

For the TCO analysis, it was assumed that the County will use two EVs per EVSE port for both Level 2 and DCFC. While these assumptions will help the County meet charging needs in the short-term, EV to EVSE ratio will likely adjust in the future to reflect improved technology and changing fleet demands. Table 12 summarizes the EVSE included in the electrification TCO assessment. The EVSE outlined in Table 13 represent the total number of EVSE needed after all electrification recommendations are adopted in 2036,

assuming approximately 4 EVs per EVSE. These EVSE do not need to be purchased all at once and can be purchased and installed in a staggered manner based on Figure 11.

Table 16. EVSE Needs by Vehicle Type (Based on 10% Scenario)

	Quantity Recommended to Convert to Electric	Level 2	DCFC
Sedan	20	5	0
SUV	1	1	0
Minivan	23	6	0
Medium-Duty Pickup	19	4	1
Van	33	7	1
Medium-Duty Vocational Truck	61	7	2
Street Sweeper	1	0	1
Shuttle Bus	21	2	3
Transit Bus	6	0	2
School Bus	1	0	1
Heavy Truck	1	0	1
TOTAL	**187**	**32**	**12**

For short-term charging needs, the County should rely on existing County-owned EVSE and public chargers available near vehicle routes and parking locations. However, since the County does not plan to integrate EVSE into the fleet until 2024, the County should examine the departments with the highest number of EVSE recommendations and begin a thorough EVSE siting analysis for efficient and effective deployment. The departments with the most EV recommendations include:

- Highway Operations (31)
- Scott Key Center (26)
- TransIT (23)
- Water and Sewer Utilities (18
- Parks and Recreation (16)

While these departments have the highest number of EV recommendations, vehicles may not all be parked at the same location. Vehicle parking locations were not collected for this assessment, but in the future the County should collect vehicle parking data to identify optimal locations for EVSE installation. A full list of EV recommendations and their assigned departments is in Appendix E.

Similarly, as noted in the Transit and Heavy-Duty Fleet Electrification Considerations section, TransIT may not be able to electrify their vehicles according to the provided retirement schedule. While this barrier may prevent the County from realizing the benefits of electrifying these vehicles in the short term, it will give the County more time to plan for EVSE necessary to support TransIT buses. Charging stations to support battery electric buses on-route, during use need to be high-powered, or over 300 kW DCFC, to provide the charging speed necessary to keep the service operational and efficient.

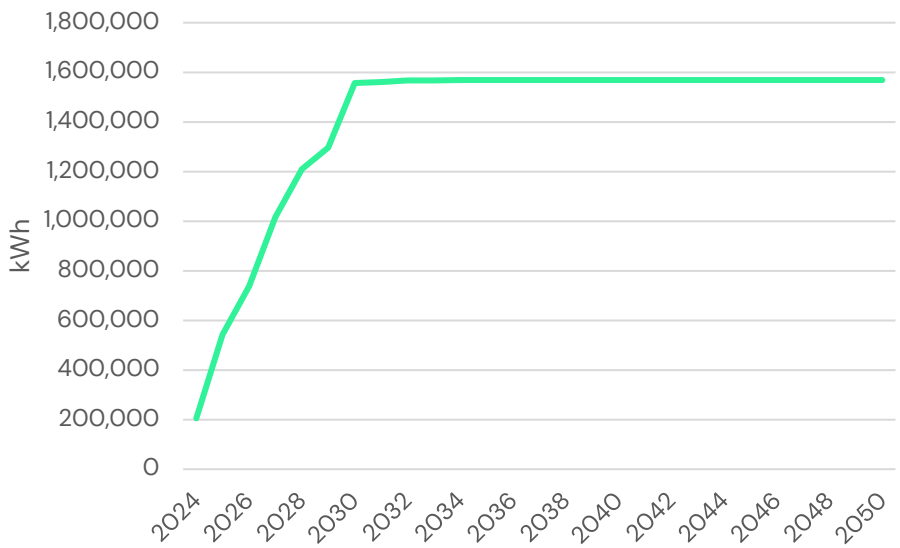
As the County builds out EVSE to support fleet EVs, the County should consider the following recommendations:

- The County should focus EVSE deployments at the locations that are recommended to have the most EVs deployed to guarantee those departments can support EV acquisitions.

- The County should reach out to department points of contact to jointly discuss and identify the best locations for EVSE deployment to meet each department's electrification needs.
- The County should consider deploying EVSE at the County Fleet Services' repair facilities so vehicles can be charged while being maintained.
- The County should consider establishing an EVSE planning lead position to serve as the primary point of contact and coordinator for local officials, Fleet Services and other County departments, drivers, and employees impacted by electrification. Having a single point of contact will help guarantee uniform communication about electrification efforts across the County and create a designated space for all EVSE-related questions and issues.
- The County should work with an electrician, Department of Facilities, Division of Public Works, and Potomac Edison to determine whether existing infrastructure can support the construction and operation of EVSE at each location recommended for electrification or whether upgrades or additional construction are needed. This will help the County ensure EVSE deployments are as cost-effective as possible.
- The County should streamline permitting and construction processes for EVSE to maximize the efficiency of EVSE deployments.

To inform the EVSE siting analysis, electrification recommendations will require a total of 1,591,683 kWh annually. A summary of energy demand is outlined in Figure 21 and provided in more detail in Appendix E.

Figure 21. Annual Electricity Demand (kWh)



EVSE Cost Considerations

The cost estimate used in the fleet electrification TCO analysis was a medium-cost scenario. This was done to average out higher and lower cost installations that will take place throughout the County and represents the average cost to install EVSE across the County. This is important to note because while the Transition Plan's assessment considers the average cost, the actual cost of each EVSE installation will likely vary, sometimes by large amounts. The total cost of charging infrastructure costs depends on several factors including equipment, installation, networking, and maintenance.

Equipment costs will vary based on factors such as application (transit versus general fleet), location (fleet yard versus shopping center), charging level (Level 2 versus DCFC), and type. Equipment features to

consider include networking capabilities, theft deterrence, output power rating (in kW), number and type of connectors, number of vehicles that can simultaneously charge, and operation and maintenance options (e.g., payment, data collection capabilities, and maintenance packages). Connectors are one of several aspects of EVSE deployment that can heavily influence costs—single connector unit costs range from $400 to $6,500 for Level 2, and $10,000 to $40,000 for DCFC, making careful consideration of all equipment options crucial to make the most cost-efficient and -effective choice.

Installation costs may vary based on the number and type of EVSE installed at each location, geographic location of the installation, trenching requirements, existing wiring and required electrical upgrades to accommodate existing and future needs, labor costs, and permitting. These factors can help be determined by local utility. Like equipment costs, installation costs can range significantly, too; from $600 to $12,700 for Level 2, and $4,000 to $51,000 for DCFC.[80] Although Level 2 equipment is less expensive to purchase, DCFC may reduce overall land use and installation labor costs as fewer units are required for fleet operations.

Networking capabilities will increase the cost of the EVSE. However, choosing a networked EVSE system will allow the County to collect and send data (e.g., frequency of use, total charge time, kWh consumed, etc.) to the fleet manager which will help calculate vehicle operation and maintenance costs. Additionally, networking allows fleets to engage in smart charging or scheduling charging events to stagger vehicle charging and take advantage of lower off-peak electricity rates.[81] It is important to note that there is currently no comprehensive EVSE cybersecurity approach in the industry.[82] However, the County should consider integrating network segmentation, intrusion detection systems, two-factor authentication, anomaly tracking, network encryption, or firewalls.

To futureproof EVSE, the County should adopt EVSE with open access capabilities. Open access physically separates the appliance aspects of the charging infrastructure from the network backend component, allowing EVSE site hosts to switch charging networks without expensive equipment upgrades.

The maintenance costs of EVSE can influence the TCO of the equipment over its lifetime. EVSE maintenance includes both electrical and non-electrical elements. General EVSE maintenance includes storing charging cables, checking parts on a regular basis, keeping the equipment clean, electrical panel repairs, and parts replacements. Typically, routine maintenance is not very costly, but expenses can increase as the equipment ages or is no longer under warranty. Before the County deploys EVSE, the County should establish which entity will have primary responsibility over the maintenance of the EVSE—site host, charging network, the fleet, or the installer. When designing a maintenance contract, the County should include uptime requirements (the percentage of time the EVSE is fully functional), response time, length of acceptable time for each type of repair, and technician training requirements. If the County selects a network with a maintenance plan, most networks offer one for an additional fee, typically up to $400 per EVSE.[83]

To help reduce EVSE costs, the County should consider setting fees for public use of the EVSE. A charging fee allows EVSE site hosts and owners to charge users an additional price, on top of the cost of electricity used to charge an EV. Fees can be collected via credit card, phone, radio-frequency identification (RFID) card, mobile phone applications, or in-person through a parking attendant or in a nearby building or

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[80] AFDC. 2022. "Charging Infrastructure Procurement and Development". Retrieved from: https://afdc.energy.gov/fuels/electricity_infrastructure_development.html
[81] AFDC. 2022. "Electric Vehicles for Fleets". Retrieved from: https://afdc.energy.gov/vehicles/electric_fleets.html
[82] Sandia National Laboratories. 2022. "Cybersecurity for EV Charging Infrastructure." Retrieved from: https://www.osti.gov/servlets/purl/1877784
[83] AFDC. 2022. "Charging Infrastructure Operation and Maintenance." Retrieved from: https://afdc.energy.gov/fuels/electricity_infrastructure_maintenance_and_operation

establishment. If the County decides to set a fee for EVSE use, there are a few pricing structures to choose from: by kWh (the amount of energy used to charge), total charging time (the amount of time it takes to charge the vehicle, usually by minute or hour), session, or subscription. The Federal Energy Management Program (FEMP) has a workplace charging program guide[84] and fee calculator[85] that the County can utilize in setting prices and fees at charging stations for employee and public use.[86]

Solar EV Charging Station Arrays

Pairing solar canopies with EV charging can maximize land use for space-constrained locations and provide shade and weather protection for vehicles and equipment. However, total system costs may be higher compared to ground-mount or roof-mounted photovoltaic (PV) systems due to higher construction costs associated with the mounting apparatus for the solar panels.[87] A 2016 study by the Clean Energy States Alliance (CESA) estimated the cost of racking systems for solar canopies to be two to four times more expensive than those used for rooftop PV.[88] Overall project costs will impacted by numerous factors, including utility rates, project financing structures, and available incentive programs.

The Maryland Energy Administration (MEA) provides funding for solar canopy installations through the Solar Canopy and Dual Use Technology Grant Program, which supports the installation of solar systems that provide multiple uses for land and water. While solar canopies over parking lots and waterborne solar installations are specifically included, applicants can propose other dual use opportunities for consideration.[89]

Off-Grid Charging

Off-grid charging is a developing area within the EV charging space. Generally, most EV charging stations are tied to the grid to ensure a plentiful and consistent power supply. There are some companies that are developing portable solar charging stations with batteries that can be moved to different parking locations based on demand. The goal behind portable, off-grid charging is to be able to provide more flexibility in charging infrastructure rather than, or in addition to, developing stationary stations that require detailed siting plans and high construction costs. However, this technology is still developing and may not offer the County fleet the support necessary to successfully operate a transitioning fleet without many existing grid-connected EVSE. Primary concerns related to off-grid solar charging include:

- Loss of solar power collected during periods when vehicle and charging station batteries are full.
- Inability to accommodate fluctuations in demand.
- Loss of potential power availability and functionality during winter months due to low sun exposure.

There are some instances where off-grid charging may be a better option for the fleet:

- If the cost to develop a grid-connected Level 2 EVSE is prohibitively high, an off-grid charger may be able to provide power at a lower cost.

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[84] DOE. 2020. "Federal Workplace Charing Program Guide." Retrieved from: https://www.energy.gov/sites/default/files/2020/11/f80/federal-workplace-charging-guide.pdf
[85] DOE. 2020. "FEMP Workplace Charging Fee Calculator." Retrieved from: https://www.energy.gov/sites/default/files/2020/11/f80/femp-workplace-charging-fee-calculator.xlsx
[86] AFDC. 2022. "Charging Infrastructure Operation and Maintenance." Retrieved from: https://afdc.energy.gov/fuels/electricity_infrastructure_maintenance_and_operation
[87] NREL. 2021. "Maximizing Solar and Transportation Synergies." Retrieved from: https://www.nrel.gov/docs/fy21osti/80779.pdf.
[88] Clean Energy States Alliance (CESA). 2016. "Vermont Solar Cost Study: A Report on Photovoltaic System Cost and Performance Differences Based on Design and Siting Factors." Retrieved from: https://www.cesa.org/wp-content/uploads/Vermont-Solar-Cost-Study.pdf.
[89] Maryland Energy Administration. "FY23 Solar Canopy and Dual Use Technology Grant Program." Retrieved from: https://energy.maryland.gov/business/Pages/incentives/PVEVprogram.aspx.

- Locations that have smaller, predictable charging demand and are for fleet-use only.

Before purchasing an off-grid EV charging station, the County should complete a detailed siting assessment to understand fleet charging needs and costs. From there, the decision can be made whether to pursue alternatives.

Biodiesel

Existing Infrastructure and Infrastructure Considerations for B20 Recommendations

At this time, there are no public biodiesel stations located in the County that are registered in the Alternative Fuels Data Center Alternative Fueling Station Locator nor are there any County-owned biodiesel stations. However, the County has several diesel fueling locations, seen in Table 17, that may be compatible with biodiesel. Most diesel storage tanks are above ground, except for Fleet Services, which utilizes underground storage tanks.

Table 17. County Fleet Fueling Locations

Facility	Address	Tank Quantity
Fleet Services	311 Montevue Lane, Frederick, MD 21702	24,000 gallons
Landfill	9041 Reichs Ford Road, Frederick, MD 21702	2,000 gallons
Thurmont Highway Yard	7407 Blue Mountain Road, Thurmont, MD 21788	6,000 gallons
Johnsonville Facility	13216 Coppermine Road, Woodsboro, MD 21791	6,000 gallons
Urbana Highway Yard	3471-A Campus Drive, Urbana, MD 21702	6,000 gallons

Discussions with County Fleet Services, tank space at existing fueling locations is limited and not readily available for conversion to B20. The County is planning to increase capacity at the Landfill location by installing a larger tank that can store up to 8,000 gallons, but supply chain and funding issues are slowing progress. Fleet Services noted that the Johnsonville Facility has a gasoline tank that experiences low use and could be converted to store B20, which would allow the location to offer both B20 and diesel. The County must continue to offer both diesel and biodiesel at all locations because emergency and Board of Education (BOE) vehicles must be able to access diesel fuel at all locations. Since BOE is a separate fleet, they may have restrictions related to biodiesel use in their vehicles, specifically school buses.

Establishing B20 Infrastructure

To accommodate the 116 vehicles recommended for B20 adoption, the County needs to ensure that the County diesel fueling stations can store and provide a minimum of 283,530 gallons of B20 per year, assuming no new diesel vehicles are added to the fleet or vehicles consume more fuel than their average annual consumption.

Biodiesel blends up to B20 have few compatibility issues with diesel infrastructure. A list of compatible infrastructure is available in Appendix G. Before the County fills any diesel storage tanks with biodiesel, the County should:

- Crosscheck existing tank compatibility with Appendix G to determine whether existing infrastructure is compatible with holding and dispensing B20. Tanks that are confirmed as compatible should be prioritized for B20.
- Evaluate diesel fuel infrastructure materials to determine if it has oxidizing metals often found in lead solders, zinc linings, copper pipes, and brass and copper fittings. Oxidizing metals can cause B20 to degrade faster than regular diesel. The County should try to ensure that infrastructure is made of stainless steel, carbon steel, or aluminum. This assessment should be relatively low effort

for the County to complete as most locations have storage tanks above ground and the fleet manager has equipment make and serial numbers.

- Take every effort to confirm storage tank compatibility for unconfirmed stations. If the County cannot confirm any additional storage tanks are compatible with biodiesel, the County should only rely on the tanks that are confirmed as compatible.
- Clean compatible diesel storage tanks prior to storing any biodiesel blend above 5% (B5). Higher blends of biodiesel have a solvent effect that allows it to easily absorb contamination left behind by diesel fuel storage.[90] While this is typically more problematic for biodiesel blends above 35%, the County should clean all tanks identified for conversion to avoid fuel injector failure. Cleaning diesel storage tanks generally consists of:
    - Draining the tank to remove residual gas, moisture, and other liquids. Store the fuel in a container or fuel caddy approved for diesel.
    - Scrubbing the tank with an industrial cleaner designed for fuel tanks to remove all residual sludge, organic matter, water, and other impurities.
    - Rinsing the tank to remove all cleaner, water, sludge, fuel residue, and other matter.
    - Inspecting the fuel tank for any rust or physical damage. If there is damage, the fuel tank must be repaired or replaced.
    - Drying the tank out after cleaning. Fuel may be stored in the tank again once it has completely dried.

Biodiesel stored in tanks that may be incompatible with the fuel poses risks related to corrosion, leaking, fuel spills, equipment damage (e.g., clog filters, damage fuel pumps, etc.), erosion, and fuel degradation. Improper or lengthy storage of B20 can result in oxidation, the formation of corrosive materials, and early degradation.

After confirming storage tank compatibility and identifying fuel suppliers that offer B20, the County may begin integrating B20 into the fleet at any time. B20 offers flexibility in implementation because vehicles can continue operating on diesel fuel until fueling locations offer B20—the County will not need to time infrastructure and vehicle use nearly as meticulously as is necessary with other AFVs whose operation is dependent on the appropriate infrastructure.

Short-Term Adoption

The County has expressed interest in a slower integration of B20 into the fleet, beginning with fuel totes. Fuel totes allow the fleet to use B20 without requiring immediate investment in new infrastructure or clean existing storage tanks. If the County introduces B20 in a limited capacity using fuel totes, tote material will need to be crosschecked for compatibility with biodiesel. Not all plastics are compatible with both diesel and biodiesel. Appendix G lists plastics that are compatible with biodiesel.

Similarly, the fleet can focus B20 use on a subset of vehicles and pilot the fuel until drivers and maintenance staff are comfortable with B20. The cost of fuel totes can vary, from smaller totes (approximately 30 gallons) costing a few hundred dollars to larger fuel totes (over 200 gallons) costing a few thousand dollars.

[90] AFDC. 2022. "Biodiesel Equipment Options." Retrieved from: https://afdc.energy.gov/fuels/biodiesel_equip_options.html

Fueling Station Cost Considerations

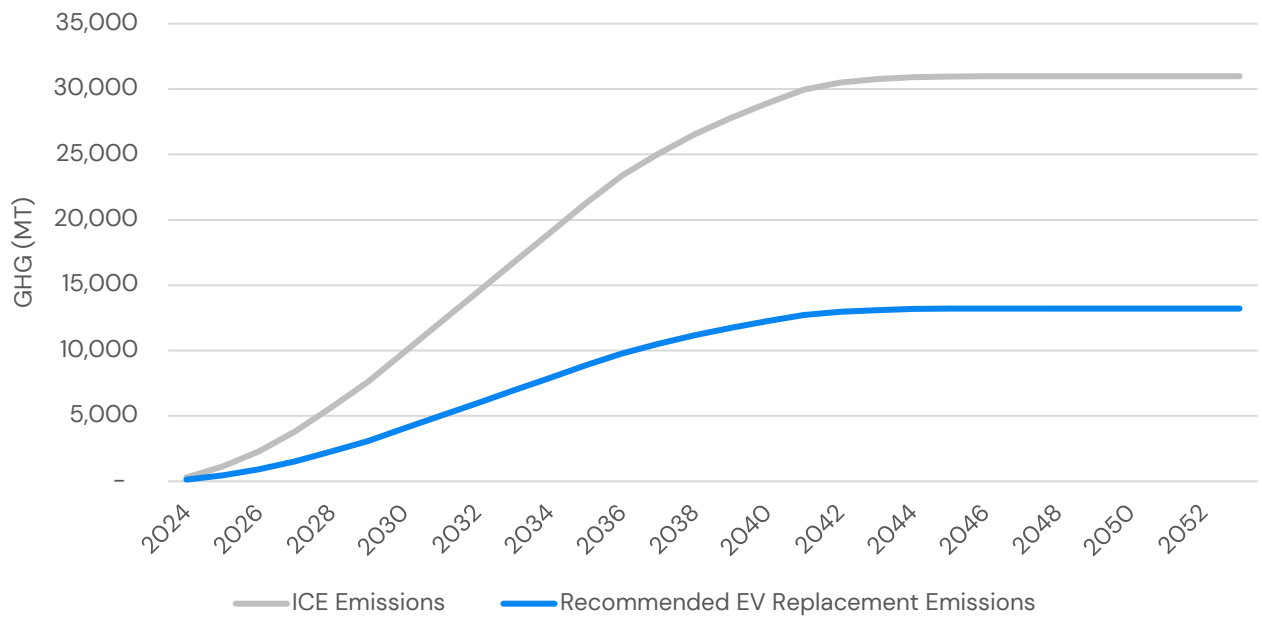
Most existing diesel infrastructure is compatible with biodiesel blends from B5 to B100. Because of the high level of compatibility with existing diesel infrastructure, the County should not need to invest in new tanks. If the County does need to install new fueling equipment compatible with B20, the costs should be almost equal to the standard diesel equipment—due to diesel equipment compatibility with B20.

Emissions and Environmental Impact Analysis

Electrification

Total cumulative GHG emissions from the recommended EV replacements compared to ICE vehicles show significant emissions savings, especially over vehicle lifespans. While vehicle technology and fuel economy improvements offer reductions in GHG emissions from ICE vehicles, those savings pale in comparison to emissions savings offered by EV equivalents. Replacing 183 fleet vehicles (5% scenario) with EV equivalents will save a total of 17,777 MT of GHG through 2050, as shown in Figure 22. The largest overall cumulative GHG emission reductions come from transit and shuttle buses, with a total cumulative reduction of 8,309 MT of GHG by 2050, followed by medium-duty vocational trucks with lifetime reductions of 3,274 MT of GHG by 2050. This replacement also results in 114,993 pounds of NOx reductions through 2050. A breakdown of emissions savings by vehicle type is included in Appendix H.

Figure 22. Cumulative Fleet GHG Emissions: ICE Vehicles vs. EVs



These calculations are for wheel-to-well[91] emissions and balance the gasoline and diesel emissions savings with the emissions created to produce electricity, based on the grid generation mix for the County. A summary of emissions savings at benchmark years 2030, 2040, and 2050 is in Table 18.[92]

Table 18. Electrification GHG Emissions Reductions by Benchmark Years

Scenario	2030	2040	2050
5%	5,846 MT	16,682 MT	17,777 MT
10%	5,866 MT	16,737 MT	17,835 MT

[91] Well-to-wheel emissions include all emissions related to fuel production, processing, distribution, and use. In the case of electricity, most electric power plants produce emissions, and there are additional emissions associated with the extraction, processing, and distribution of the primary energy sources they use for electricity production.

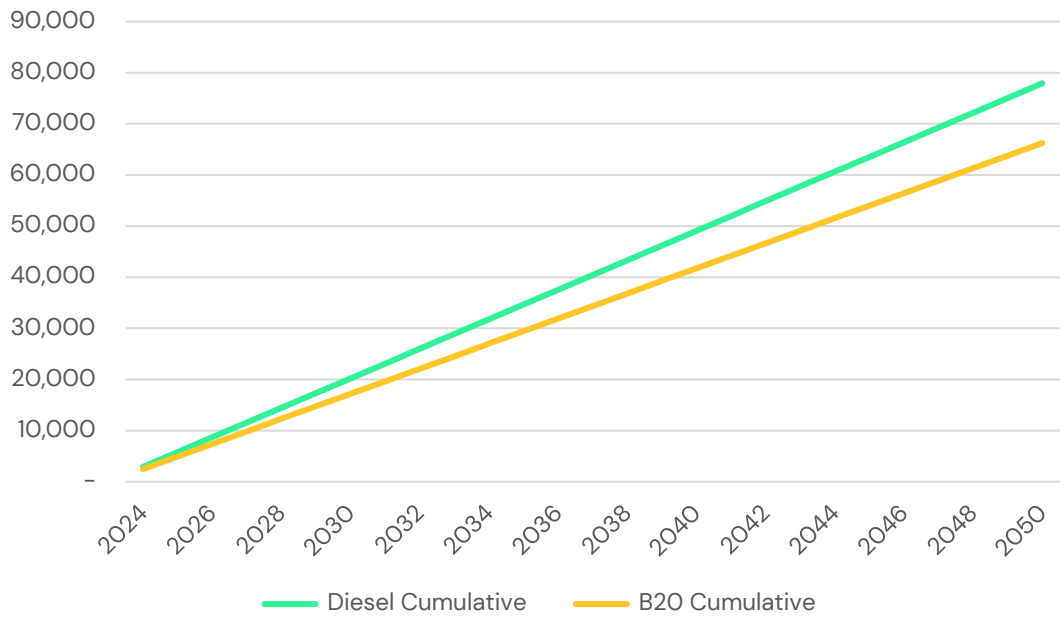
[92] The emissions calculations from this report feed into the County's Climate and Energy Action Plan (2023). This assessment only considers one round of vehicle replacements for the fleet, but the Climate and Energy Action Plan assumes continual replacement of all ICE vehicles with EVs beyond one replacement cycle.

Biodiesel

A total of 116 diesel vehicles are recommended to transition to B20. In sum, these 116 vehicles consume over 283,500 gallons of diesel annually. By transitioning to B20 County can reduce emissions by 15%.[93] By 2050, cumulative diesel emissions will total approximately 77,931 MT of GHG while cumulative B20 emissions would total 66,241 MT of GHG, resulting in GHG emissions savings of 11,690 MT. Figure 21 provides an overview of cumulative GHG emissions of diesel versus B20, and Appendix H provides a breakdown of these emissions savings estimates.

Longer-term emissions savings may vary if the fleet does not adopt B20 for all 116 vehicles, adopts B20 for more than 116 vehicles, or if the fleet also uses B20 for diesel vehicles recommended for electrification later than 2024.

Figure 23. Comparison of Diesel vs. B20 GHG Emissions[94]



A summary of emissions savings at benchmark years 2030, 2040, and 2050 is in Table 19.

Table 19. B20 GHG Emissions Reductions by Benchmark Years

Year	GHG Reductions (MT)
2030	3,031
2040	7,360
2050	11,690

[93] AFDC. 2022. "Biodiesel Vehicle Emissions." Retrieved from: https://afdc.energy.gov/vehicles/diesels_emissions.html

[94] The emissions calculations from this report feed into the County's Climate and Energy Action Plan (2023). This assessment only considers one round of vehicle replacements for the fleet, but the Climate and Energy Action Plan assumes continual replacement of all ICE vehicles with EVs beyond one replacement cycle.

Switching to B20 has additional benefits related to emissions including:

- Reducing hydrocarbon emissions by approximately 20%
- Reducing carbon monoxide emissions by approximately 15%.
- Reducing particulate matter emissions approximately 15% for B20.[95]

Beyond how widely the fleet adopts B20, total emissions reductions also depend on the blend of biodiesel used, feedstock, and any additives included in the blend. Regardless of exact emissions savings the County can achieve with B20, reducing emissions by switching to an alternative fuel will help limit County employee and community exposure to GHG emissions and hazardous pollutants.

[95] International Council on Clean Transportation. 2012. "Biodiesel carbon intensity, sustainability and effects on vehicles and emissions." Retrieved from: https://theicct.org/publication/biodiesel-carbon-intensity-sustainability-and-effects-on-vehicles-and-emissions/

Barriers to Fleet Electrification

Supply Chain

The global supply chain and EV backlogs, leading to long periods of time between vehicle down payment or purchase and fleets receiving their vehicle order, will present a near-term barrier for the County. The production and delivery of vehicles and necessary charging station components are delayed and are slowing deployment across the country. On top of longer delivery times, EV battery prices have increased over the last year due to ongoing demand increase and supply chain constraints. To circumvent as many complications as possible, the County should focus on ordering critical components and vehicles promptly and stay in touch with vehicle and EVSE suppliers. Ordering and purchasing equipment as soon as possible will also decrease the likelihood of inflated costs impacting project plans and budgets. Coincidentally, the County should take advantage of this anticipated delay to expedite the required permitting for EVSE and prepare "shovel-ready" projects, allowing for faster installation once equipment is received.

However, should supply chain issues prevent the County from purchasing the desired EV in time for replacement, they may need to adopt an ICE vehicle instead. Certain vehicles that perform essential services or need immediate replacement will not have the flexibility to wait for longer delivery times. If this happens, the vehicle should be flagged for electrification in the next round of vehicle replacements.

Capital Costs

In general, EVs have higher capital costs (i.e., purchase prices or MSRPs) than ICE vehicles, with battery packs being the largest driver in EV purchase prices. While EVs typically have lower TCOs than ICE vehicles, the County may not have the financial capacity to purchase vehicles initially. While the global supply chain issue is causing battery prices to increase in the short-term, battery pack prices have been steadily declining over the long-term, as noted earlier in this Transition Plan, leading to overall lower EV purchase prices across the market. Battery price forecasts originally suggested that EV prices will become competitive around 2024, when the County plans to begin electrifying the fleet. However, it is now estimated that EVs will reach cost parity with ICE vehicles around 2026.[96]

Electric Capacity and Supply

Electric capacity and supply needs for charging infrastructure projects will be informed by numerous factors specific to each individual site. However, there are best practices that all charging infrastructure projects can follow to set up current and future charging installations for long-term success.

An assessment of a charging site's power needs will be informed by the number of vehicles the site plans to host and how quickly the vehicles need to charge. This assessment should include both current infrastructure upgrades to accommodate immediate charging needs and "make-ready" infrastructure to prepare a site for future expansions. An example of make-ready infrastructure would be installing conduit for future charging installations or infrastructure to support future power capacity upgrades for faster, higher power chargers (e.g., upgrading 50 kW chargers to 150 kW chargers).

While the options for fleet charging may be dictated by the location where vehicles are parked overnight, there are criteria that can inform the best location for siting charging infrastructure. The California

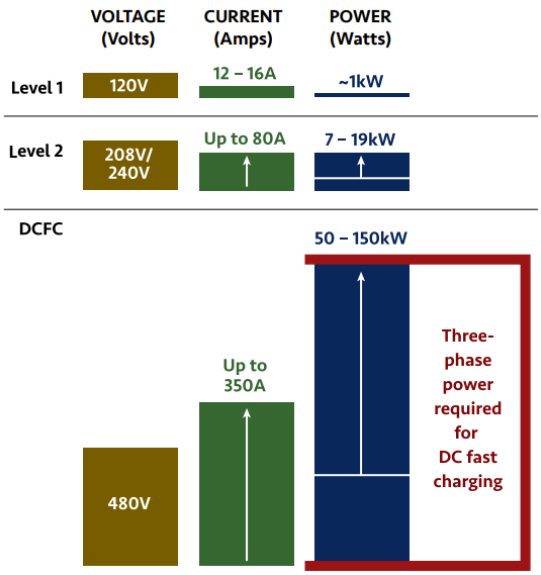
[96] BloombergNEF. 2022. "Lithium-ion Battery Pack Prices Rise for First Time to an Average of $151/kWh." Retrieved from: https://about.bnef.com/blog/lithium-ion-battery-pack-prices-rise-for-first-time-to-an-average-of-151-kwh/

Department of General Services recommends accounting for the following when choosing a location for charging equipment:[97]

- **Existing electrical panel distribution voltage.** Does the existing voltage meet the requirement of the desired charging station? If not, can transformers be added to obtain the desired voltage?
- **Existing panel capacity evaluation.** The sum of the proposed charging equipment full load amperage and existing electrical load may be more than the existing electrical distribution equipment can handle. Load testing can help determine if adding EV charging stations will exceed current capacity.
- **Distance between the electrical panel and charger location.** The length of the conductors will affect installation design and material costs. Factors such as conduit size, conductor sizing, trenching, circuit voltage drop, and other requirements will need to be assessed, especially if additional future charging equipment is planned. These factors will determine where chargers can and cannot be installed without additional construction costs.

The primary charging technology used in fleet applications are Level 2 and DCFC stations. Figure 24 highlights the different voltage, current, and power requirements for both Level 2 and DCFC stations, along with Level 1 charging. The 208V/240V requirements for Level 2 charging will generally be met by either residential (240V) or commercial (208V) electrical service. DCFC stations require three-phase power; the increased power levels are achieved using three-phase circuits that contain three live wires, each with their own AC signal.

Figure 24. EV Charging Electricity Supply Requirements[98]

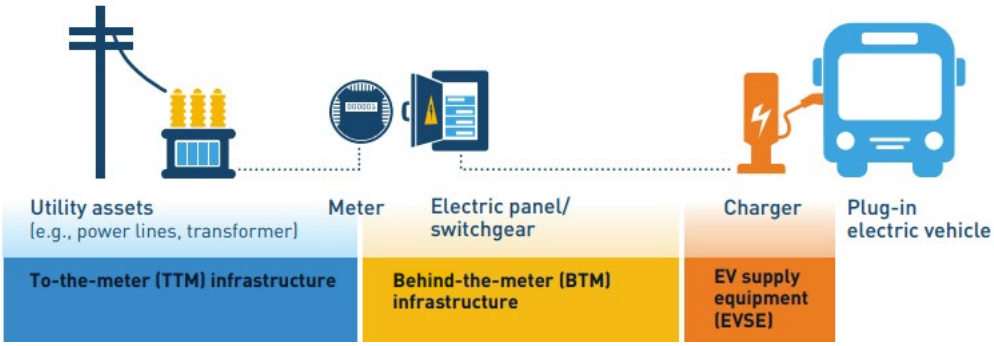


As the County works to identify suitable fleet charging locations, a siting analysis is recommended to better understand the necessary upgrades required to install EVSE at each location. Upgrades can include both to-the-meter (TTM) infrastructure, which is typically constructed, owned, and operated by the utility, and behind-the-meter (BTM) infrastructure, which is typically under the per view of the customer. Figure

[97] California Department of General Services. 2014. "Electric Vehicle Supply Equipment Guidance Document." Retrieved from: https://lgsec.org/members/meetings/2014_5_23-State%20of%20CA%20evse-guidance-document-01-28-14%20(3).pdf.
[98] USDOT. 2022. "Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure." Retrieved from: https://www.transportation.gov/sites/dot.gov/files/2022-01/Charging-Forward_A-Toolkit-for-Planning-and-Funding-Rural-Electric-Mobility-Infrastructure_Feb2022.pdf.

25 represents the breakdown of the infrastructure responsibilities highlighted in Pacific Gas and Electric's (PG&E) EV fleet program guidebook.

Figure 25. Infrastructure Breakdown - EV Charging[99]



In addition to a siting analysis, the County can assess whether managed charging strategies can be used to reduce the peak power demand for each charging site. Managed charging is a strategy that seeks to balance vehicle energy needs with site energy control objectives.[100] A successful managed charging strategy has the potential to reduce necessary TTM and BTM equipment upgrades and lower the cost to charge a fleet. Managed charging can be achieved either through automated software processes, often called networked or smart charging, or manually through operational planning to coordinate charging during times that will reduce peak power requirements or electricity costs. Best practices for managed charging include:

- Installing smart EV charging stations that can adjust power levels or shift charging sessions through software, with minimal human intervention.
- Develop a charging schedule based on time-of-use rates and scheduling vehicles to charge during off-peak times to minimize costs and reduce the risk of demand charges.
    - If electricity costs $0.20 per kWh from 6am to 12am and $0.05 per kWh from 12am to 6am, the vehicle and charging station should be scheduled to charge from 12am to 6am.
    - To avoid demand charges, fleets can stagger charging times by scheduling different groups of vehicles to charge at different times. For example, fleets could charge one third of third of their vehicles at 9pm, one third at 1am, and one third at 5am. Diversifying charging times will help the fleet avoid demand charges on all their vehicles. While charging during off-peak is ideal, charging on-peak is still more cost-effective than receiving demand charges on all vehicles.
- Fleet managers should work with facility managers and departments with fleet vehicles to determine optimal charging times.

[99] Pacific Gas and Electric. 2019. "Take Charge: A Guidebook to Fleet Electrification and Infrastructure." Retrieved from: https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/ev-fleet-program/PGE_EV-Fleet-Guidebook.pdf.
[100] DOE. 2022. "Managed Electric Vehicle Charging." Retrieved from: https://www.energy.gov/eere/femp/managed-electric-vehicle-charging.

Electrification and Snowplowing Use Case

The County fleet's light-duty pickup trucks and heavy-duty straight trucks are used in the winter months for emergency snow removal. At this time, due to the vehicle's emergency status and the use requirements, these vehicles may not refuel (i.e., charge) for longer than five minutes. The current state of DCFC stations and the cost to install enough chargers to support these vehicles during situations of extreme snowfall makes electrification cost prohibitive. However, the County should continue monitoring EV charging technology developments (e.g., faster charging times) and snowplowing case studies[101] and pilot programs for opportunities to electrify in the future.

> New York City is experiencing similar concerns, with electric snowplows failing to meet New York City's operational standards for snow events. New York City's Sanitation Commissioner noted that snowplows need to operate continuously for 12 hours, but their pilot program was only able to keep the vehicles going for four hours. New York City still has a goal of electrifying all fleet vehicles, including trucks and emergency vehicles, by 2040. However, in December 2022, the Sanitation Commissioner noted that trucks used to plow snow will likely not be able to meet this deadline.

Physical Space

Regardless of EV adoption and EVSE deployment, the County fleet is concerned about having the physical capacity to house and maintain new vehicles and charging stations. The County fleet needs resources from the County or other funding sources for the expansion or purchase of a fleet services property. To successfully integrate EVs into the fleet and help the County meet GHG emissions reductions goals, the fleet manager needs support from County counterparts to acquire the space needed to operate the fleet efficiently and effectively. Without adequate support and capacity, the fleet may be slower to adopt EVs or other AFVs.

Range Anxiety

Range anxiety, or the fear of running out of charge while driving an EV, is common in drivers that are unfamiliar with EVs and where to charge them. To help familiarize County employees that will be driving EVs, Frederick can use the following materials and resources to develop educational materials to give drivers the confidence they need:

Maryland-Based Resources:

- MarylandEV
- Maryland EV Journey

Federal Resources:

- The AFDC's Electricity Basics.
- The AFDC's Developing Infrastructure to Charge EVs.
- The DOE's Electric-Drive Vehicles report.

[101] New York 1. 2022. City's sanitation fleet will likely not electrify by 2040 deadline, commissioner says. Retrieved from: https://www.ny1.com/nyc/all-boroughs/news/2022/11/16/city-sanitation-fleet-electrify-2040-deadline

- The DOE's fueleconomy.gov website for EV models available and information on them (including vehicle range).

Other Resources:

- CALSTART's Zero-Emission Technology Inventory (ZETI) tool.
- EVADC's EV Information website.
- SemaConnect's Basics about Charging Stations.

Best Practices for Fleet Electrification

Electrical Upgrades and Installation

Once the initial charging station layout has been drafted, the County should determine the electrical charging capacity of the specific site or location. As noted previously, the County should:

- Engage with Potomac Edison throughout the infrastructure planning process. Potomac Edison can provide an electrical upgrade estimate and confirm sufficient information is gathered to ensure the most cost-effective hardware installation. Required upgrades could include panel, transformer, electric distribution line, or substation level upgrades.[102]
- Develop charging configurations that work with the facility's existing space, support current and future operations, and maximize equipment life cycles and control costs. In most cases, charging stations need a dedicated circuit for each EV charging station on the electrical panel, sufficient electrical capacity from the utility connection the electrical panel, and sufficient electrical capacity at the panel. The grid can expand as needed to accommodate the needs of any customer, but the time and resources needed to make the required upgrades are highly dependent on the specific facility and the circuit that serves it.
- Conduct a microgrid feasibility study, the County should collect the follow types of data:
    - Electricity use and billing data for all sites being evaluated for EVSE.
    - Data from on-site generation sources (e.g., PV panels), including historic performance data, project installation agreements, and power purchase agreements.
    - Site-specific information, including site plans, facilities drawings, parcel maps, electrical and architectural designs, utilities diagrams, easements, civil engineering and geotechnical reports, and flood zone maps.
    - Incentive availability to help offset costs of the feasibility study and the cost of installing EVSE as a result of the study.
    - Project permitting requirements.
- Consider the electricity infrastructure for EV charging stations when building a new County facility. It is less expensive to install extra panels and conduit capacity during initial construction than to modify the site later. To minimize costs, the County should install infrastructure capable of meeting both current, anticipated, and future charging needs.
- Consider the location of existing electrical equipment, which will determine the complexity of the required electrical installation and limit the need for trenching and conduit. For example, an

[102] Washington State University. 2021. "Get Started on Transportation Electrification." Retrieved from: https://www.energy.wsu.edu/documents/RCM-GetStartedOnTransElectricifation-WSUEP21-004_FINAL.pdf

isolation transformer may be required to step electricity down to Level 2 or up to DCFC voltage.[103] The County should site EVSE as close to existing conduit and electrical infrastructure as possible to limit installation costs.

Maintenance Costs for EVs and EVSE

EVs typically require less maintenance than conventional vehicles. Their electrical systems require little maintenance, but battery life and warranties should be well understood upfront. The batteries in EVs are generally designed to last for the expected lifetime of the vehicle. Like engines in conventional vehicles, the advanced batteries in EVs are designed for extended life but will wear out eventually. Battery warranties vary by manufacturer; however, the County should look for OEMs that offer a minimum of 8-year or 100,000-mile warranties for their EV batteries. To minimize costs to the fleet from both EV and EVSE maintenance, the County should:

Look for 8-year or 100,000-mile EV battery warranties

- Consider the EVSE OEM's maintenance and support packages and the availability of local service options.
- Develop a service agreement that outlines who 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.
- Have both electrical and non-electrical maintenance staff available for servicing EVSE.
- Consider extended warranties for Level 2 and DCFC EVSE.
- Check with the dealer about battery life and length of warranties and compare manufacturer policies. Identify when manufacturers will replace the battery under warranty. If considering purchasing previously owned EVs, confirm whether the warranty is transferrable between vehicle owners.

EVSE Siting Considerations

When evaluating the locations of EV charging stations throughout the County, the fleet manager and Potomac Edison should work together to evaluate potential charging sites. It is important to involve Potomac Edison early in the siting process to confirm charging requirements (in both the short- and long-term), understand the electrical demand of EV recommendations (and any impacts on electricity pricing), and determine whether electric upgrades may be needed at the charging site. Once the County fleet manager and utility work together to evaluate and select EV charging sites, the County should consider the following factors.[104]

Short- and Long-Term EVSE Needs

Evaluate the need to add extra circuits, electrical capacity, and conduit from the electrical panel to support future charger installations. Oftentimes, it is less expensive to add this extra capacity during initial construction versus upgrading sites in the future. The County should consider hiring engineers to develop electrical designs for on-site charging and general contractors to make site upgrades related to electricity, site design, and construction. Work to be performed may include:

[103] AFDC. 2022. "Electric Vehicles for Fleets." Retrieved from: https://afdc.energy.gov/vehicles/electric_fleets.html
[104] AFDC. 2022. "EVs for Fleets." Retrieved from: https://afdc.energy.gov/vehicles/electric_fleets.html

- Evaluating current and future fleet EV charging station needs based on current fleet EV makeup and future fleet EV makeup, based on this fleet transition plan.
- Locating the exact vehicle parking locations for vehicles recommended for electrification.
- For parking locations with EV recommendations, examine the existing building electrical capacity and infrastructure to determine if the parking location can support the installation and use of EVSE without infrastructure upgrades. Alternatively, this evaluation will help identify the infrastructure upgrades necessary to support EVSE.
- Once charging infrastructure needs and building electrical capacity are evaluated, develop plans for EVSE construction. These plans may include electrical panel upgrades, building electrical capacity upgrades, utility-side infrastructure upgrades, trenching for electrical conduit, etc.

Proximity to Electrical Infrastructure

As the County is working on locating and siting EVSE, the distance from electrical infrastructure to EVSE should be considered. The farther away an EVSE is from the necessary electrical infrastructure, the more expensive that site construction will likely be.

Signage

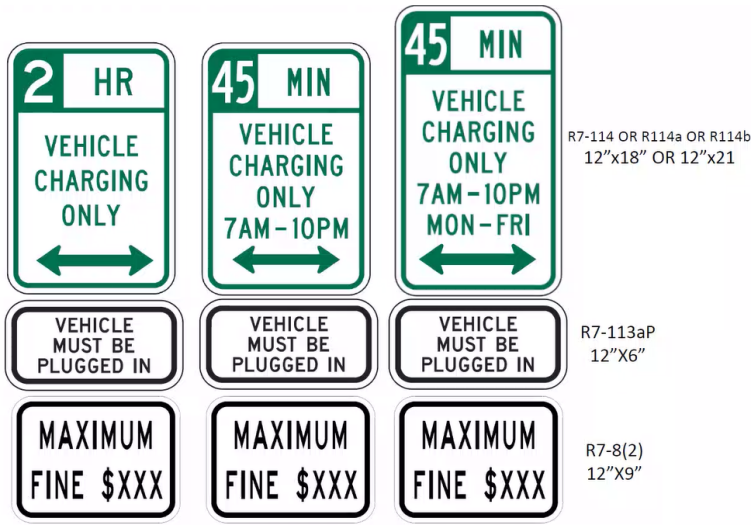
EVSE signage signals to drivers where charging stations are located. Having easily understood and highly visible EVSE signage will help the County guarantee that drivers know where they can charge and will help reduce range anxiety. Signage may include information about charging policies such as access, time limits, hours of us, and penalties for improper use. Wayfinding signage helps EV drivers navigate to charging stations from other locations, such as freeway exits. Station signage helps eV drivers identify EV charging stations, communicate charging policies, and specify EV parking spaces.

The County should choose signs that can be seen over parked vehicles to designate EV-only parking spaces. Signage should include wayfinding, parking restrictions that prevent ICE vehicles from using EV-dedicated spaces, guidance on EVSE usage, and penalties for violators. Signs should follow the minimum requirements set out by the FHWA's Manual on Uniform Traffic Control Devices (MUTCD).[105] FHWA recommends two charging designs, a symbol, and written descriptions:[106]

Maryland DOT State Highway Administration is currently developing charging station signage for use at state facilities per Senate Bill 146, 2022. These signs are designed to prevent non-EVs and EVs not actively charging from parking in a space equipped with an EVSE. Once finalized, the County may use these designs as examples for charging station signage at County charging locations.

[105] Ibid.
[106] For more information, including examples of signage, see the AFDC's Signage for EV Charging Stations website.

Figure 26. Draft EV Charging Station Signage from MDOT SHA[107]



Metering

The County should consider installing meters to separately track EV electricity usage. This will give the County information on charging patterns and electricity use and may help the County negotiate better EV electricity rates from utilities.

EVSE Parking Space Design

EVSE spaces should have a standardized design to prevent a variety of different charging structure designs across the County, increasing difficulty of use. EVSE parking space design should establish minimum dimensions for EV parking spaces to ensure the safe and effective operation of the EVSE. At a minimum, EVSE parking spaces should be 21 feet long (18 feet for the length of the parking space and 3 feet of clearance) by 8 feet wide. Similarly, standardizing EVSE parking spaces will require different designs for different scenarios—parallel parking, perpendicular parking, and on- and off-street parking locations. The County should tailor EVSE parking designs to best fit the fleet's unique needs and usage. It is assumed most of the fleet vehicle parking and EVSE use will be off-street. Best practices for off-street EVSE parking spaces include:

- Installing EVSE at the front of parking spaces (perpendicular and angled).
- Adding an access aisle of at least three feet on one side of the parking space to ensure drivers can safely move around their EV and operate the EVSE.
- Building bollards, wheel stops, curbs, and setbacks to prevent EVs, or other vehicles, from colliding with EVSE.
- Installing EVSE with retractable cords to minimize the tripping hazard presented by EVSE charging cables. This feature can help minimize hazards to both fleet drivers and pedestrian traffic.
- Installing adequate lighting and surveillance cameras around the EVSE to help drivers feel safe operating EVSE at night, reduce chances of vandalism, and prevent user error due to poor visibility.

[107] Not yet finalized. This is a draft as presented at the November 2022 Zero Emission Electric Vehicle Infrastructure Council meeting.

Pooled Water, Irrigation, and Snow Removal

Charging equipment is designed to operate safely in wet areas, but drivers will be more comfortable if EVSE are not in locations where water pools (due to rain or snowmelt) or irrigation systems spray. The County should assess the flood potential of all possible EVSE sites and select the ones that are least prone to flooding but still meet convenience and usage requirements of the fleet. If the County decides to build an EVSE in a known flood plain, the County should consult with an electrical contractor to ensure appropriate codes and building requirements are addressed, including mounting height and storage for connectors, and ensure the EVSE is waterproof (Ingress Protection ratings, such as IP66). The County should make sure all EVSE sites have good drainage to remove water as quickly as possible. Drainage will likely need to be examined more frequently in spring and fall months to remove any blockages caused by leaves and trash contained in snowmelt.

Similarly, snow will need to be hand cleared from around EVSE. Best practices to avoid or reduce snow build up surrounding charging areas include:

- Routine hand-shoveling around EVSE, including planning for emergency snow removal scenarios for heavy snowfall events. Hand-shoveling, while slower than snow blowers or plows, will be necessary to avoid accidental damage of EVSE.
- Canopies that cover the charging area to keep the operating area clear of snow and reduce weather-related pavement damage
- Sub-surface heating such a hydronic and electric pavement is another option to keep the charge area from snow and ice.
- Retractable cable to access the connectors with minimal snow removal.

Accessibility

The County should evaluate and address requirements for complying with the Americans with Disabilities Act (ADA) as well as state, local, and company accessibility policies. In this case, the County should follow the DOE's guidance for complying with the ADA requirements for EVSE, outlined in Table 20.

Table 20. DOE Guidance for EVSE Site Compliance with ADA Requirements[108]

EVSE Design Component	Description
Number of Spaces	4% of parking spaces, or 1 for every 25 spaces, in any given lot, should be an ADA accessible space.
Parking Stall	8′ by 18′ for a car and 11′ by 18′ for a van.
Accessible Route Slope/Cross Slope	Maximum 5% running slope and 2% cross slope; Accessible vehicle spaces 2% in all directions and 90-inch clearance for vans.
Wheelchair Reach Range	48 inches front and side to allow reach to all operable parts from a wheelchair.
Accessible Controls	Operable with one hand and not requiring grasping, pinching, or twisting of the wrist or force more than 5 lbs.
Accessible Ramps	A ramp or curb-cut must be accessible to allow for operation of charging station.
Facility Accessibility	Must be connected by a minimum of 50-inch-wide accessible route in proximity (not necessarily adjacent) to the entrance of the building.
Side Access Aisle	Side access aisle of 60 inches wide to allow space for wheelchair and equipment in and out of space.
Accessible Card Reading Devices	Must be connected by a minimum 50-inch-wide accessible route in proximity (not necessarily adjacent) to the entrance of the building.
Other Considerations	Ensure that bollards, wheel stops, or curb do not obstruct use of charging station.

In addition, the County should require that new stations intended for public use meet the requirements of Section 302 and Subsections 502.1 through 502.5 of the Americans with Disabilities Act Accessibility Standards (ADAAS) with regard to size, surfacing, etc., for parking spaces to ensure equal access to charging facilities.[109] If the County does eventually adopt design standards for these facilities, the location of the charging equipment will also be a factor to consider because of implications it could have for accessible routes and the ability of persons with mobility impairments to park, plug-in, and access adjacent facilities.

Battery Disposal and Recycling

EVs are still relatively new, with only a small number having reached the end of their useful lives. Because EV batteries are still a nascent technology, the battery disposal, recycling, and reuse market is still developing. With EV adoption growing rapidly and the market rapidly adapting and expanding, it is anticipated that, by the time the County is ready to dispose of, recycle, or reuse EV batteries, there will be many new options and opportunities. For now, options include:

- Second-life applications for batteries that allow reuse of batteries in older EVs.
- Storage for renewable energy or electric utilities.
- Sending batteries to recycling companies to recover still-useful components and precious metals.

[108] DOE. 2014. "Guidance in Complying with ADA Requirements." Retrieved from: https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf
[109] U.S. Access Board. 2023. ADAAS. Retrieved from: https://www.access-board.gov/ada/#about-the-ada-accessibility-standards

The DOE houses a battery policies and incentives database[110] that the County can continue to monitor for federal and Maryland policies related to battery disposal and recycling.

Vehicle Battery Life

EV batteries have a limited number of charging cycles—the number of times the battery can be charged and discharged before its useful life declines, also called "cycle life". Under normal operating conditions, EV batteries are generally designed to last for the expected lifetime of the vehicle, approximately 10 to 12 years.[111]

During vehicle life, there are several factors that include battery health.[112] These factors include:

- Temperatures the vehicle and battery are exposed to.
- Driving behavior.
- Driving terrain.
- Cargo loads.
- Vehicle heating and cooling.

While it is unclear how much different practices can influence battery longevity, there are a few best practices the County can encourage its drivers to abide by to maintain a healthy battery life, including:

- Practicing safe driving habits, as speeding, aggressive driving, and heavy loads can reduce range.[113]
- Minimize vehicle exposure to extreme temperatures by parking vehicles out of the sun, snow, or wind in shaded or canopied areas or by parking the vehicles indoors. While cold temperatures are often perceived as the most detrimental to battery range, research suggests that extremely hot temperatures may be more harmful to battery life. Prolonged exposure to high temperatures can accelerate the rate of degradation, shortening battery life, and impact an EV's range overtime.[114]
- Minimize frequently charging batteries to 100%. Similarly, do not leave EVs plugged in and charged to 100% for longer than necessary. If compatible with vehicle use cases and charging schedules, aim to keep batteries at a charge between 20% to 80%.[115] Keeping vehicles in extremely high or low states of charge puts more stress on the battery.
- Emphasize to drivers that EVs should not regularly be fully discharged.
- Use of air conditioners and heaters can reduce vehicle range. However, these features are essential for safe and comfortable operation of vehicles. Using EV features like regenerative breaking or choosing vehicles with more efficient cabin heating will help minimize range impacts.
- If vehicle use and duty cycle allow, use Level 2 instead of DCFC EVSE when possible.

[110] DOE. 2022. "Battery Policies and Incentives." Retrieved from: https://www.energy.gov/eere/vehicles/battery-policies-and-incentives-search#/
[111] DOE. 2021. "At a Glance: Electric Vehicles." Retrieved from: https://afdc.energy.gov/files/u/publication/electric-drive_vehicles.pdf
[112] Medium- and heavy-duty vehicles may be more heavily impacted by can be more impacted by factors that reduce range
[113] DOE. 2021. "Electric Vehicle Basics." Retrieved from: https://afdc.energy.gov/files/u/publication/electric_vehicles.pdf
[114] NREL. 2021. "Electrifying Transit: A Guidebook for Implementing Battery Electric Buses." Retrieved from: https://www.nrel.gov/docs/fy21osti/76932.pdf
[115] 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

Battery Packs for Worksite Use

Bidirectional EVs can be used as mobile battery storage across several different applications, including vehicle-to-building (V2B), vehicle-to-grid (V2G), and vehicle-to-load (V2L). V2L is a feature that allows an EV to provide power to appliances or tools and can be used for backup, emergency, or off-grid power. This technology can be used to reduce dependence on diesel generators, often used at construction sites or mobile work sites. The County will need to monitor electricity consumption to ensure it does not overload the vehicle. Charging can often be managed via the vehicle's software or a third-party application.

Applications vary by vehicle model, with some EV models not offering this capability. For EVs that do provide V2L, the onboard energy, number of charging ports, and available power thresholds will vary by vehicle model. The County would need to coordinate with individual OEMs regarding capabilities of their vehicle models to provide mobile worksite charging support. An example of a vehicle that does have this technology is the Ford F-150 Lightning, which offers 9.6 kW of portable power and standard outlets in the cab, frunk, and bed of the truck and can power a home for up to three days.[116] However, the feasibility of EVs supporting worksites long-term is an understudied area of battery research. The County may rely on these vehicles for a short period of time but should not plan to use these vehicles as a main power source for prolonged periods of time. The County should consider the following topics when implementing V2L:

- EV battery capacity.
- Electricity load for appliances or tools that need powered.
- The amount of time the EV will need to provide power.
- The number of EVs on-site that can provide power.
- Whether the electricity demand will prevent the EV from returning to base to charge.

Similarly, battery swapping (i.e., replacing a vehicle's battery with a full battery) to continuously power heavy-duty vehicles or worksites is understudied. Battery swapping presents challenges in non-depot settings due to the battery pack size required by heavy-duty vehicles, specialized tools necessary to swap the batteries, and potential additional vehicles or technicians necessary to swap batteries.

EV Charging Station Networking and Ownership Models

The County should determine who will own, operate, and maintain the EV charging stations and related electrical infrastructure. Charging station ownership typically falls into one of two categories: site host-owned or third party-owned (e.g., owned by a charging network), though there are other possible arrangements. Charging infrastructure owned by the site host is purchased, installed, and maintained by the site host, which allows for full control over the station and the ability to keep all revenue from the station (if applicable). If the County decides to own the infrastructure, they are responsible for all associated costs, including any maintenance or payment transaction fees. If a third-party owns the charging infrastructure, the infrastructure is installed and maintained by the third party, which minimizes responsibility to the site host.[117] With third-party ownership and operation, the site host does not directly profit from the charging station revenue. Further, the County should determine ownership models between site-owned or third-party owned chargers. As the County begins procuring EV charging stations, the

[116] https://www.ford.com/trucks/f150/f150-lightning/features/intelligent-backup-power/
[117] AFDC. 2022. "Electric Vehicles for Fleets." Retrieved from: https://afdc.energy.gov/vehicles/electric_fleets.html

County needs to determine whether they want to provide EVSE maintenance or if maintenance requirements should be incorporated into EVSE RFPs and contracts.[118, 119]

EV Charging Station Interoperability

Interoperability refers to the ability of a system—EVs, charging stations, charging networks, the electrical grid—to work seamlessly and effectively together.[120] This looks like designing an open access system where fleet EVs can charge at all County-owned charging stations without barrier, limiting the number of protocols and requirements fleet vehicle operators need to follow.

The Open Charge Point Protocol (OCPP) is the industry standard for open access. By selecting charging infrastructure with hardware that uses the OCPP version 1.6 or higher, which physically separates the appliance aspects of the charging infrastructure from the network backend component, EVSE site hosts can easily switch charging networks without expensive equipment upgrades. This prevents stranded assets by allowing any network the ability to operate the equipment if a site host decides to switch charging networks, or the existing provider no longer offers charging. Open standards also allow users to choose many different hardware and network provider options. The County should implement networked EVSE to promote open access, allowing easier use for drivers and futureproofing EVSE from shifts in charging providers.

Recent federal and state efforts have worked to establish the adoption of interoperability standards for publicly available charging stations. The 90-day guidance released for the NEVI program highlighted the importance of interoperability, noting that "…EV charging infrastructure should be capable of using open protocols and standards for network connectivity to meet interoperability requirements to allow for easier transfer of operations to a new network provider if needed in the future."[121] California requires the installation of the OCPP interoperability billing standard on all publicly available EV charging stations[122], while Connecticut identified EVSE interoperability criteria as a key strategy in their Electric Vehicle Roadmap.[123]

Fire Suppression Systems

EV fires are rare, occurring in only 0.025% of EVs,124 but heavy media coverage of these events can fan the flames of anxiety in drivers and fleets looking to adopt EVs.125 To ensure the fleet is prepared in the rare case of an EV fire, the National Fire Protection Association recommends using a water-based fire suppression system to extinguish lithium-ion battery EV fires due to its high cooling potential.126

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[118] DOT. 2022. "Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure." Retrieved from: https://www.transportation.gov/rural/ev/toolkit
[119] AFDC. 2023. "Charging Infrastructure Procurement and Installation." Retrieved from: https://afdc.energy.gov/fuels/electricity_infrastructure_development.html
[120] Electric Power Research Institute. 2019. "Interoperability of Public Electric Vehicle Charging Infrastructure." Retrieved from: https://www.epri.com/research/products/000000003002017164.
[121] DOT FHWA. 2022. "National Electric Vehicle Infrastructure (NEVI) Formula Program Guidance." Retrieved from: https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf.
[122] AFDC. 2022. "Electric Vehicle Charging Station Open Access Requirements." Retrieved from: https://afdc.energy.gov/laws/11067.
[123] Connecticut Department of Energy and Environmental Protection. 2020. "Electric Vehicle Roadmap for Connecticut." Retrieved from: https://portal.ct.gov/DEEP/Climate-Change/EV-Roadmap.
[124] 25 out of 100,000 vehicles.
[125] AutoinsuranceEZ. 2022. "Gas vs. Electric Car Fires." Retrieved from: https://www.autoinsuranceez.com/gas-vs-electric-car-fires/
[126] National Fire Protection Association. 2019. "Fixed Fire Suppression Systems for EVs." Retrieved from: https://www.nfpa.org/-/media/Files/News-and-Research/Resources/Research-Foundation/Symposia/2019-SUPDET/Presentations

However, the County should primarily rely on the Fire Department and other emergency services if the fleet ever experiences a fire event.

Biodiesel Considerations and Best Practices

Feedstock Variations

There are several types of feedstocks that are manufactured from plant oils and animal fats, which serve as the base for the creation of biodiesel. Feedstocks include canola oil, soybean oil, yellow grease, beef tallow and more. Each feedstock has unique properties that result in some performance variations across biodiesel blends. In the Central Atlantic, soybean oil is one of the most common feedstocks used for biodiesel production.

The County should select a biodiesel blend that uses a feedstock with a low amount of saturated fats (e.g., soybean oil) to ensure the fuel has a naturally lower cloud point than blends made from feedstocks with high amounts of saturated fats. While B20 can be purchased and transported from almost any fuel provider, the availability of biodiesel with soybean oil feedstock means the County can source B20 from the Central- and North-Atlantic regions.

Cloud Point

Different feedstocks can cause biodiesel to gel at different temperatures, ranging from 0°C to 15°C (32°F to 60°F) or higher. This is called the cloud point—the temperature at which solid crystals form in the fuel, making the feedstock of the B20 an important consideration. Soybean and canola oil feedstocks are two of the most common biodiesel feedstocks in the United States and suitable for winter use.[127] Tallow, yellow grease, and white grease are also popular feedstocks, but are not suitable for winter use in the County due to their high cloud point.

When a fuel is exposed to temperatures at or below its cloud point, this creates the opportunity for gelling to occur. Gelling will happen when solid crystals form in the vehicle or in fuel storage tanks and block or limit the flow of fuel, preventing proper operation. To ensure biodiesel does not negatively impact engine operability, the County should follow American Society for Testing and Materials (ASTM) specifications that recommend biodiesel blends be capable of operating in the 10th percentile minimum ambient temperature of the region the fuel will be used. Low temperatures may be cause for concern between October and March. The temperature range appropriate for the County is outlined in Table 21.

Table 21. 10th Percentile Temperatures for Maryland - Winter[128]

	Oct	Nov	Dec	Jan	Feb	Mar
10th Percentile Temperature	2°C | 35.6°F	-3°C | 26.6 °F	-10°C | 14°F	-12°C | 10.4°F	-10°C | 14°F	-4°C | 24.8°F

To ensure optimal cold weather vehicle performance, the County should use fuel tank, filter, and line heaters to prevent gelling and improve cold weather operability. Similarly, to limit vehicle exposure to temperatures at or below cloud point, vehicles should be parked indoors when they are not in use.

[127] EIA. 2018. "Biodiesels produced from certain feedstocks have distinct properties from petroleum diesel". Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=36052
[128] ASTM Biodiesel B20 Specification D7467.13

Petroleum Diesel Fuels

Biodiesel can be blended with two types of petroleum diesel fuels that can act as the base: No. 1 and No. 2 diesel. No. 1 petroleum diesel performs better in winter due to a low cloud point, and No. 2 petroleum diesel, while typically more affordable and fuel efficient than No. 1, is less suitable for cold weather with a cloud point of approximately -10°C. However, mixing these diesel blends with biodiesel will raise the cloud point, possibly to a level incompatible with winter climate.

Biodiesel Supplier Engagement

In the winter months, engaging with the fuel supplier will help guarantee operability in cold weather. If the Frederick pursues a B20 fuel contract, the County can follow these best practices:

- Confirm that fuel suppliers can provide cold weather specifications at all times; and,
- Ask fuel suppliers to verify the cloud point of samples of their B20 with additives to determine effectiveness.
- Require the fuel supplier to increase the amount of No. 1 diesel in the B20, keeping the final cloud point at least 15°F below the current temperature.[129]
- Work with fuel supplier to ensure the biodiesel will not accidentally raise the cloud point above the County's 10th percentile minimum ambient temperature.
- Ask fuel suppliers to provide results of their fuel performance in winter months that they deliver to Central Atlantic fleets to ensure it is compatible with the County's climate.
- Ask the fuel supplier about different pricing options for each cold weather blend of B20.
- Ask the fuel provider if additives will be necessary to guarantee cold weather operability and the associated pricing options.
- If B20 is not possible in winter months, the County should use a lower blend of biodiesel like B10 or B5, allowing some emissions savings to still be realized.

Additives

Fuel additives can improve and support the suitability of biodiesel for long-term storage and cold weather. Cold flow improvers lower the cloud point of the biodiesel blend to prevent filter plugging by preventing the growth of wax crystals in the fuel.[130] It is important to note that the National Biodiesel Board does not endorse the performance of any fuel additives, but cold weather fleets still rely on additives and they are generally more affordable than No. 1 diesel.[131] Regardless of additive use or endorsement, to ensure fuel quality is acceptable for fleet use, all fuel should meet ASTM specification D7467.[132]

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[129] DOE. 2008. "Biodiesel Handling and Use Guide." Retrieved from: https://www.canr.msu.edu/uploads/files/Fuels/Handling%20and%20Use%20Guidelines.pdf

[130] National Biodiesel Board & Advanced Fuel Solutions. 2007. "Biodiesel Fuel Management Best Practices for Transit." Retrieved from: https://rosap.ntl.bts.gov/view/dot/16246/dot_16246_DS1.pdf

[131] Illinois Soybean Association. 2018. "Biodiesel Specialist Shares Five Steps to Better Cold Weather Fuel Performance." Retrieved from: https://www.ilsoy.org/press-release/biodiesel-specialist-shares-five-steps-better-cold-weather-fuel-performance

[132] This is the ASTM standard for biodiesel blends B6 to B20. Additional information may be found at: https://www.astm.org/d7467-20a.html

Performance

B20 typically performs equivalently to diesel. However, issues with performance can arise if the biodiesel blend is not appropriate for cold weather. If fleet managers choose to use additives in their winter B20 blends, industry literature indicates there are no serious performance issues associated with any cold flow improvers. Similarly, a common concern for fleets, is whether using B20 will void the vehicle warranty. Many OEMs have stated that using biodiesel blends up to B20 will not void their warranty.[133] Some OEMs specify that the biodiesel blends must meet ASTM D-6751 specifications to not void their warranty. The County should conduct an extensive review to determine whether the use of B20 in their fleet vehicles will void the OEM's warranty.

Seasonal Blend Transitions

Some jurisdictions that experience colder weather transition to B5 in winter months to prevent gelling issues in their vehicles. Typically, these locations regularly experience temperatures much lower than 32°F (e.g., Minnesota) and need to reduce the biodiesel blend to keep the fuel above its cloud point. This transition does not occur instantaneously. Rather, the amount of biodiesel blended into the fuel supply steadily declines for a period of weeks (e.g., biodiesel blend level is 20% from May through September, falls to 10% in the fall, drops to 5% in the winter, rises to 10% in the spring, and finally returns to 20% for the summer).[134] To blend down biodiesel, the County can continually add lower and lower blends to fuel storage tanks until the average biodiesel blend drops to 5%, which can take a couple weeks. Fleet Services may need to adopt this practice if procured biodiesel has a cloud point above the temperatures listed in Table 21.

Fleet Maintenance and Technician Training

Electric Vehicles

EVs require less maintenance than ICE vehicles, but they can involve new skills, knowledge, and techniques. To ensure the fleet maintenance staff and technicians receive adequate training on EV and EVSE maintenance, the County 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 that teaches participants the different 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 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.

[133] Statements made by OEMs are available at: https://www.biodiesel.org/using-biodiesel/oem-information
[134] Minnesota's B20 Handling Guide provides an example of how to transition to lower biodiesel blends in winter months.

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

Biodiesel

Biodiesel is a drop-in fuel and does not require changing any vehicle parts for fleet use. While there should be no significant changes to how mechanics interact with these vehicles, the County should consider increasing vehicle maintenance intervals to ensure filters are unclogged and that there is plenty of lubrication oil. Biodiesel acts as a cleaning agent, which can loosen petroleum deposits in a vehicle's fueling system and clog the filter. This is an issue that disproportionately impacts older diesel vehicles, as they have accumulated more petroleum deposits throughout their lives. If drivers report sluggish acceleration, the filter is likely plugged, and the vehicle should be serviced immediately. However, the cleaning effects of biodiesel depend heavily on the blend level. Blends above 35% biodiesel have a much stronger cleaning effect than B20 and lower.

To ensure vehicles operate efficiently and effectively, the County should take a few steps to prepare their mechanics:

- Hold mandatory general biodiesel training for all mechanics with special training on complications associated with biodiesel in diesel vehicles with petroleum buildup and use in winter months. The training should cover fuel filters, additives, nozzle coking, and fuel stabilizing.
- If Fleet Services finds that filters clog more frequently with B20 than they do with diesel, the fueling system should be checked and replaced with biodiesel-compatible parts.

Training and educational resources include:

- Advanced Biofuels USA's Online Courses resource.
- ASTM International's Biodiesel eLearning Bundle.
- Clean Fuels Alliance America's (formerly National Biodiesel Board) Biodiesel Training Toolkit.
- U.S. Department of Energy National Renewable Energy Lab's Biodiesel Handling and Use Guide.
- U.S. Department of Energy's Office of Science and Technical Information's biodiesel resources.
- West Virginia University's National Alternative Fuels Training Consortium.

Funding Options and Opportunities

At the time of this assessment, all active financial incentive programs that were collecting applications were incorporated into the electrification assessment. While no state-level incentive programs were actively seeking applications, the County should continue to monitor both the federal and state incentive programs listed below and monitor for the release of future programs. Similarly, the County should monitor programs and incentives offered by Potomac Edison. Programs listed below may offer future funding. The U.S. Department of Energy's Alternative Fuels Data Center[135] lists all currently available Maryland and Federal EV and EVSE incentives. Maryland funding opportunities include:

- **MEA EVSE Rebate Program:** MEA offers a rebate to individuals, businesses, or state and local government entities for the purchase and installation of qualified EVSE.
- **MEA Clean Fuels Incentive Program:** MEA offers grants to local government fleets for the purchase of new light-, medium-, and heavy-duty AFVs, including EVs and vehicles using biodiesel.
- **MEA Solar Canopy Grant Program:** MEA offers grants to businesses, non-profits, government entities, public schools, and community colleges to install solar canopies on parking lots and parking garages to support EV charging stations under or around the solar canopy.
- **Maryland Smart Energy Communities Program:** MEA offers grants to local governments for transportation-related projects, including the purchase of new EVs, AFVs, or EV charging stations.
- **Maryland Department of the Environment (MDE) Charge Ahead Grant Program:** MDE offers grants to local governments, along with other entities, for the purchase, design, installation, and operation of workplace Level 2 EVSE.

Utility program opportunities include:

- **Public Charging Stations – Potomac Edison:** Potomac Edison offers to install and operate public Level 2 or DCFC EVSE on government property at no cost to government hosts.

Federal funding opportunities include:

- **Buses and Bus Facilities Program:** FTA offers grants to government entities for the replacement, rehabilitation, and purchase of buses, vans, related equipment, and associated facilities.
- **Commercial EV and FCEV Tax Credit:** This tax credit is available for the purchase of new EVs and FCEVs. Tax credits are available for the incremental cost of light-, medium-, and heavy-duty EVs and FCEVs. The County may elect to receive this tax credit as a direct payment.
- **Discretionary Grant Program for Charging and Fueling Infrastructure**: This grant program will allocate $2.5 billion into two different funding opportunities: one for alternative fuel infrastructure along corridors and one for alternative fuel infrastructure in communities. The corridors through Frederick County include I-70, I-270, and US-15. The community grants will offer an opportunity for the County to receive funding to build EV charging stations on public roads, parking facilities, and at public buildings, schools, and parks. Rural areas, low- and moderate-income neighborhoods, and communities with low ratios of private parking and high ratios of multifamily housing will be prioritized for funding. Minimum standards and requirements for EV charging infrastructure, as

[135] AFDC. 2022. "Federal and State Laws and Incentives." Retrieved from: https://afdc.energy.gov/laws

outlined in the NEVI Formula Program Final Rule from February 2023, will apply to all Title 23 funded EV charging programs.

- **Infrastructure for Rebuilding America (INFRA) Grant:** The US DOT provides grants to local governments, among other entities, for transportation projects that address climate change and environmental justice concerns, including ZEV infrastructure.
- **Carbon Reduction Program:** The US DOT will establish a program to provide grants for truck stop electrification, diesel retrofits, AFVs, EV charging stations, and the purchase or lease of EVs. This program should be available by November 15, 2023.
- **Heavy-Duty ZEV Grants:** US EPA is creating a Clean Heavy-Duty Vehicle Program that will provide funding for the replacement of heavy-duty vehicles with ZEVs, the deployment of ZEV-related infrastructure, and workforce development.
- **Higher Blends Infrastructure Incentive Program (HBIIP):** The U.S. Department of Agriculture offers grants for the installation, retrofitting, and upgrading of fueling equipment and infrastructure to dispense biofuels above certain blends, including biodiesel blends above 5%.
- **Low and Zero Emission Public Transportation Funding:** The US DOT FTA provides grants to local governments for the purchase or lease of low or zero emission transit buses and associated charging infrastructure. Funding is available through fiscal year 2026.
- **Public Transportation Innovation Program:** The US DOT FTA offers grants to local governments for the deployment zero emission public transportation vehicles.
- **Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grants:** US DOT offers grants to local governments for the purchase of EVs and associated charging infrastructure.
- **Energy Efficiency and Conservation Block Grant (EECBG) Grants:** US DOE offers grants to government entities for a variety of energy efficiency projects, including ZEVs and associated infrastructure.

Cooperative Purchasing Programs

Cooperative purchasing programs allow groups within the same industry to form a collective unit to buy goods or services. In this case, a cooperative purchasing program can be used to help the County purchase vehicles. These types of programs help government entities, among other groups, to combine purchasing requirements into a single contract, aggregate volume, and enhance purchasing power. Benefits of joining a cooperative may include lower prices, less time in procurement and contracting, and more favorable terms and conditions in purchasing. However, while cooperative purchasing programs provide price ceilings, they may not always offer the most competitive prices and may minimize the control the County fleet has over vehicle procurement contracts.

The County should consider the following questions before joining a cooperative purchasing program:

- **Age:** How long has it been operating?
- **Fees:** Will the County need to pay a one-time or annual fee to be part of the cooperative?
- **Contracts:** How does the cooperative solicit, evaluate, and award contracts? What procurement rules or laws does it follow?
- **Customer Service:** Does the cooperative offer customer service for questions, concerns, or requests for information? Will the County be able to get the information it needs to make smart purchasing decisions with the cooperative?

If the County is considering joining a cooperative purchasing program, MWCOG and the Baltimore Metropolitan Council are partners in the development of the Mid-Atlantic Purchasing Team (MAPT), which provides additional opportunities to participate in cooperative purchases and to ride on the contracts of these jurisdictions. The County may join MAPT to purchase commodities and services through economies of scale and reduce administrative costs. The County can make recommendations for commodities, such as EVs or AFVs, and volunteer to serve as a lead jurisdiction. Similarly, Montgomery County, Maryland, recently launched a pilot EV purchasing cooperative in early 2022.[136] However, at this stage, Montgomery County's program is still in development and not ready for evaluation or adoption. In the future, Montgomery County intends to offer residents, businesses, and surrounding local governments the opportunity to join the cooperative and secure negotiated discounts on new and used EVs. If interest in joining a purchasing cooperative persists, the County should monitor the development of Montgomery County's program and inquire about program details. With increasing interest in EVs and AFVs, other jurisdictions may be interested in participating in a solicitation with the County.

[136] Montgomery County. 2022. "Montgomery County Launches Region's First EV Purchasing Cooperative Pilot Program and Issues Challenge for Residents to Buy EVs." Retrieved from: https://www2.montgomerycountymd.gov/mcgportalapps/Press_Detail.aspx?Item_ID=39884

County Vehicle Policies

County Vehicle Policies and Procedures

The County Division of Public Works' Vehicle Operator Policy and Procedures does not explicitly mention EVs or AFVs. Additional guidance may be necessary to ensure compliance with County vehicle policies. Similarly, additional training may be necessary to ensure driver safety and comfort while operating AFVs. The County should also add EV etiquette, charging, vehicle accident procedures, take-home vehicle assignments, and vehicle maintenance procedures to County vehicle policies.

The County Division of Public Works is developing an EV charging policy that aims to ensure the availability of EVSE for EVs in the County fleet by standardizing EV charging station availability for fleets and the public, specifying electricity rates, and ensuring parking enforcement in EV charging station parking locations. However, these policies need to be officially adopted before they are effective.

At the state level, Maryland requires that EV charging station spaces remain available only to EVs and legislated this policy in early 2022 (Transportation Article § 21-1003.2). This policy prevents individuals from stopping, standing, or parking a vehicle in a designated EV charging space unless it is an EV that is actively charging and will fine violators.[137] The County should consider adopting a similar policy for fleet vehicle parking locations to ensure all fleet vehicles always have access to EVSE.

EVSE Pre-Wiring and Building Codes

Building codes are a common mechanism through which state and local governments can require pre-wiring or charging. Pre-wiring involves installing raceways and infrastructure capable of supporting future electrical demands from EV charging. Having the electrical infrastructure pre-installed will allow the charging station equipment to be easily and cost-effectively added later. Maryland requires that builders must provide buyers the option to include a Level 2 EV charging station or electric pre-wiring to support a Level 2 EV charging station in all new homes which include a garage, carport, or driveway.[138] The County Code requires that new construction of residential single-family detached units and townhouses and duplexes having an on lot parking area must include an electric panel and raceways with capacity to support wiring for a Level 2 EV charging station.[139] The County's building standards for County buildings include general pre-wiring requirements. Components to incorporate in make-ready EV building codes Components to incorporate in make-ready EV building codes include:

- Clear voltage requirements that indicate future installation of a Level 2 or DCFC station.
- Requirements for electrical conduit and wiring to run electricity to EVSE.
- Requirements for electrical panels positioned near dedicated EV parking spaces.
- The number of parking spaces that must be EV-ready.
- An indication of whether the pre-wiring requirements apply to new buildings, existing buildings, and/or large renovations. Make-ready infrastructure is more affordable to include in new buildings or large renovation projects, which is why many make-ready requirements are not focused on existing buildings.

[137] Maryland Senate Bill 146, 2022 and House Bill 157, 2022
[138] Maryland Statutes. 2022. "Public Safety Code 12-205." Retrieved from: https://mgaleg.maryland.gov/mgawebsite/
[139] Frederick County Code. 2022. "1-6-23." Retrieved from: https://www.frederickcountymd.gov/7989/Regulations-and-Ordinances

- Identification of what buildings the pre-wiring code applies to (e.g., all County-owned buildings, certain departments, school buildings, etc.)

The Pacific Northwest National Laboratory published sample code for residential and commercial building EV-make ready requirements. The sample code also includes definitions of EV-capable and EV-ready.[140] The same report contains a table of cities with EV charging infrastructure requirements for residential and commercial buildings.

Examples of pre-wiring requirements for EVSE at the state level include:

- **Connecticut:** Beginning January 1, 2023, new state buildings with project costs greater than $100,000 must install Level 2 EV charging stations at a minimum of 20% of light-duty vehicle (LDV) parking spaces. New commercial or multi-unit dwelling buildings with at least 30 LDV parking spaces must be capable of supporting Level 2 or DCFC stations at 10% of such spaces.
- **Virginia:** Any executive branch agency or institution designing new building construction of more than 5,000 square feet, or a renovation that costs more than 50% of the value of the building, must include EV charging infrastructure. EV charging infrastructure must be sufficient to support charging for every centralized fleet vehicle based at that building.
- **Virginia:** Any locality designing new building construction of more than 5,000 square feet, or a renovation that costs more than 50% of the value of the building, must include sufficient ZEV charging and fueling infrastructure. The building must be capable of supporting projected ZEV charging and fueling demand over the first 10 years following building occupancy. Alternatively, the building must earn a ZEV or EV charging credit from the Virginia Energy Conservation and Environmental Standards (VEES), the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) green building rating standard, or the Green Building Initiative's Green Globes building standard.

EVSE Permitting

Permit applications for EV charging installations are generally reviewed to ensure compliance with building, electrical, accessibility, and fire safety regulations. It is common for municipalities around the country to require these permit applications to be submitted by station developers, site hosts, or contractors prior to beginning construction on a project. Jurisdictions may also require EV charging stations to comply with public safety, structural, and engineering review processes. Failure of an application to satisfy a local jurisdiction's compliance standards will likely result in an application being returned to the submitter with a request for revisions. This process of submission, review, and revision can continue until the application meets all required standards.

While permits are designed to ensure the safety and reliability of EV chargers, a lengthy permitting cycle can discourage those wishing to install EV charging stations. Implementing a streamlined permitting process can greatly cut back on the project time and costs associated with installation.

The County permitting process currently aligns with most EVSE permitting best practices, like creating a streamlined approval process and publishing an estimated processing time. The County currently has a 2-step permitting application process. First, the location must be chosen on an approved site plan. Site plans may either be for an original development or an amended site plan for an existing development.

[140] Example code can be found at: https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021.pdf

Once site plans are submitted or approved, commercial non-residential sites may need additional building permits.

Any new wiring, such as that required for installation of EV charging stations, requires an electrical permit from the County. While the County offers expedited permitting through its Expedited Permit and Inspection Certificate, EV charging stations are not an eligible project. According to the County Department of Permits and Inspections, electrical permits are usually issued within a time frame of one to two days from the day the application is submitted. Applications must be submitted before the wiring is started. The County should develop an expedited process for EVSE permitting to ensure infrastructure deployments are not unnecessarily delayed.

Vehicle Acquisitions

Vehicle acquisition policies outline how a fleet will plan for and purchase vehicles. These policies can outline the types of vehicles a fleet should prioritize for purchasing, vehicle retirement and replacement requirements, and timelines for integrating select technologies into the fleet. In the case of the County, the County should set vehicle acquisition policies that support EV prioritization and adoption. This will provide guidelines for fleet vehicle purchasing and help ensure the fleet is working towards supporting decarbonization goals. Best practices for designing vehicle acquisition requirements include:

- Identify vehicle technology that the County would like to integrate into the fleet (e.g., EVs).
- Consider setting priorities for different technologies so that Fleet Services purchases preferred alternative fuel vehicles before others.
- Add caveats for use cases or scenarios where EVs or PHEVs may not be affordable or appropriate for assigned tasks to prevent requiring the County from purchasing vehicles that are too expensive or not effective.
- Add fuel economy standards.
- Set different goals for light-, medium-, and heavy-duty vehicles if necessary to prevent purchase requirements that will not meet use case needs (e.g., EV acquisition requirements only apply to light-duty vehicles whereas MHD vehicles may be.
- Set purchase price thresholds for vehicle purchases

Examples of vehicle fleet acquisition requirements include:

- **Maryland:** 100% of passenger vehicles in the state fleet must be ZEVs by 2031 and other light-duty vehicles must be ZEVs by 2036. To support the state fleet transition to ZEVs, state agencies must coordinate vehicle acquisition efforts to increase the share of ZEVs in the state fleet.
- **Arizona:** At least 75% of the total municipal fleet must operate on alternative fuels. Alternatively, municipal fleets may meet AFV acquisition requirements through biodiesel or other alternative fuel use or apply for waivers. Local governments in counties with populations of more than 500,000 people with bus fleets must purchase or convert buses to operate on alternative fuels. For the purpose of these requirements, alternative fuels include propane, natural gas, electricity, hydrogen, qualified diesel fuel substitutes, E85, and a blend of hydrogen with propane or natural gas.
- **Connecticut:** In addition, all cars and light-duty trucks that the state purchases or leases must be hybrid electric vehicles, PHEVs, or capable of using alternative fuel. All AFVs purchased or leased must be certified to the California Air Resources Board's (ARB) Ultra Low Emission Vehicle II (ULEV II) standard, and all light-duty gasoline vehicles and hybrid electric vehicles the state purchases or leases must be certified, at a minimum, to the California ARB ULEV II standard.

Beginning January 1, 2026, cars and light-duty trucks purchased by state agencies must meet the following EV acquisition goals:

- 50% of vehicle acquisitions must be EVs by 2026.
- 75% of vehicle acquisitions must be EVs by 2028.
- 100% of vehicle acquisitions must be EVs by 2030.

- **District of Columbia:** Fleets that operate at least 10 vehicles in the District of Columbia must ensure that 70% of newly purchased vehicles with a gross vehicle weight rating (GVWR) of 8,500 pounds (lbs.) or less and 50% of vehicles with a GVWR between 8,500 lbs. and 26,000 lbs. are clean fuel vehicles. For this requirement, a clean fuel is any fuel, including diesel, ethanol (including E85), hydrogen, propane, natural gas, reformulated gasoline, or other power source (including electricity) used in a clean fuel vehicle that complies with standards and requirements applicable to such vehicles.

Additional vehicle acquisition requirement examples can be found in the AFDC.

Historic Preservation Review

The installation of EV charging stations may require additional review if the desired project location is on the Register of Historic Places.[141] The Frederick County Historic Preservation Commission reviews exterior changes to a County Register property, which would include EV charging stations, to ensure the proposed changes minimally impact the historic character of the property. As of April 2022, there are 24 registered historic places in Frederick County. Historic preservation laws require state and federal government agencies to consider the effects of their projects on historic and archaeological resources through a consultation process known as "Section 106" review. Local agencies may submit projects for review to the Maryland Historical Trust. The City of Frederick has a separate electrical permitting process from the County, which eligible EV charging stations need approval for prior to installing.[142] If the proposed property is in a historic area, Historic Preservation Commission or staff-level historic preservation approval is required before an electrical permit is secured.[143]

[141] See the list of Frederick County Register of Historic Places on Frederick County's Historic Preservation website.
[142] City of Frederick. Permits & Applications. Retrieved from: https://www.cityoffrederickmd.gov/902/Permits-Application-Center
[143] City of Frederick. Historic Preservation. Retrieved from: https://www.cityoffrederickmd.gov/225/Historic-Preservation

Fleet Electrification Case Studies and Lessons Learned

Frederick County Ford E-Transit Test

In 2022, after reviewing initial recommendations, Fleet Services worked with a local dealer to test Ford E-Transit vans. After piloting the vehicle, Fleet Services determined the vehicle would not meet fleet range needs. The primary issues Fleet Services experienced with this vehicle had to do with range and speed. Fleet Services reports that the vehicles could not achieve a speed greater than 60 miles per hour on I-70 when weight loaded and driving uphill. Alternatives to this vehicle make and model include Arrival Van H1 and H2 Cutaway; ELMS Urban Utility; Ford F-350, F-450, or F-550; GMC 3500 or 4500 Cutaway; and others.

Frederick County's EV Pilot Program

In 2021, the County rented a Hyundai Kona EV for several County departments to test-drive in weekly segments and provide feedback via a survey. Results were overall positive and the following benefits were reported by test drive participants:

- Easy to operate.
- Provided a comfortable ride.
- No stopping to "fill up" the tank.
- Warmed up faster than an ICE vehicle.
- User-friendly interface.
- No tailpipe emissions.

Conversely, some of the drawbacks reported include:

- Small interior of the Hyundai Kona created concerns for storage and transporting passengers.
- May not be appropriate for off-road or construction uses due to low ground clearance and lack of AWD or 4WD.
- Anxiety regarding if the vehicle was not plugged in to charge overnight.

The pilot found that EV sedans and SUVs are a reliable option for the County fleet, especially as the EV market grows and more options will become available.

Alaska Gateway School District Electric Buses

Transportation provider, Tok Transportation, operates Alaska's first electric school bus. The electric bus has successfully operated in winter weather—with temperatures as low as -40°F—without missing a shift for two years. To help the bus operate in extreme cold, bus operators add some insulation around the batteries to minorly improve vehicle efficiency. The primary issue with vehicle operation is warming the bus, which reduces the vehicles battery charge by over 50% on extremely cold days.[144]

Massachusetts Electric School Buses

Three Massachusetts school fleets participated in a pilot project to upgrade the school bus fleet to include electric school buses and Level 2 bidirectional vehicle-to-grid (V2G) charging stations to test the

[144] Ellis, Tim. 2021. *"Alaska's first electric-powered school bus is performing well – even at 40 below."* Retrieved from: https://alaskapublic.org/2021/11/16/alaskas-first-electric-powered-school-bus-is-performing-well-even-at-40-below/

technology in cold weather environments. Combined, the three electric school buses traveled approximately 14,000 miles and provided transportation 279 days. A critical takeaway from the pilot program was the importance of charging EVs at night to minimize higher charging costs and help reduce peak load at the substation level.[145]

District of Columbia Biodiesel Refuse Trucks

The District of Columbia's Department of Public Works mandated the use of B100 in the District's diesel fleet vehicles. In 2018, the District launched a pilot program to use B100 in six refuse trucks. The pilot program reduced emissions by 75%, and the district reported minimal operational impacts. The pilot program paved the way for the District to purchase 17 new B100 trucks in 2020, and the biodiesel trucks are still used throughout the district at the time of this report.[146]

Iowa DOT Biodiesel Snow Removal and Road Maintenance Trucks

The Iowa Department of Transportation has used B20 for more than 20 years without traditional issues associated with biodiesel. After the success of B20, Iowa launched a pilot program in 2020 to test B100 in five trucks. The pilot program resulted in the purchase of an additional five B100 trucks. Today, these trucks are even used in colder temperatures for snow removal and road maintenance during the winter.[147]

Baltimore Gas and Electric

Baltimore Gas and Electric (BGE) has committed to electrifying 50% of their fleet by 2030.[148] The BGE fleet is made up of 1,300 vehicles and 700 pieces of equipment. They are piloting emerging technologies such as electric excavators and trailer movers. Best practices included:

- Utilizing management software to track scheduling, parts inventory, maintenance and repair activity, and expenses, and accessing telematics data to analyze engine operating parameters and to serve as an early warning diagnostic tool.[149]
- Promoting strong collaboration with fleet managers from other companies.

Maryland Fleet Electrification

At the state level, Maryland has been replacing eligible retired vehicles with EVs. Maryland Department of General Services leads the strategy for planning and installation of EV infrastructure, with support from MEA, MDE, MDOT, and the Department of Budget and Management.[150]

DGS developed a phased approach for planning and installation of EV infrastructure. Part I of Maryland's EV Infrastructure Strategy included the installation of 21 charging ports installed at 6 sites, which supported 45 vehicles added to the state fleet. Phase II plans for future needs, using a data-based approach to ramp up infrastructure. Phase III will evaluate charging needs of fleet vehicles and consider expansion needs for fleet-only charging. In Phase I and II, some fleet charging infrastructure was shared

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[145] AFDC. 2020. "Massachusetts School Fleets get Answers through Electric Bus Testing." Retrieved from: https://afdc.energy.gov/case/3092
[146] District of Columbia Department of Public Works. 2019. "DPW to Receive Felet Leadership Award for Its Use of Clean Fuel." Retrieved from: https://dpw.dc.gov/release/dpw-receive-fleet-leadership-award-its-use-clean-fuel
[147] Biodiesel Magazine. 2022. "Iowa reduces emission from snow removal with B100 fueled trucks." Retrieved from: https://biodieselmagazine.com/articles/2518161/iowa-reduces-emissions-from-snow-removal-with-b100-fueled-trucks
[148] Yost, R. 2020. "Solar EV chargers provide BGE's EV fleet with flexibility and full batteries." *BGE Now*. Retrieved from: https://www.bgenow.com/2020/10/27/solar-powered-ev-chargers-provide-flexibility-and-full-batteries/
[149] Skydel, S. 2022. "Utility fleet plugs into electrification." *FleetOwner*. Retrieved from: https://www.fleetowner.com/emissions-efficiency/electric-vehicles/article/21213603/bge-fleet-plugged-in
[150] Maryland Department of General Services. 2022. "EV Infrastructure at Maryland State Facilities." Retrieved from: https://dgs.maryland.gov/Documents/ElectricVehicle/StatewideEVStrategyDocument.pdf

with workplace and public charging. A high-level process overview is available in Maryland's EV Infrastructure at Maryland State Facilities document.

Best practices from the Maryland EV Infrastructure Strategy include:

- Coordination of state agencies by developing a centralized EV program, standardized policies and procedures, legal agreements, procurements, and other guidance.
- Data collection on existing, planned, and in progress EV charging infrastructure at state facilities.
- Anticipating future needs of the state EV fleet by identifying potential EV charging station sites.
- Coordination with utilities on statewide EV infrastructure through the Public Service Commission (PSC) pilot program.

Howard County Police Department

As of June 2021, the Howard County Police Department had 187 electric and hybrid vehicles, making it the largest EV fleet in Maryland at the time. Analysis by the Department found that PHEV patrol cars used 80% less gas when idling.[151] The fleet includes hybrid Ford Explorers, Nissan Leafs, and electric motorcycles. Best practices included:

- Prioritizing vehicles with energy efficient idling settings, due to frequent idling of police vehicles.
- Procuring longer range vehicles to reduce range anxiety for users.
- Demonstrating the business case and lower costs for EVs.
- Providing Level 1 chargers for Nissan Leafs if home charging is not available.

[151] PlugInSites. 2021. "Howard County Police Add EVs to Fleet." Retrieved from: https://pluginsites.org/howard-county-police-add-electric-vehicles-to-fleet/

Additional Considerations

Fuel Payments and Billing for Fleet Vehicles

Fuel payments are often a large expense for fleets. The County is no exception, with annual fuel costs reaching almost $2.8 million. Tracking fuel and electricity consumption across County departments and by vehicle can help the County better manage fuel consumption. Fuel cards present an easy, useful way to track fuel purchases. Fuel cards can track information and reveal driving habits, vehicle conditions, and other data related to fuel consumption. Similarly, fuel cards can require a driver (or department) ID to identify who is purchasing the fuel, restrict purchases, and alert the fleet manager of questionable fuel purchases. Considerations for fuel cards include:

- **Security:** Authorization controls or restrictions, purchasing limits, alerts, and more.
- **Data Collection Capabilities:** Cards with Level-3 data capabilities can collect information on the amount of fuel purchased and the corresponding date, time, and location. Similarly, Level-3 data collection can include driver or department ID numbers and odometer readings.
- **Online Accounting:** Some cards can provide fleet managers with an online dashboard showing detailed purchasing information, including unusual behavior.
- **Restrictions:** Determine the level of control the fleet needs to have over purchase authorizations and whether drivers can spend beyond certain limits.

Vehicle-To-Grid

V2G is an emerging, smart charging technology that allows EV batteries to give electricity back to the grid, allowing car batteries to both power EVs and provide backup storage for the electrical grid. This push-and-pull of power uses bidirectional charging to move power between the vehicle and the grid through the battery. Power from V2G can be used to power homes and even larger buildings, making it a great source of backup energy. For V2G to work, charging stations must have software that allows the station to communicate with the electrical grid and evaluate the grid's electricity demand at any given time. However, this technology is still in development with few bidirectional chargers available and few studies. Because V2G is a still-nascent technology and requires EVSE technology more complex than a regular smart EVSE, they are also more expensive.

If Frederick is interested in adopting V2G technology in the future, the County should deploy chargers that at least have smart charging capabilities, which will allow the County to manage the EVSE and optimize energy consumption. For County-owned EVSE, publicly accessible EVSE may not be good options for V2G due to the nature of public charging (short-term, variable, etc.), but EVSE that are accessible only to the fleet may be a valuable investment. If the County deploys EVSE with bidirectional energy transfer capabilities, it should be in locations like fleet yards, transit depots, or behind-the-fence parking locations away from the public where fleet vehicles may be parked reliably for long periods of time (e.g., overnight). A fleet of EVs connected to V2G-capable EVSE can support the grid during peak load and emergencies, as well as provide power directly to local buildings.

Fleet Data Record Keeping Assessment and Recommendations

The County fleet contains over 1,000 on- and non-road vehicles that each have valuable data for the fleet manager to use in maintaining and evaluating the fleet. Ensuring that fleet data is up-to-date and accurate will help the fleet operate more efficiently and effectively in the long term by providing the fleet manager to evaluate vehicle use and efficiency, duty cycles, fuel consumption, maintenance and repair costs, and more. Best practices for fleet data and record keeping include:

- Develop routine data collection standards (e.g., collecting data from vehicles are regular intervals, training staff to record certain data points like vehicle mileage on a regular basis, etc.). Instead of recording this data manually, Fleet Services should consider developing an online portal for drivers to input data. Data that should be collected includes:
    - Vehicle status, annual mileage, recent odometer reading (and date recorded), vehicle fuel economy, annual fuel costs, annual maintenance costs. For EVs and charging needs, Fleet Services should also track domiciled vehicles, number of days in use, number of shifts per day, time available to charge overnight or during the day, and parking locations.
- Train drivers on how to properly record data, particularly vehicle mileage.
- Develop a quality control review process for fleet data to identify outliers in the data (e.g., extremely high or low numbers for mileage, fuel economy, maintenance costs, etc.) and examine those vehicles more closely.
- Adopt fuel cards that can track department ID, gallons of fuel purchased, and more. This will help the County identify fuel costs per vehicle or department. If fuel costs do not match vehicle mileage, fleet can investigate vehicle use and fuel purchases further.
- Purchase or update fleet asset management systems and software capable of identifying data that is out-of-date, outliers, or other vehicle complications. Fleet managers are adopting telematics systems to help automate data collection and simplify data analysis.
- Consider GPS tracking systems for real-time and historic visibility into fleet vehicle activity, duty cycles, and use.
- Adopt a consistent, routine maintenance schedule and collect data during the maintenance visit (i.e., odometer reading, track maintenance activity and associated costs, etc.). This will allow the fleet manager to keep updated cost records for each vehicle.
- Collect vehicle cost per mile, total vehicle cost trends, and vehicle operating costs. Ideally, these would be updated annually, incorporating all operation, fuel, and maintenance costs logged throughout the year. Once individual vehicle costs are calculated, the fleet manager may use aggregate the data to identify trends in costs in particular vehicle groups.

Next steps for updating fleet data record keeping include:

- Reviewing the fleet data to identify any fields that have not been updated in the last 12 months.
- Identify a point in the year to conduct a fleet data quality review. To prepare for this review, Fleet Services should identify any outliers in the data.
- Develop data collection standards for EVs and EV charging station use. This includes considerations like:
    - How EVs are performing. (e.g., Are they meeting range requirements? Are they able to perform their assigned tasks?)
    - Are drivers charging regularly? Or are vehicles regularly left without charge?
    - Where are fleet vehicles charging regularly? Are there enough stations and ports to support demand?
    - How much is EV charging costing compared to equivalent ICE vehicle fuel costs?

- Which driving groups have better fuel economy? If any groups are performing particularly poorly, investigate further.

Appendices

Appendix A. Fleet Retirement Schedule Breakdown

Existing Fleet Retirement Schedule: All Vehicles

Vehicle Types	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Sedan	45	22	21	4	8	8	1	2	1		1				
SUV	15	15	28	15	19	7	18	14							
Minivan	4	2	4	1		7	11								
Medium-Duty Pickup	3	3	1	5	5				1		1				
Van	3	2	3	4	4	3	12	4							
Medium-Duty Vocational Truck	7	9	13	20	13	11	3	5	2				1		
Box Truck			1			1	1	1							
Street Sweeper			1		1										
Shuttle Bus	4	3	1	6	4		4								
Transit Bus	3	4	2	1	1	4									
School Bus	1														
Bucket Truck												1			
Heavy Truck	4	2	14	14	13	9	2	2	1	1	2				
Motorcycle				1											
Other[152]	22	3	3	2	2	4	1	3	3	4					
Total	**111**	**65**	**92**	**73**	**70**	**54**	**53**	**31**	**8**	**5**	**4**	**1**	**1**		

Existing Fleet Retirement Schedule: Assessed Vehicles[153]

Vehicle Types	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Sedan	8	2	4	1	2	4	1	2	1		1				
SUV					1										
Minivan	4	2	4	1		7	11								
Medium-Duty Pickup	3	3	1	5	5				1		1				
Van	3	2	3	4	4	3	12	4							
Medium-Duty Vocational Truck	7	9	13	20	13	11	3	5	2				1		
Street Sweeper			1		1										
Shuttle Bus	4	3	1	6	4		4								
Transit Bus	3	4	2	1	1	4									
School Bus	1														
Heavy Truck	1														
Total	**34**	**25**	**29**	**38**	**31**	**29**	**31**	**11**	**4**		**2**		**1**		

[152] "Other" vehicle types include, but are not limited to, ambulances, fire trucks, trailers, recreational vehicles, etc.
[153] Only vehicles included in the electrification assessment are listed.

Appendix B. Rightsizing Results: Vehicles for Additional Consideration

Fleet Vehicles with Zero Annual Mileage

Asset Number	Vehicle Type	Make	Model	County Department
5049	Shuttle Bus	GMC	C5500	Independent Hose Company
7021	Sedan	Ford	Focus	Social Services
7024	Sedan	Ford	Focus	Social Services
7027	Sedan	Ford	Focus	Social Services
7028	Sedan	Ford	Focus	Social Services
7031	Sedan	Ford	Focus	Social Services
39585	Sedan	Dodge	Charger	Sheriff-School Resource
38847	SUV	Jeep	Patriot	Water and Sewer Utilities
5057	SUV	Chevrolet	Suburban	Dive Team
39728	Light-Duty Pickup	Ford	F150	Solid Waste and Recycling
WC11	Light-Duty Pickup	Chevrolet	Silverado 1500	Weed Control
39729	Light-Duty Pickup	Ford	F150	Animal Control

Vehicles with Annual Mileage Under 10% of the Average for that Vehicle Type

Asset Number	Vehicle Type	Make	Model	Annual Mileage	Department
37583	Box Truck	Mitsubishi	FE145	1,307	Hazmat Team
37049	Heavy Truck	Freightliner	M2	2,885	W&S Maintenance
37389	Heavy Truck	Freightliner	M2	2,999	W&S Plant Operations
37778	Heavy Truck	Freightliner	M2-112	5,503	Solid Waste Management
39199	Heavy Truck	Freightliner	108 SD	3,944	Highway & Transportation Dept
39578	Heavy Truck	Freightliner	108 SD	6,250	Highway & Transportation Dept
27402	Heavy Truck	International	2500 Rolloff	2,985	Solid Waste Management
39469	Heavy Truck	Freightliner	Utility	762	W&S Maintenance
27058	Heavy Truck	Ford	F8000	2,331	W&S Plant Operations
39346	Heavy Truck	Freightliner	114 SD	4,161	Highway & Transportation Dept
37031	Heavy Truck	Freightliner	M2	1,829	Solid Waste Management
32790	Heavy Truck	Volvo	Truck	656	Solid Waste Management
37230	Heavy Truck	International	7400	2,032	W&S Maintenance
38900	Heavy Truck	Kenworth	T-800	2,013	W&S Maintenance
37121	Heavy Truck	International	4000 Series	233	W&S Maintenance
39728	Light-Duty Pickup	Ford	F150	935	Solid Waste Management
35898	Medium-Duty Vocational Truck	Chevrolet	K3500 Silverado	1,019	Solid Waste Management
37395	Medium-Duty Vocational Truck	Freightliner	M2106	1,966	Solid Waste Management
38531	Motorcycle	Harley Davidson	FLHTP	600	Sheriff
39411	Shuttle Bus	Chevrolet	E3500	1,134	Senior Services
39412	Shuttle Bus	Chevrolet	E3500	1,154	Senior Services
38890	Shuttle Bus	Ford	F550	803	Sherriff
5049	Shuttle Bus	GMC	C5500	1,123	Independent Hose Company
39428	Van	Dodge	Caravan	979	Library Operations
38944	Van	Dodge	Grand Caravan	2,690	Health Dept-HIV
39245	Van	Ford	Transit	2,577	Division Of Animal Control
39246	Van	Ford	Transit 350	2,080	Family Partnership
35865	Van	Chevrolet	Express 3500	1,300	Solid Waste Management
39161	Van	Ford	Van 15PSG	1,033	Sheriff-Work Release Center
39186	Van	Ford	Van 15PSG	2,339	Family Partnership
39296	Van	Dodge	Ram Promaster	2,283	Health Dept-Syringe Services
5159	Van	Chevrolet	Express 2500	1,093	Health Dept-Safe Kids
35802	Van	Chevrolet	Express G3500	2,410	Maintenance Dept
37419	Van	Ford	E350	1,088	Sheriff
39035	Sedan	Ford	Fusion	4,158	Sheriff
39615	SUV	Ford	Escape	997	W&S Administration

Annual Mileage Assumptions for 10% Mileage Assessment

Vehicle Type	Average Annual Vehicle Mileage (miles)	10% of Average Annual Mileage
Sedan	12,400	1,240
Sedan – Police	54,250	5,425
Minivan	12,700	1,270
SUV	13,000	1,300
SUV – Police	50,500	5,050
Light-Duty Pickup	11,400	1,140
Medium-Duty Pickup	24,000	2,400
Van – Passenger	30,000	3,000
Van – Cargo	27,000	2,700
Step Van	16,500	1,650
Medium-Duty Vocational Truck	24,000	2,400
Box Truck – Class 4/5	23,000	2,300
Box Truck – Class 6	23,000	2,300
Street Sweeper	12,600	1,260
Refuse Truck	23,400	2,340
Shuttle Bus	30,000	3,000
Transit Bus – Non-Articulated	45,000	4,500
Transit Bus – Articulated	45,000	4,500
School Bus – Type A	15,000	1,500
School Bus – Type C	15,000	1,500
School Bus – Type D	15,000	1,500
Bucket Truck	91,00	910
Heavy Truck – Straight Truck	10,350	1,035
Heavy Truck – Truck Tractor	65,000	6,500
Motorcycle	19,688	1,969
Motorcycle – Police	19,688	1,969
Transit Bus – Coach Bus	34,000	3,400

Appendix C. Biodiesel Fuel Suppliers in the Mid-Atlantic and Northeast Region

Business Name	Address	City	State	ZIP	Phone	B20
Apex	1622 South Clinton	Baltimore	MD	21224	410-342-7800	Yes
Tevis Energy, Inc	82 John St	Westminster	MD	21157	866-838-4764	
Buckeye	6200 Pennington Ave	Baltimore	MD	21226	410-355-0700	Yes
Tri-Gas & Oil Co., Inc.	3941 Federalsburg Hwy	Federalsburg	MD	21632	800-638-7802	Yes
Ascent Aviation Group. Inc.	115 Farrell Rd	Syracuse	NY	13209	315-625-7299	Yes
John Ray & Sons	2900 Sixth Ave	Troy	NY	12180	518-272-4432	
Metro Fuel Oil	500 Kingsland Ave	Brooklyn	NY	11222	718-383-1400	Yes
Mirabito Fuel Group	10 Carbon St	Oneonta	NY	13820	607-432-5100	Yes
New Hyde Park Oil Terminal	1900 Plaza Ave	New Hyde Park	NY	11040	516-352-4245	Yes
Sprague Energy	540 Riverside Dr	Rensselaer	NY	12144	800-225-1560	Yes
Suma Energy, LLC	303 Park Ave S #1281	New York	NY	10010	917-464-3841	Yes
TMT Biofuels LLC	3792 Hunkins Rd	Port Leyden	NY	13433	315-348-5338	
Tri-State Biodiesel	531 Barretto St	Bronx	NY	10474	718-860-6600	Yes
Windsor Fuel	80 Windsor Ave	Mineola	NY	11501	516-746-5900	Yes
American Biodiesel Energy Inc	4680 Iroquois Ave	Erie	PA	16511	814-899-0621	
Americans Energy Supply	1704 Chichester Ave	Upper Chichester	PA	19061	610-494-4874	Yes
Barnes Petroleum Products, Inc	12802 Dunnings Hwy	Claysburg	PA	16625	814-239-8161	
Beck Fuels, Inc.	4655 Susquehanna Trail	Turbotville	PA	17772	570-538-1833	Yes
Bernville Quality Fuels, Inc.	330 Blair Ave	Reading	PA	19601	610-372-2709	Yes
Drescher Fuel Oil, Inc.	193 Greble Rd	Myerstown	PA	17067	717-933-4368	
Eagle Bio Diesel	99 Wetmore Ave	Kane	PA	16735	814-837-1093	
Francis L Werley, Inc.	16527 Pottsville Pike	Hamburg	PA	19526	610-562-2236	
Glassmere Fuel Service, Inc.	1967 Saxonburg Blvd	Curtisville	PA	15032	724-265-4646	
Independence BioFuels	55 Doe Run Rd	Manheim	PA	17545	717-665-1402	
K.E. Weaver	144 Church St	Lititz	PA	17543	717-626-7169	
Keystone Biofuels, Inc.	2850 Appleton St	Camp Hill	PA	17011	717-761-3511	
Moyer Plumbing and Heating Co.	105 East Main St	Kutztown	PA	19530	610-683-7364	
Shipley Energy	415 Norway St	York	PA	17403	717-848-4100	
Sprague Philadelphia	6310 Passyunk Ave	Philadelphia	PA	19153	914-328-6770	
United Oil Company	1800 North Frankin St	Pittsburgh	PA	15233	412-231-1270	
Vincent R. Boltz, Inc.	45 Guilford St	Lebanon	PA	17046	717-272-4881	

Culpeper Petroleum Cooperative	15297 Brandy Rd	Culpepper	VA	22701	540-825-9651	
Foster Fuels, Inc.	16720 Brookneal Hwy	Brookneal	VA	24528	434-376-2322	Yes
James River Petroleum	10487 Lakeridge Pkwy Suite	Ashland	VA	23005	800-825-5599	Yes
Northern Neck Oil Company	11549 History Land Hwy	Warsaw	VA	22572	804-333-3835	Yes
PAPCO, Inc.	4920 Southern Blvd	Virginia Beach	VA	23462	757-499-5977	Yes
Phillips Energy Incorporated	2586 George Washington Memorial Hwy	Hayes	VA	23072	804-642-2166	Yes
Woodfin Watchcard	1625 N Hamilton St	Richmond	VA	23230	804-355-7104	Yes
Emerald Circle Fuel Manufacturing	1344 N West Blvd	Vineland	NJ	8360	610-737-8731	
EPDS GROUP INC	85-34 167TH St	Jamaica	NJ	11432	917-423-3959	
Innovation Fuels	126 Passaic St	Newark	NJ	07104	917-699-8877	
Medford Fuel	188 Route 70	Medford	NJ	08055	(609) 654-2188	Yes
Mitchell Supreme Fuel	532 Freeman St	Orange	NJ	07110	973-678-1800	Yes
Ross Enterprise - Vineland Shell	1955 N Main Rd	Vineland	NJ	08360	609-965-6800	
Sprague Newark	436 Doremus Ave	Doremus	NJ	07105	914-328-6770	Yes
Taylor Oil Co., Inc.	77 Second St	Somerville	NJ	08876	908-725-7737	Yes
TransMontaigne	78 Lafayette St	Carteret	NJ	07008	303-860-5304	
Petroleum Traders[154]	7120 Pointe Inverness	Fort Wayne	IN	46804	800-348-3705	Yes

[154] This Indiana supplier is listed because it is one of the fleet's current fuel suppliers.

Appendix D. Fleet Assessment Assumptions

Electrification Assessment Assumptions: Model Adjustments

Factor	Input	Note
Assessment Start Year	2024	Set by County
Vehicle Retirement Year	Based on vehicle age	Provided Fleet Services for each vehicle, June 2022
Net Present Value (NPV) Discount Rate	3%	Set by County
Diesel Price	$4.27 per gallon	Provided by County, April 2022
Gasoline Price	$3.54 per gallon	Provided by County, April 2022
Electricity Price	$0.11 per kWh	EIA 2021, average price for Maryland[155], price for delivered electricity, County approved
TCO Threshold	5% and 10%	This assumption allows the model to recommend vehicles for electrification with TCOs up to 5% more than ICE vehicle equivalents. There is also a second analysis done at the 10% TCO threshold, allowing the model to recommend vehicles for electrification with TCOs up to 10% more than ICE vehicle equivalents. Set by County.
EVs per EVSE	4	Set by ICF
Overnight Charging Availability	6 hours	Standard model assumption, assumes all EVs can charge for 6 hours overnight
eGRID Region	RFCW	Set by US EPA.[156] The electrification assessment uses the existing grid mix. No alterations were made to the County's energy sources.

[155] EIA. 2021. "Electric Power Monthly." Retrieved from: https://www.eia.gov/electricity/monthly/
[156] EPA. 2022. "Emissions & Generation Resource Integrated Database (eGRID)." Retrieved from: https://www.epa.gov/egrid

Electrification Assessment Assumptions: Model Inputs

Input Type	Notes/Source
Vehicle Type	Fleet provided, ICF adjusted to match GVWR
Make	Fleet provided
Model	Fleet provided
Year	Fleet provided
Engine Fuel Type	Fleet provided
Annual Mileage	Fleet provided. Due to annual mileage discrepancies, ICF adjusted annual mileage to reflect current odometer reading divided by the number of years the vehicle has been in service.
Typical Mileage per Day in Use	Model assumption: Annual milage divided by 250 days per year
Scheduled Vehicle Retirement Year	Fleet provided
Vehicle Sub-Type	Fleet provided, ICF adjusted as needed to match vehicle use
VIN	Fleet provided
In-Service Date	Fleet provided
Current Mileage Based on Recent Odometer Reading	Fleet provided
Date of Most Recent Mileage Reading	Fleet provided
Asset Status	Fleet provided, the fleet manager assumes vehicles with zero miles are inactive
Fuel Economy	Fleet provided; AFLEET assumptions based on vehicle type applied for outliers
Annual Fuel Costs	Calculated using annual mileage, fuel economy, and County fuel pricing
Annual Maintenance Costs	Calculated using fleet milage data, and AFLEET vehicle type assumptions (includes parts, labor, and basic insurance price)
Return to Base at Night	Model assumption, yes

Appendix E. Vehicle Electrification Recommendations

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39053	Shuttle Bus	Chevrolet	3500	2028	Aurora Health Management	Ford - E-Transit Van (Cutaway)
5%	38784	Shuttle Bus	Chevrolet	E4500	2024	Transit-Section 9 Urban Transportation	Ford - E-Transit Van (Cutaway)
5%	38785	Shuttle Bus	Chevrolet	E4500	2024	Transit-Section 9 Urban Transportation	Ford - E-Transit Van (Cutaway)
5%	38878	Shuttle Bus	Ford	E450	2025	Transit-SSTAP Grant	SEA Electric - SEA Ford F-650 EV
5%	38879	Shuttle Bus	Ford	E450	2025	Transit-SSTAP Grant	SEA Electric - SEA Ford F-650 EV
5%	39280	Shuttle Bus	Ford	E450	2027	Transit-Section 18 Rural Transportation	Ford - E-Transit Van (Cutaway)
5%	39281	Shuttle Bus	Ford	E450	2027	Transit-Section 18 Rural Transportation	Ford - E-Transit Van (Cutaway)
5%	39282	Shuttle Bus	Ford	E450	2027	Transit-SSTAP Grant	Ford - E-Transit Van (Cutaway)
5%	36073	Shuttle Bus	Ford	E350	2024	Senior Services	Ford - E-Transit Van (Cutaway)
5%	39411	Shuttle Bus	Chevrolet	E3500	2027	Senior Services	Ford - E-Transit Van (Cutaway)
5%	39412	Shuttle Bus	Chevrolet	E3500	2027	Senior Services	Ford - E-Transit Van (Cutaway)
5%	39118	Shuttle Bus	Ford	E450	2030	Transit-Section 9 Urban Transportation	SEA Electric - SEA Ford F-650 EV
5%	39119	Shuttle Bus	Ford	E450	2030	Transit-Section 9 Urban Transportation	SEA Electric - SEA Ford F-650 EV
5%	39120	Shuttle Bus	Ford	E450	2030	Transit-Section 9 Urban Transportation	SEA Electric - SEA Ford F-650 EV
5%	39121	Shuttle Bus	Ford	E450	2030	Transit-SSTAP Grant	SEA Electric - SEA Ford F-650 EV
5%	39301	Shuttle Bus	Chevrolet	E4500	2028	Scott Key Center-Buses	Ford - E-Transit Van (Cutaway)
5%	39302	Shuttle Bus	Chevrolet	E4500	2028	Scott Key Center-Buses	Ford - E-Transit Van (Cutaway)
5%	38635	Shuttle Bus	Ford	E450	2025	Scott Key Center-Buses	Ford - E-Transit Van (Cutaway)
5%	38636	Shuttle Bus	Ford	E450	2024	Scott Key Center-Buses	Ford - E-Transit Van (Cutaway)
5%	38956	Transit Bus	Eldorado	EZ Rider II	2025	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus
5%	38957	Transit Bus	Eldorado	EZ Rider II	2025	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus
5%	38958	Transit Bus	Eldorado	EZ Rider II	2025	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus
5%	39122	Transit Bus	Eldorado	EZ Rider II	2025	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus
5%	39123	Transit Bus	Eldorado	EZ Rider II	2026	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39124	Transit Bus	Eldorado	EZ Rider II	2026	Transit-Section 9 Urban Transportation	Lightning eMotors - Electric City Bus
5%	39661	School Bus	Freightliner	Thomas Bus	2024	Fire & EMS Operations	Starcraft - E-Quest XL
5%	38890	Shuttle Bus	Ford	F550	2028	Sherriff-Law enforcement	Ford - E-Transit Van (Cutaway)
5%	5049	Shuttle Bus	GMC	C5500	2026	Independent Hose Company	Ford - E-Transit Van (Cutaway)
5%	37823	Sedan	Toyota	Prius	2025	Solid Waste Management	Nissan - Leaf S
5%	39514	Sedan	Toyota	Prius	2029	Housing	Nissan - Leaf S
5%	39627	Sedan	Toyota	Prius	2029	Health Dept-Environmental	Nissan - Leaf S
5%	38762	Sedan	Honda	Civic	2024	Sheriff-Civil	Nissan - Leaf S
5%	39277	Sedan	Chevrolet	Cruze	2028	Health Dept-Environmental	Nissan - Leaf S
5%	39278	Sedan	Chevrolet	Cruze	2028	Health Dept-Environmental	Nissan - Leaf S
5%	39295	Sedan	Honda	Civic	2027	Sheriff-SAU/Task Force	Nissan - Leaf S
5%	7009	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7021	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7022	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7023	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7024	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7027	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7028	Sedan	Ford	Focus	2024	Social Services	Nissan - Leaf S
5%	7031	Sedan	Ford	Focus	2030	Social Services	Nissan - Leaf S
5%	7032	Sedan	Ford	Focus	2032	Social Services	Nissan - Leaf S
5%	7033	Sedan	Chevrolet	Cruze	2034	Social Services	Kia - Niro Plug-in Hybrid
5%	39185	Sedan	Ford	Fusion	2029	Health Dept-BHS Recovery/OTM	Nissan - Leaf S
5%	38961	Sedan	Ford	Taurus	2025	Fire & EMS Operations	Nissan - Leaf S
5%	5139	Medium-Duty Vocational Truck	Chevrolet	4500	2028	Independent Fire Company	Ford - E-Transit Van (Cab Chassis)
5%	5053	SUV	Jeep	Wrangler	2028	Independent Fire Company	Kia - Niro Plug-in Hybrid SUV
5%	5147	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2027	New Market Fire Company	Ford - E-Transit Van (Cab Chassis)
5%	5051	Medium-Duty Vocational Truck	Ford	F350	2026	United Fire Company	Ford - E-Transit Van (Cab Chassis)
5%	5063	Medium-Duty Vocational Truck	Ford	F350	2024	Middletown Fire Company	Ford - E-Transit Van (Cab Chassis)
5%	38753	Medium-Duty Pickup	Ford	F350	2024	Fire & EMS Operations	Atlis - XT (300 mi) (Crew Cab)
5%	38754	Medium-Duty Pickup	Ford	F350	2025	Fire & EMS Operations	Atlis - XT (300 mi) (Crew Cab)
5%	39328	Medium-Duty Pickup	Ford	F350	2028	Weed Control	Atlis - XT (300 mi) (Crew Cab)
5%	39329	Medium-Duty Pickup	Ford	F350	2027	Fire & EMS Operations	Atlis - XT (300 mi) (Crew Cab)
5%	39628	Medium-Duty Pickup	Chevrolet	Silverado 3500	2032	Middletown Fire Company	Atlis - XT (300 mi) (Crew Cab)
5%	32767	Medium-Duty Pickup	Ford	F350	2024	Green Valley Fire Station	Atlis - XT (300 mi) (Crew Cab)
5%	5046	Medium-Duty Pickup	Chevrolet	K3500 Silverado	2024	Junior Fire Company	Atlis - XT (300 mi) (Crew Cab)
5%	5146	Medium-Duty Pickup	Chevrolet	K3500 Silverado	2026	United Fire Company	Atlis - XT (300 mi) (Crew Cab)

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	38638	Medium-Duty Vocational Truck	Ford	F550	2026	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38914	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2032	Solid Waste Management	Ford - E-Transit Van (Cab Chassis)
5%	38929	Medium-Duty Vocational Truck	Ford	F350	2027	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39054	Medium-Duty Vocational Truck	Ford	F350	2028	Maintenance Dept	Ford - E-Transit Van (Cab Chassis)
5%	39055	Medium-Duty Vocational Truck	Ford	F350	2026	Maintenance Dept	Ford - E-Transit Van (Cab Chassis)
5%	39351	Medium-Duty Vocational Truck	Ford	F350	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39352	Medium-Duty Vocational Truck	Ford	F350	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39353	Medium-Duty Vocational Truck	Ford	F350	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39354	Medium-Duty Vocational Truck	Ford	F350	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39527	Medium-Duty Vocational Truck	Ford	F350	2031	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	38867	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2024	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38869	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2024	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38870	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2025	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38871	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2025	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38892	Medium-Duty Vocational Truck	Chevrolet	K3500 Silverado	2026	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	38893	Medium-Duty Vocational Truck	Chevrolet	K3500 Silverado	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	38904	Medium-Duty Pickup	Chevrolet	Silverado 3500	2025	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	38905	Medium-Duty Pickup	Chevrolet	Silverado 3500	2027	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	38923	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2026	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38924	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2026	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39073	Medium-Duty Pickup	Chevrolet	Silverado 3500	2025	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	39074	Medium-Duty Pickup	Chevrolet	Silverado 3500	2027	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	39141	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	2026	Maintenance Dept	Ford - E-Transit Van (Cab Chassis)
5%	39239	Medium-Duty Vocational Truck	Dodge	Ram 5500	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39402	Medium-Duty Pickup	Dodge	Ram 3500 4x4	2027	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39403	Medium-Duty Pickup	Dodge	Ram 3500 4x4	2028	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	39404	Medium-Duty Pickup	Dodge	Ram 3500 4x4	2028	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	39405	Medium-Duty Pickup	Dodge	Ram 3500 4x4	2027	Highway & Transportation Dept	Atlis - XT (300 mi) (Crew Cab)
5%	39529	Medium-Duty Vocational Truck	Ford	F350	2029	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39563	Medium-Duty Vocational Truck	Ford	F350	2029	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	5163	Medium-Duty Pickup	Ford	F350	2034	Independent Fire Company	Atlis - XT (300 mi) (Crew Cab)
5%	39581	Medium-Duty Vocational Truck	Ford	F550	2029	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39167	Medium-Duty Vocational Truck	Ford	F550	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39410	Medium-Duty Vocational Truck	Dodge	Ram 5500	2029	Fleet Services-Shop Vehicles & Equipment	Ford - E-Transit Van (Cab Chassis)
5%	39413	Medium-Duty Pickup	Ford	F350 Super Duty	2028	W&S Plant Operations	Atlis - XT (300 mi) (Crew Cab)
5%	39560	Medium-Duty Vocational Truck	Ford	F450	2029	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39710	Medium-Duty Vocational Truck	Dodge	Ram 5500	2030	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39158	Medium-Duty Pickup	Ford	F350	2028	Fire & EMS Operations	Atlis - XT (300 mi) (Crew Cab)
5%	39427	Medium-Duty Vocational Truck	Ford	F450	2030	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	38835	Medium-Duty Vocational Truck	Dodge	Ram 5500	2025	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	38980	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	38981	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39007	Medium-Duty Vocational Truck	Ford	F550	2026	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39008	Medium-Duty Vocational Truck	Ford	F550	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39025	Medium-Duty Vocational Truck	Ford	F550	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	38984	Medium-Duty Vocational Truck	Ford	F550	2029	Fire & EMS Operations	Ford - E-Transit Van (Cab Chassis)
5%	39009	Medium-Duty Vocational Truck	Ford	F550	2026	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39026	Medium-Duty Vocational Truck	Ford	F550	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39027	Medium-Duty Vocational Truck	Ford	F550	2026	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39028	Medium-Duty Vocational Truck	Ford	F550	2025	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39029	Medium-Duty Vocational Truck	Ford	F550	2026	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39166	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39168	Medium-Duty Vocational Truck	Ford	F550	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39169	Medium-Duty Vocational Truck	Ford	F550	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39170	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39171	Medium-Duty Vocational Truck	Ford	F550	2027	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39259	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39260	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39261	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39262	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39263	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39310	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39311	Medium-Duty Vocational Truck	Ford	F550	2027	Highway & Transportation Dept	Ford - E-Transit Van (Cab Chassis)
5%	39312	Medium-Duty Vocational Truck	Ford	F550	2028	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39313	Medium-Duty Vocational Truck	Ford	F550	2028	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39314	Medium-Duty Vocational Truck	Ford	F450 Super Duty	2028	W&S Maintenance	Ford - E-Transit Van (Cab Chassis)
5%	39561	Medium-Duty Vocational Truck	Ford	F550	2029	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	39562	Medium-Duty Vocational Truck	Ford	F550	2029	Parks & Rec	Ford - E-Transit Van (Cab Chassis)
5%	37587	Heavy Truck	Freightliner	CL120	2024	Solid Waste Management	Tesla - Semi
5%	39419	Minivan	Dodge	Caravan	2025	Scott Key Center-Vans	Canoo - Lifestyle Vehicle
5%	39420	Minivan	Dodge	Caravan	2024	Scott Key Center-Vans	Canoo - Lifestyle Vehicle
5%	39421	Minivan	Dodge	Caravan	2026	Scott Key Center-Vans	Canoo - Lifestyle Vehicle
5%	39422	Minivan	Dodge	Caravan	2026	Transit-SSTAP Grant	Canoo - Lifestyle Vehicle
5%	39423	Minivan	Dodge	Caravan	2026	Senior Services	Canoo - Lifestyle Vehicle
5%	38735	Minivan	Dodge	Caravan	2027	Senior Services	Canoo - Lifestyle Vehicle
5%	39267	Minivan	Dodge	Grand Caravan	2029	Transit-SSTAP Grant	Canoo - Lifestyle Vehicle
5%	39268	Minivan	Dodge	Grand Caravan	2030	Family Partnership	Canoo - Lifestyle Vehicle
5%	39325	Minivan	Dodge	Grand Caravan	2030	Scott Key Center-Vans	Canoo - Lifestyle Vehicle
5%	39326	Minivan	Dodge	Grand Caravan	2030	Scott Key Center-Vans	Canoo - Lifestyle Vehicle

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39327	Minivan	Dodge	Grand Caravan	2030	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39330	Minivan	Dodge	Grand Caravan	2029	Sheriff-SAU/Task Force	Canoo - Lifestyle Vehicle
5%	39331	Minivan	Dodge	Grand Caravan	2030	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39333	Minivan	Dodge	Grand Caravan	2029	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39337	Minivan	Dodge	Grand Caravan	2029	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39338	Minivan	Dodge	Grand Caravan	2029	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39348	Minivan	Dodge	Grand Caravan	2030	Scott Key Center-Buses	Canoo - Lifestyle Vehicle
5%	39415	Minivan	Dodge	Grand Caravan	2030	Transit-Section 18 Rural Transportation	Canoo - Lifestyle Vehicle
5%	39416	Minivan	Dodge	Grand Caravan	2030	Transit-SSTAP Grant	Canoo - Lifestyle Vehicle
5%	39417	Minivan	Dodge	Grand Caravan	2030	Transit-Section 9 Urban Transportation	Canoo - Lifestyle Vehicle
5%	39418	Minivan	Dodge	Grand Caravan	2030	Transit-SSTAP Grant	Canoo - Lifestyle Vehicle
5%	39515	Van	Chrysler	Voyager	2031	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39516	Van	Chrysler	Voyager	2031	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39517	Van	Chrysler	Voyager	2031	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	7030	Minivan	Dodge	Caravan	2024	Social Services	Canoo - Lifestyle Vehicle
5%	39077	Van	Ford	Van 12PSG	2027	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39078	Van	Ford	Van 12PSG	2027	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39079	Van	Ford	Van 12PSG	2028	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39080	Van	Ford	Van 12PSG	2029	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39245	Van	Ford	Transit	2030	Division Of Animal Control	Arrival - Van H1 Passenger
5%	39246	Van	Ford	Transit 350	2030	Family Partnership	Arrival - Van H1 Passenger
5%	38813	Van	Ford	Van 15PSG	2027	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	38814	Van	Ford	Van 15PSG	2028	Scott Key Center-Vans	Arrival - Van H1 Passenger
5%	39175	Van	Ford	Van 15PSG	2030	Parks & Rec	Arrival - Van H1 Passenger
5%	39186	Van	Ford	Van 15PSG	2030	Family Partnership	Arrival - Van H1 Passenger
5%	39189	Van	Chevrolet	Express 2500	2028	Health Dept-Recovery/OTM	Arrival - Van H1 Passenger
5%	39257	Van	Dodge	Ram Promaster	2026	W&S Maintenance	ELMS - Urban Delivery Van
5%	39270	Van	Nissan	NV200	2029	Maintenance Dept	ELMS - Urban Delivery Van
5%	39296	Van	Dodge	Ram Promaster	2030	Health Dept-Syringe Services	ELMS - Urban Delivery Van
5%	39431	Van	Ford	Transit	2030	Division Of Animal Control	ELMS - Urban Delivery Van
5%	38897	Van	Ford	Cargo	2028	Senior Services	ELMS - Urban Delivery Van
5%	39279	Van	Dodge	Ram Promaster	2030	Maintenance Dept	ELMS - Urban Delivery Van

Scenario	ID	Vehicle Type	Make	Model	Retirement	Owning Department	EV Make/Model Recommendation
5%	39408	Van	Chevrolet	Express 2500	2030	Maintenance Dept	ELMS - Urban Delivery Van
5%	39409	Van	Chevrolet	Express 2500	2030	Maintenance Dept	ELMS - Urban Delivery Van
5%	5159	Van	Chevrolet	Express 2500	2025	Health Dept-Safe Kids	ELMS - Urban Delivery Van
5%	37419	Van	Ford	E350	2026	Sheriff-Law Enforcement	ELMS - Urban Delivery Van
5%	37611	Van	Chevrolet	Express 3500	2024	IIT-Voice Services	ELMS - Urban Delivery Van
5%	38424	Van	Chevrolet	Express 3500	2024	Sheriff-Detention Center	ELMS - Urban Delivery Van
5%	38701	Van	Chevrolet	Express 3500	2027	Maintenance Dept	ELMS - Urban Delivery Van
5%	39128	Van	Ford	Transit 350	2029	W&S Maintenance	ELMS - Urban Delivery Van
5%	39307	Van	Chevrolet	Express 3500	2030	Sheriff-Detention Center	ELMS - Urban Delivery Van
5%	39323	Van	Dodge	Ram Promaster 2500	2030	W&S Maintenance	ELMS - Urban Delivery Van
5%	39545	Van	Chevrolet	Express 4500	2031	Maintenance Dept	ELMS - Urban Delivery Van
5%	39083	Street Sweeper	Isuzu	NR254	2028	Highway & Transportation Dept	Global - M3 SUPERCHARGED
10%	39521	Sedan	Chevrolet	Malibu	2031	Health Dept-BHS Recovery/OTM	Kia - Niro Plug-in Hybrid
10%	35988	Minivan	Chevrolet	Venture Economy	2024	Senior Services	Canoo - Lifestyle Vehicle
10%	39161	Van	Ford	Van 15PSG	2030	Sheriff-Work Release Center	Arrival - Van H1 Passenger
10%	5048	Van	Ford	E350 Super Duty	2026	Independent Fire Company	Arrival - Van H1 Passenger

Appendix F. Recommendations for B20 Adoption

ID	Vehicle Type	Make	Model	Owning Department
36086	Box Truck	Ford	E350	Fleet Service-Sub Pool Rentals
36499	Box Truck	Chevrolet	C3500 Silverado	Custodial Services
37583	Box Truck	Mitsubishi	FE145	Hazmat Team
39523	Bucket Truck	Ford	F550	W&S Maintenance
37003	Bucket Truck	Freightliner	M2	Highway & Transportation Dept
37446	Bucket Truck	International	4300SBA	Highway & Transportation Dept
35095	Heavy Truck	International	Tractor	W&S Plant Operations
37990	Heavy Truck	International	9400I6X4	Highway & Transportation Dept
38763	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39110	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
36057	Heavy Truck - Straight Truck	Freightliner	FL80	Parks & Rec
37049	Heavy Truck - Straight Truck	Freightliner	M2	W&S Maintenance
37389	Heavy Truck - Straight Truck	Freightliner	M2	W&S Plant Operations
37778	Heavy Truck - Straight Truck	Freightliner	M2-112	Solid Waste Managements
38884	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38885	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38894	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38895	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38896	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38898	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38899	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38906	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38907	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38909	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38910	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38911	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38912	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
38913	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39160	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39179	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39180	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39181	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39187	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39188	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39191	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39192	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39193	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39194	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39195	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39196	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39197	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39198	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39199	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39369	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39370	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39399	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39400	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39503	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39504	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39505	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39506	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39576	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39577	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39578	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
39579	Heavy Truck - Straight Truck	Freightliner	108 SD	Highway & Transportation Dept
27402	Heavy Truck - Straight Truck	International	2500 Rolloff	Solid Waste Managements
39469	Heavy Truck - Straight Truck	Freightliner	Utility	W&S Maintenance
27058	Heavy Truck - Straight Truck	Ford	F8000	W&S Plant Operations
38978	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
38979	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept

ID	Vehicle Type	Make	Model	Owning Department
39346	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39347	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39349	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39350	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39371	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39372	Heavy Truck - Straight Truck	Freightliner	114 SD	Highway & Transportation Dept
39522	Heavy Truck - Straight Truck	Kenworth	T-880	W&S Maintenance
18626	Heavy Truck - Straight Truck	International	Sept Tank Truck	Solid Waste Management
30101	Heavy Truck - Straight Truck	International	4700	Solid Waste Management
37031	Heavy Truck - Straight Truck	Freightliner	M2	Solid Waste Management
39241	Heavy Truck - Straight Truck	Mack	Tanker	W&S Plant Operations
39407	Heavy Truck - Straight Truck	Freightliner	114 SD	W&S Plant Operations
32790	Heavy Truck - Straight Truck	Volvo	Truck	Solid Waste Management
37230	Heavy Truck - Straight Truck	International	7400	W&S Maintenance
38900	Heavy Truck - Straight Truck	Kenworth	T-800	W&S Maintenance
37121	Heavy Truck - Straight Truck	International	4000 Series	W&S Maintenance
37089	Light-Duty Pickup	Ford	F250 Super Duty	Solid Waste Management
37713	Light-Duty Pickup	Chevrolet	K2500HD Silverado	Highway & Transportation Dept
39363	Light-Duty Pickup	Ford	F250	Parks & Rec
37615	Light-Duty Pickup	Chevrolet	K2500HD Silverado	Sheriff-Work Release Center
37866	Light-Duty Pickup	Chevrolet	K2500HD Silverado	W&S Plant Operations
39249	Light-Duty Pickup	Dodge	Ram 2500 4x4	Maintenance Dept
38192	Light-Duty Pickup	Ford	F250	W&S Plant Operations
38967	Light-Duty Pickup	Chevrolet	Silverado 2500	W&S Maintenance
38968	Light-Duty Pickup	Chevrolet	Silverado 2500	W&S Maintenance
37435	Medium-Duty Pickup	Ford	F350	Weed Control
35588	Medium-Duty Pickup	Ford	F350	Weed Control
37442	Medium-Duty Pickup	Ford	F350	W&S Maintenance
35898	Medium-Duty Vocational Truck	Chevrolet	K3500 Silverado	Solid Waste Management
37896	Medium-Duty Vocational Truck	Ford	F350	W&S Plant Operations
37117	Medium-Duty Vocational Truck	Ford	F350	Fleet Services-Shop Vehicles & Equipment
37897	Medium-Duty Vocational Truck	Ford	F450	W&S Maintenance
38868	Medium-Duty Vocational Truck	Chevrolet	Silverado 3500	Highway & Transportation Dept
35899	Medium-Duty Vocational Truck	Ford	F350	Solid Waste Managements
38665	Medium-Duty Vocational Truck	Ford	F550	Highway & Transportation Dept
38674	Medium-Duty Vocational Truck	Ford	F550	Highway & Transportation Dept
37395	Medium-Duty Vocational Truck	Freightliner	M2106	Solid Waste Management
37534	Medium-Duty Vocational Truck	Ford	F450	Fleet Services-Shop Vehicles & Equipment
36450	Other	Pierce	Rescue Squad	Hazmat Team
37987	Other	Freightliner	MT55	Library Operations
37988	Other	Freightliner	MT55	Library Operations
37192	Shuttle Bus	Ford	E450	Aurora Health Management
38704	Shuttle Bus	Chevrolet	4500	Transit-SSTAP Grant
38624	Shuttle Bus	Ford	E450	Transit-SSTAP Grant
38798	Shuttle Bus	Ford	E450	Transit-Section 18 Rural Transportation
38799	Shuttle Bus	Ford	E450	Transit-Section 18 Rural Transportation
38959	Shuttle Bus	Champion	Defender	Transit-Section 18 Rural Transportation
38891	Street Sweeper	Elgin	Pelican NP	Solid Waste Management
37981	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
37982	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
37983	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
37984	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
37985	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
37986	Transit Bus	Gillig	G27E102N2	Transit-Section 9 Urban Transportation
38157	Transit Bus	Gillig	G30B102N4	Transit-Section 9 Urban Transportation
38158	Transit Bus	Gillig	G30B102N4	Transit-Section 9 Urban Transportation

Appendix G. Biodiesel Infrastructure Compatibility[157]

Fuel Tank Manufacturers with Biodiesel Compatible Diesel Tanks

Manufacturer	Compatible?
Fiberglass	
Containment Solutions	✓
Owens Corning	✗
Xerxes	✓
Steel	
Acterra Group Inc.	✓
Caribbean Tank Technologies Inc.	✓
Eaton Sales & Service LLC	✓
General Industries	✓
Greer Steel, Inc.	✓
Hall Tank Co.	✓
Hamilton Tanks	✓
Highland Tank	✓
J.L. Houston Co.	✓
Kennedy Tank and Manufacturing Co., Inc.	✓
Lancaster Tanks and Steel Products	✓
Lannon Tank Corporation	✓
Mass Tank Sales Corp.	✓
Metal Products Company	✓
Mid-South Steel Products, Inc.	✓
Modern Welding Company	✓
Newberry Tanks & Equipment, LLC	✓
Plasteela	✓
Service Welding & Machine Company	✓
Southern Tank & Manufacturing Co., Inc.	✓
Stanwade Metal Products	✓
Talleres Industriales Potosinos, S.A. de C.V.	✓
Tanques Antillanos C. x A.	✓
Watco Tanks, Inc.	✓
We-Mac Manufacturing Company	✓

[157] DOE. 2016. Biodiesel Handling and Use Guide. Retrieved from: https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf

Plastic Compatible with Biodiesel Storage[158]

Material	Compatibility
Chemraz	Satisfactory
Fluorocarbon	Satisfactory
Fluorosilicon	Mild effect; increase swelling
Fluorosilicone	Mile effect
Hifluour	Satisfactory
Nylong	Satisfactory
Perfluoroelastomer	Satisfactory
Polypropylene	Moderate effect: increased swelling, hardness reduced
Polyurethane	Mild effect; increased swelling
Teflon	Satisfactory
Viton	Satisfactory; type of cure affects compatibility with oxidized biodiesel see specific types of Viton
Viton A-401C	Satisfactory with fresh RME; not recommended for oxidized blends B20 and above
Viton F-605C	Satisfactory with fresh RME; not recommended for oxidized blends B20 and above
Viton GBL-S	Satisfactory with RME and with all oxidized blends
Viton GF-S	Satisfactory with RME and with all oxidized blends

[158] Ibid.

Appendix H. Emissions Savings Details

Cumulative GHG Emissions and Reductions (MT) with EV Recommendations

Year	ICE Emissions (MT)	Recommended EV Emissions (MT)
2024	294	127
2025	1,153	463
2026	2,310	919
2027	3,850	1,548
2028	5,694	2,297
2029	7,642	3,100
2030	9,929	4,063
2031	12,205	5,029
2032	14,488	5,999
2033	16,772	6,969
2034	19,060	7,940
2035	21,349	8,911
2036	23,493	9,819
2037	25,166	10,555
2038	26,657	11,228
2039	27,918	11,798
2040	29,053	12,316
2041	30,071	12,776
2042	30,608	13,019
2043	30,876	13,156
2044	31,039	13,241
2045	31,083	13,263
2046	31,095	13,268
2047	31,100	13,269
2048	31,105	13,271
2049	31,105	13,271
2050	31,105	13,271

Electrification Recommendations: Lifetime GHG Emissions

Vehicle Types	Total ICE Emissions (MT)	Total Emissions from Recommended EVs (MT)	Total Emissions Reductions (MT)
Sedan	2,510	2,172	337
SUV	5	2	3
Minivan	2,547	1,593	954
Medium-Duty Pickup	2,822	981	1,840
Van	4,507	3,056	1,451
Medium-Duty Vocational Truck	7,752	4,478	3,274
Street Sweeper	2,240	941	1,299
Shuttle Bus	12,376	8,264	4,112
Transit Bus	14,732	10,535	4,197
School Bus	288	116	172
Heavy Truck	899	705	194
TOTAL	**50,678**	**32,843**	**17,835**

Annual Emissions Savings for B20 Adoption

Year	Diesel Cumulative	B20 Cumulative	GHG Reductions (MT)
2024	2,886	2,453	433
2025	5,773	4,907	866
2026	8,659	7,360	1,299
2027	11,545	9,814	1,732
2028	14,432	12,267	2,165
2029	17,318	14,720	2,598
2030	20,204	17,174	3,031
2031	23,091	19,627	3,464
2032	25,977	22,080	3,897
2033	28,863	24,534	4,330
2034	31,750	26,987	4,762
2035	34,636	29,441	5,195
2036	37,522	31,894	5,628
2037	40,409	34,347	6,061
2038	43,295	36,801	6,494
2039	46,181	39,254	6,927
2040	49,068	41,708	7,360
2041	51,954	44,161	7,793
2042	54,840	46,614	8,226
2043	57,727	49,068	8,659
2044	60,613	51,521	9,092
2045	63,499	53,974	9,525
2046	66,386	56,428	9,958
2047	69,272	58,881	10,391
2048	72,158	61,335	10,824
2049	75,045	63,788	11,257
2050	77,931	66,241	11,690