Wisconsin Office of Energy Innovation

Milwaukee County

Wisconsin's SAFER2 Program

January 2023

The Wisconsin Office of Energy Innovation's SAFER2 Program is a U.S. Department of Energy- funded effort to improve the efficacy of the state's response to long-term energy outages via ongoing collaboration with regional, tribal, county and local emergency management professionals. Wisconsin Clean Cities (WCC) is proud to partner with the Wisconsin Office of Energy Innovation and Wisconsin Emergency Management to serve local, county and tribal emergency managers and achieve the following goals:

- *Gaining a better understanding of the resiliency of critical energy infrastructure around the state*
- *Providing templates for fuel shortage contingency plans and cybersecurity awareness in energy outages sharing lessons learned from the 2018 Dark Sky exercise and state fuel planning process*
- *Enhancing the understanding of the roles and responsibilities of state and tribal/local partners during an energy emergency*

This Alternative Fuel Vehicle and Feasibility Study is based on information and data collected during Wisconsin Clean Cities conversations with the associated fleet. Therefore, this report is intended to be used as a reference and not as a substitute to strategic decision-making that may incorporate other administrative and operational factors.

Wisconsin Clean Cities is a 501(c)(3) nonprofit organization managed by Legacy Environmental Services, Inc., an Indiana Certified Women's Business Enterprise. Established in 1994, Wisconsin Clean Cities is one of the U.S. Department of Energy's more than 75 Clean Cities coalitions. The organizations support the nation's energy and economic security by building partnerships to advance affordable domestic transportation fuels, energy efficient mobility systems and other fuel-saving technologies and practices.

Milwaukee County
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Fleet Assessment Introduction

Wisconsin Clean Cities (WCC) has partnered with the Wisconsin Office of Energy Innovation to assist local governments in advancing energy emergency resiliency, mitigation, and response. This project is part of the Wisconsin Statewide Assistance for Energy Resiliency and Reliability or SAFER2 Program.

This Alternative Fuel Vehicle and Feasibility Study is designed to examine the feasibility and cost-savings potential of deploying a range of commercially available alternative fuel, advanced vehicle, and efficiency solutions within Milwaukee County's fleet of vehicles.

Milwaukee County provided for analysis a listing of 182 gasoline vehicles for analysis. This represents the fleet vehicles for 11 departments. Vehicle types included in the analysis include passenger cars and squad cars, passenger and cargo vans. Milwaukee County has established an Office of Sustainability and has "committed to supporting the Paris Climate Agreement and achieving zero net community emissions by 2050."[1] Following meeting with members of the Milwaukee County Supervisory Board and Fleet Director they indicated a high degree of interest in opportunities to reduce fleet emissions through the adoption of alternative fuels, particularly electric vehicles where possible.

Based on discussed goals, the vehicles provided for analysis are those with the greatest opportunity for electrification. Criteria were provided to indicate vehicles which are most likely to be due for replacement in the near future. Replacement criteria were as follows for non-squad cars a 10 to 15 year vehicle life for vans, 7-10 years for passenger cars, and 130 to 150,000 miles for squad cars. Planning generally assumes replacing 10-15 squad cars per year and 10 administrative vehicles. A preference for SUV format in replacements was indicated. Details related to other fuels will be provided for reference, comparison, and consideration.

WCC and the Wisconsin Office of Energy Innovation are pleased to present the following Alternative Fuel Vehicle and Feasibility Report to Milwaukee County. This report is designed to provide the following core deliverables:

1) Develop priority criteria and goals for the fleet in evaluating technologies.
2) Provide a baseline analysis for current fleet operations.
3) Outline relevant alternative fuels and efficiency improvements for the fleet's operations.
4) Assess the operating costs and other investments needed to implement the various technology options.
5) Provide total cost of ownership scenarios and recommendations based on the analysis.

[1] Milwaukee County Administrative Services Facilities Management. *Office of Sustainability.* *https://county.milwaukee.gov/EN/Administrative-Services/Facilities-Management/Sustainability*

Priority Criteria for Analysis

1) Use total cost of ownership projections as the primary tool for evaluating each potential fuel and vehicle technology option.

2) Provide data on environmental performance, which will factor into the decision matrix as a secondary evaluation tool.

WCC will utilize this priority criteria to evaluate alternative fuel and efficiency technologies that will be most relevant and effective for the fleet's operations. Findings throughout this report were calculated using the U.S. Department of Energy's AFLEET tool, GREET tool and the U.S. Environmental Protection Agency's Diesel Emissions Quantifier tool.

Process and Method of Analysis

In addition to the priority criteria, the analysis utilized real world fleet data provided by Milwaukee County to create key current vehicle performance profiles. The analysis utilized these profiles to create alternative fuel vehicle replacement scenarios and chart similar models of alternative fuel vehicles (including vehicle acquisition costs, miles per gallon differences, maintenance cost differences, etc.). The core analysis and report focus is on comparing the operational costs and returns on investment between the fleet's current vehicle performance profiles and various alternative fuel replacement vehicle scenarios.

Alternative Fuel or High Efficiency Vehicles

The market for and use of high efficiency and alternative fuel vehicles has continually expanded in recent years. The transportation market now includes vehicles that can fuel, or be powered by, propane, electricity, compressed or liquefied natural gas and other fuels such as ethanol or biodiesel. The enhanced fuel economy and use of alternative fuels provides fleets with an opportunity to achieve a blend of reduced operating costs, vehicle emissions and petroleum consumption. However, operational savings achieved through use of these fuels or technologies comes at a higher upfront incremental vehicle purchase price, with savings accruing over the lifecycle of the vehicle.

ALTERNATIVE FUEL COMPARISON

Fuel Type Overview

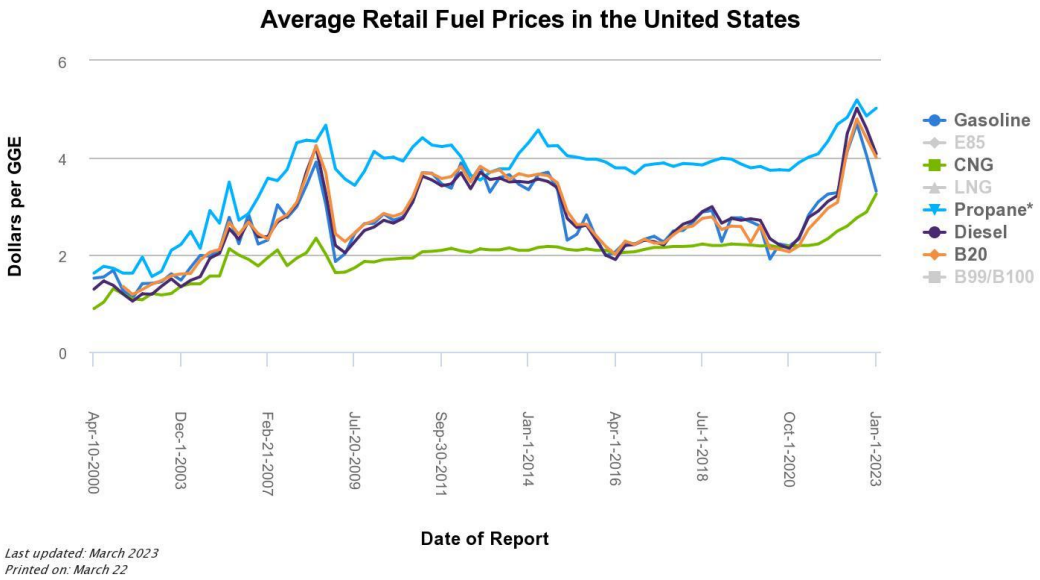
This report provides a range of alternative fuel and vehicle options for the fleet's operations. This section is designed to provide foundational information for the high-level comparison of five commercially available alternative fuel types: biodiesel (B20), ethanol (E85), compressed natural gas (CNG), propane (LPG) and electric vehicles (EV). The following sections of this report will provide a more detailed explanation and analysis of each fuel type, as well as chart out prospective vehicle and capital cost return on investment scenarios based on each fleet partner's real-world vehicle and usage data. Table 1 provides a high-level summary of each fuel option.

Table 1. High Level Alternative Fuel Comparisons					
	Biodiesel (B20)	**Ethanol (E85)**	**CNG**	**Propane**	**EV**
Basics	Biodiesel is a renewable fuel that can be manufactured from organic oils, fats or recycled grease for use in diesel vehicles	Ethanol is a widely used renewable fuel made from corn and other plant materials. It is blended with gasoline	Natural gas is a domestically abundant gaseous fuel that can have significant fuel cost savings over gasoline and diesel fuel	Propane is a readily available gaseous fuel that has been widely used in vehicles throughout the world for decades	Electricity can be used to power plug-in electric vehicles, which are increasingly available. Hybrids use electricity to boost efficiency
Retail Availability	Widely available	Widely available	Purchased through utility pipeline or retail filling station, if station infrastructure is available	Regional/local distributors	Charging infrastructure varies based on desired charging speed
Retail Cost	Moderate	Moderate	Low	Low to Moderate	Low
Tailpipe Emissions	B100 emissions offer 74% lower GHG emissions compared to petroleum diesel[2]	E85 emissions produce 40% less GHG emissions with corn-based ethanol vs. gasoline	CNG vehicles emit 13-21% fewer GHG emissions vs. gasoline and diesel vehicles[3]	Propane vehicles reduce GHG emissions by nearly 10%. When derived as a by-product of natural gas product, propane reduced petroleum use by 98% to 99%[4]	An all-electric vehicle doesn't produce any tailpipe emissions. A plug-in hybrid electric vehicle doesn't produce any emissions when it is in battery mode[5]
Major Pros	Universal availability and moderate cost. Environmental benefit	Universal availability and moderate cost savings	Low fuel cost. Low emissions & noise. Extensive distribution	Simpler station than CNG. Fuel savings vs. gasoline likely in fleets.	Lower maintenance costs, lower fuel costs, and no tailpipe emissions
Major Cons	No major cost savings. Cold flow issues if not properly treated	Lower energy per gallon. Limited environmental benefit	High cost/complexity of stations	Seasonal price spikes if not under contract. No heavy vehicle options	Limited range and not well suited to heavy vehicles because of range and battery weight. A charge takes hours and applications are limited based on vehicle drive cycle

[2] Alternative Fuels Data Center, *Biodiesel Vehicle Emissions.* https://www.afdc.energy.gov/vehicles/diesels_emissions.html
[3] Alternative Fuels Data Center, *Natural Gas Vehicles: Status, Barriers, and Opportunities*. https://www.afdc.energy.gov/pdfs/anl_esd_10-4.pdf
[4] Alternative Fuels Data Center, Propane Vehicle Emissions. https://www.afdc.energy.gov/vehicles/propane_emissions.html
[5] Alternative Fuels Data Center, Electric Vehicle Emissions. https://www.afdc.energy.gov/fuels/electricity_benefits.html

Fuel Price Report

Fuel is consistently one of the largest components of a fleet's total operating costs. And, as with most commodities, fuel prices fluctuate driven by seasonal driving demand, weather conditions, events in crude oil markets, and many other potential factors. The chart below shows average monthly retail fuel prices in United States from April 2000 to January 2023.[6]



The chart above also depicts the volatility of the retail fuel price market since 2000. Even in the most aggressive scenarios of alternative fuel adoption, the fleet will continue to use significant amounts of gasoline and diesel in various operations for years to come. Therefore, in addition to exploring hedging options, we recommend the fleet use lifecycle cost analyses to select the most energy-efficient conventional vehicle models if acquiring new gasoline or diesel-powered units.

Milwaukee County Fleet Analysis

Alternative Fuel Vehicle Analysis

Milwaukee County is interested in identifying opportunities to reduce the cost and emissions associated with its vehicle fleet. To identify potential opportunities, WCC performed a total cost of ownership calculation for replacing certain segments of the organization's fleet with alternative fuel or advanced vehicle technologies.

[6] Alternative Fuels Data Center, *Fuel Prices*, https://afdc.energy.gov/fuels/prices.html

In order to provide an accurate comparison among fuel and infrastructure types that would best suit the needs of the fleet, WCC used the following fuel costs:

Table 2. Fuel Cost Comparison		
Fuel Type	**Unit Price**	**Fuel Per One Gallon of Gasoline**
Unleaded Gasoline	$3.216 gallon	1 gallon of gasoline
Diesel	$4.212 gallon	0.88 gallons of diesel
Electricity	$0.1065 kWh	33.7 kilowatt-hours*
Propane (LPG)	$3.56 gallon	1.353 gallons of LPG
Compressed Natural Gas (CNG)	$2.68 GGE	126.67 cubic ft. of CNG
Ethanol (E85)	$3.23 gallon	1.39 gallons of E85

* According to the EPA, burning one gallon of gas produces 115,000 BTUs (British thermal units). To generate the same amount of heat by way of electricity, it takes 33.7 kilowatt-hours (kWh). Kilowatt-hours is the standard energy unit for electricity. If an electric vehicle can travel 100 miles on 33.7 kWh of electricity, the EPA rates it at 100 MPGe. As you can see, this would be a very efficient vehicle, because a gas car would have to travel 100 miles per gallon to be equivalent.

Fuel prices were based on a variety of sources, including:

- The U.S. Department of Energy's Alternative Fuel Price Report for the Midwest
- AAA Gas Prices daily average value for Wisconsin
- Electricity Local
- Fuel pricing estimates from vendors
- EIA Refiner Gasoline Prices by Grade & Sales Type

As Milwaukee County purchases fuel wholesale and distributes from its own facilities EIA Midwest (PADD2) refiner gasoline prices will be used as a primary point of comparison with commercial electricity pricing. Most recent data available for wholesale gasoline is from March of 2022.[7]

In review of the National Renewable Energy Laboratory Alternative Fuel Data Center TransAtlas Milwaukee County has public refueling stations for CNG, Ethanol (E85), Electric, and Propane. Biodiesel blends can be purchased for use in county owned fueling facilities. Electricity is priced based on commercial rates and may differ from what is available from public and dedicated county installed infrastructure. The City of Milwaukee currently has 57 electric vehicle charging stations, 3 CNG Stations, 5 LPG stations, and 6 stations offering ethanol blends.

In the case of ethanol E85, it was unknown whether any of the fleet's existing vehicles were flex fuel vehicles capable of running on E85 or mid-level ethanol blends. If this was the case, the fleet could investigate the cost of a blender pump and fuel cost for higher ethanol blends, as there may be long- term savings with this option.

[7] U.S. Energy Information Administration, *Refiner Gasoline Prices by Grade and Sales Type,* https://www.eia.gov/dnav/pet/pet_pri_refmg_dcu_R20_m.htm

Milwaukee County Fleet

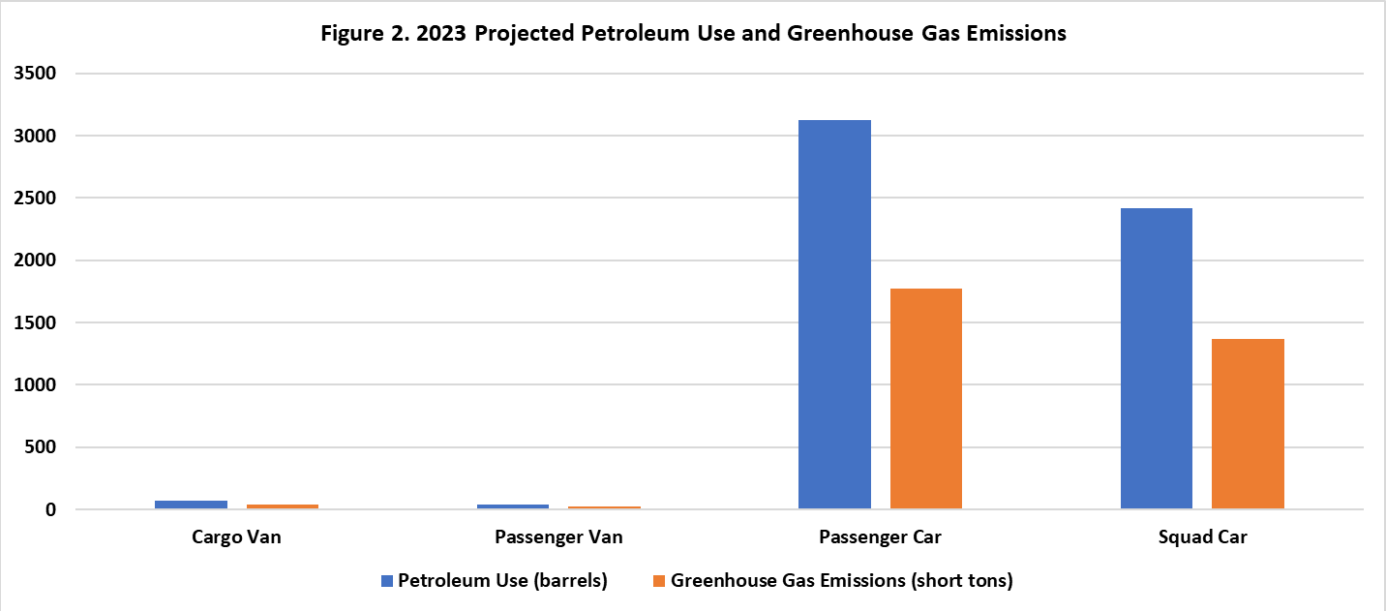
WCC performed a total cost of ownership calculation using the current fleet's usage data to provide cost comparisons for replacing certain fleet segments with new alternative fuel and high efficiency vehicles, instead of conventionally fueled vehicles. To do so, WCC grouped vehicles into segments based on vehicle size and vocation to provide a more accurate comparison between current and potential vehicle replacements. The total cost of ownership calculation provides an objective comparison of the operating and fixed costs associated with the ownership of these vehicles over their associated lifespans.

Milwaukee County provided WCC with a vehicle asset list which included unit, department, model year, make, model, fuel type, annual vehicle miles travelled, annual gallons consumed, odometer reading, and vehicle classification. Also provided was details replacement cycles and vehicle identification for replacement. WCC separated vehicles based on the provided classification details and then by department for individual segment analysis. Table 3 is based on usage in 2022. Vehicle fuel economy was calculated based on actual miles and gallons consumed details provided.

Table 3. Milwaukee County Analyzed Fleet Breakdown

Type	Number of Vehicles	Fuel	Average Model Year	Average Annual VMT	Average Annual Fuel Consumption
Cargo Van	10	Gasoline	2008	3,432	327
Passenger Van	9	Gasoline	2017	3,360	201
Passenger Car	79	Gasoline	2014	6,788	210
Squad Car	84	Gasoline	2017	15,900	1,388
Total	**182**		2015	10,639	760

Figure 2 provides a baseline measurement for each fleet segment's well-to-wheels petroleum use (barrels) and greenhouse gas emissions (short tons) for the operating year of 2022 based on predicted vehicle use provided by Milwaukee County. These measurements are designed to establish operational emission baseline measurements for the fleet's current operations. These measurements can be used to gauge reductions in petroleum use and greenhouse gas emissions for the fleet moving forward.



Vehicle emissions throughout this report were calculated on a well-to-wheels basis. WCC used data from Argonne National Laboratories' Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) fuel-cycle model to generate necessary well-to-wheels petroleum use and greenhouse gas (GHG) emission co-efficient for key fuel production pathways and vehicle types. This tool also uses the U.S. Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) and certification data to estimate tailpipe air pollutant emissions.

Vehicle Analysis #1: Cargo Vans

Milwaukee County deploys 10 cargo vans across 3 departments. Facilities and Maintenance operates 7 vans ranging in age from 1998 to 2007, GMIA-Maintenance General operating 2 2020 model year vans, and Parks-Concessions operating a single 2015 model year van. Table 4 below provides details on this fleet segment.

Table 4. Current Cargo Van Fleet

UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
152004	FACILITIES MAINTENANCE	1998	GMC	TG21	1,215	103	30,376	11.77	2008	2013
152006	FACILITIES MAINTENANCE	2001	GMC	SAVA	2,741	248	60,299	11.04	2011	2016
152013	FACILITIES MAINTENANCE	2003	Chevrolet	2500	4,246	482	84,921	8.82	2013	2018
152540	FACILITIES MAINTENANCE	2003	Chevrolet	GVAN	1,600	132	31,997	12.17	2013	2018
152015	FACILITIES MAINTENANCE	2005	Chevrolet	GVAN	3,106	311	55,905	9.98	2015	2020
152016	FACILITIES MAINTENANCE	2005	Chevrolet	GVAN	2,473	372	44,515	6.65	2015	2020
152018	FACILITIES MAINTENANCE	2007	Chevrolet	EXPR	4,680	373	74,882	12.53	2017	2022
152587	GMIA-MAINTENANCE GENERAL	2020	Chevrolet	EXPR	3,607	482	10,820	7.48	2030	2035
152588	GMIA-MAINTENANCE GENERAL	2020	Chevrolet	EXPR	1,668	344	5,005	4.85	2030	2035
152559	PARKS -CONCESSIONS	2015	Chevrolet	EXPR	8,982	418	71,853	21.48	2025	2030

Based on provided replacement guidelines all cargo vans being operated by the Facilities Maintenance department could be considered for replacement during the current cycle. The newest cargo van in this department is 16 years old, and the rest more significantly exceed the 10-15 year planned operational life. Fuel economy for vehicles in this category is close to EPA estimates of 12 city / 17 highway for most vehicles. Operational review should be considered for vehicles that are falling below the city economy value, especially

unit 152588, a 2020 Chevrolet Express Van averaging less than 5mpg. In comparison of vehicle average daily mileage, three vehicles fall below 5 miles per day. Of these 152004, the oldest van in the fleet, averages 3.33 miles per day yet achieves 11.7 miles per gallon. A newer van 152540 averages 4.38 miles per day, and achieves 12 miles per gallon. In contrast 152588, one of the newest vans, averaging 4.57 miles per day is only delivering 4.85 miles per gallon. No van in this segment averages more than 25 miles per day. This indicates that an electric cargo van, even in base range configurations and factoring temperature losses would be sufficient to meet operational range requirements. Additional fuel conservation strategies available on the Alternative Fuel Data Center website[8] and considering the implementation of auxiliary technologies to provide heat or power as needed for fixed location operation should be considered for vans that are not going to be replaced.

Electric cargo vans are one of the market segments with the largest manufacturer interest with vehicles being provided by established companies, such as the Ford eTransit and GM Brightdrop to newer companies such as Rivian and Via Motors. These vehicles typically have ranges from 100 to 150 miles which should be sufficient for operations currently experienced. Other options in this category include diesel and biodiesel compatible versions of the GM cargo vans, and hybrid conversions by factory approved upfitters. As these are considered commercial vehicles they do not receive ratings on Fuel Economy.gov. Check the Alternative Fuels Data Center Alternative Fuel and Advanced Vehicle Search[9] tool to see the latest offerings in this category.

Table 5. Total Cost of Ownership Comparison 10 YR Ownership Cargo Vans							
	Gasoline	Diesel	Electric	B20	E85	LPG	CNG
Price Per Vehicle	$43,455	$47,000	$49,575	$47,000	$43,455	$51,455	$59,455
Depreciation	$236,462	$255,752	$269,764	$255,752	$236,462	$279,994	$323,526
Fuel	$66,540	$67,827	$25,821	$43,012	$98,627	$106,296	$58,026
Diesel Exhaust Fluid	$0	$960	$0	$960	$0	$0	$0
Maintenance and Repair	$45,742	$70,361	$28,839	$70,361	$45,742	$45,742	$45,742
Insurance	$96,147	$101,439	$105,284	$101,439	$96,147	$108,091	$120,034
License and Registration	$23,590	$23,590	$30,217	$23,590	$23,590	$23,590	$23,590
Total Cost of Ownership	**$468,481**	**$519,930**	**$459,925**	**$495,115**	**$500,568**	**$563,714**	**$570,919**
Savings vs. Gasoline	-	**($51,449)**	**$8,556**	**($26,633)**	**($32,087)**	**($95,232)**	**($102,438)**

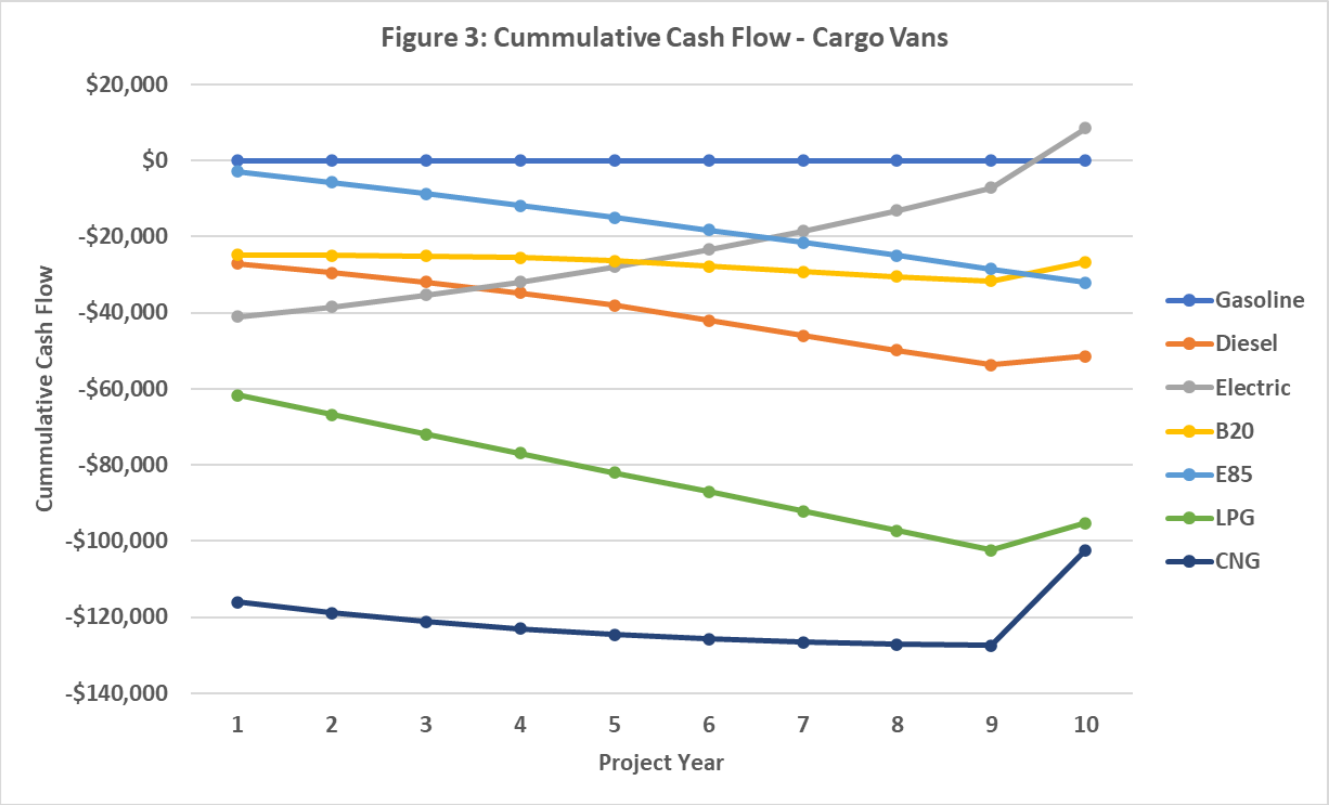
In this case pricing is based on the following vehicles:

- Base 2023 Ford Transit Connect gasoline
- Base 2023 Mercedes Benz Sprinter diesel
- Base 2023 Ford Transit Connect electric

Afleet estimated costs were used to modify for operation as compressed natural gas and propane. In this scenario $8,556 can be saved over 10 years. With available incentives for vehicle purchase this amount can be increased considerably, even when compared to purchasing gasoline wholesale.

Figure 3 provides cumulative cash flow details for electric vans over a 10 year period.

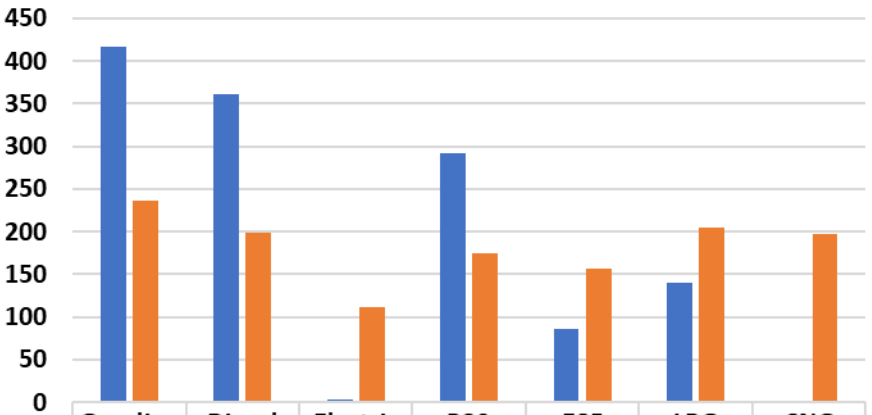
[8] Alternative Fuels Data Center, *Strategies to Conserve Fuel, https://afdc.energy.gov/conserve/*
[9] Alternative Fuels Data Center, *Alternative Fuel and Advanced Vehicle Search*, https://afdc.energy.gov/vehicles/search/



In regards to emissions, electric vans offer the greatest operational benefit by far. Table 6 and Figure 4 provide details for emissions over a 10 year operating period.

Table 6. Lifetime Vehicle Operations Air Pollutants Comparison Cargo Van 10 YR Operation							
	Gasoline	**Diesel**	**Electric**	**B20**	**E85**	**LPG**	**CNG**
Petroleum Use (barrels)	417	361	3	292	86	139	2
GHGs (short tons)	236	199	112	174	156	204	198
CO (lb)	405	274	0	274	405	405	405
NOx (lb)	9	72	0	72	9	9	9
PM10 (lb)	14	16	13	16	14	14	14
PM2.5 (lb)	2	3	2	3	2	2	2
VOC (lb)	73	54	0	54	71	61	60
Sox (lb)	2	2	0	2	1	0	1

Figure 4. Lifetime Petroleum Use and Greenhouse Gas Emissions



	Gasoline	Diesel	Electric	B20	E85	LPG	CNG
Petroleum Use (barrels)	417	361	3	292	86	139	2
GHGs (short tons)	236	199	112	174	156	204	198

A switch to electric cargo vans can offer a significant decrease in petroleum use and emissions compared to petroleum fueled alternative.

Vehicle Analysis #2: Passenger Vans

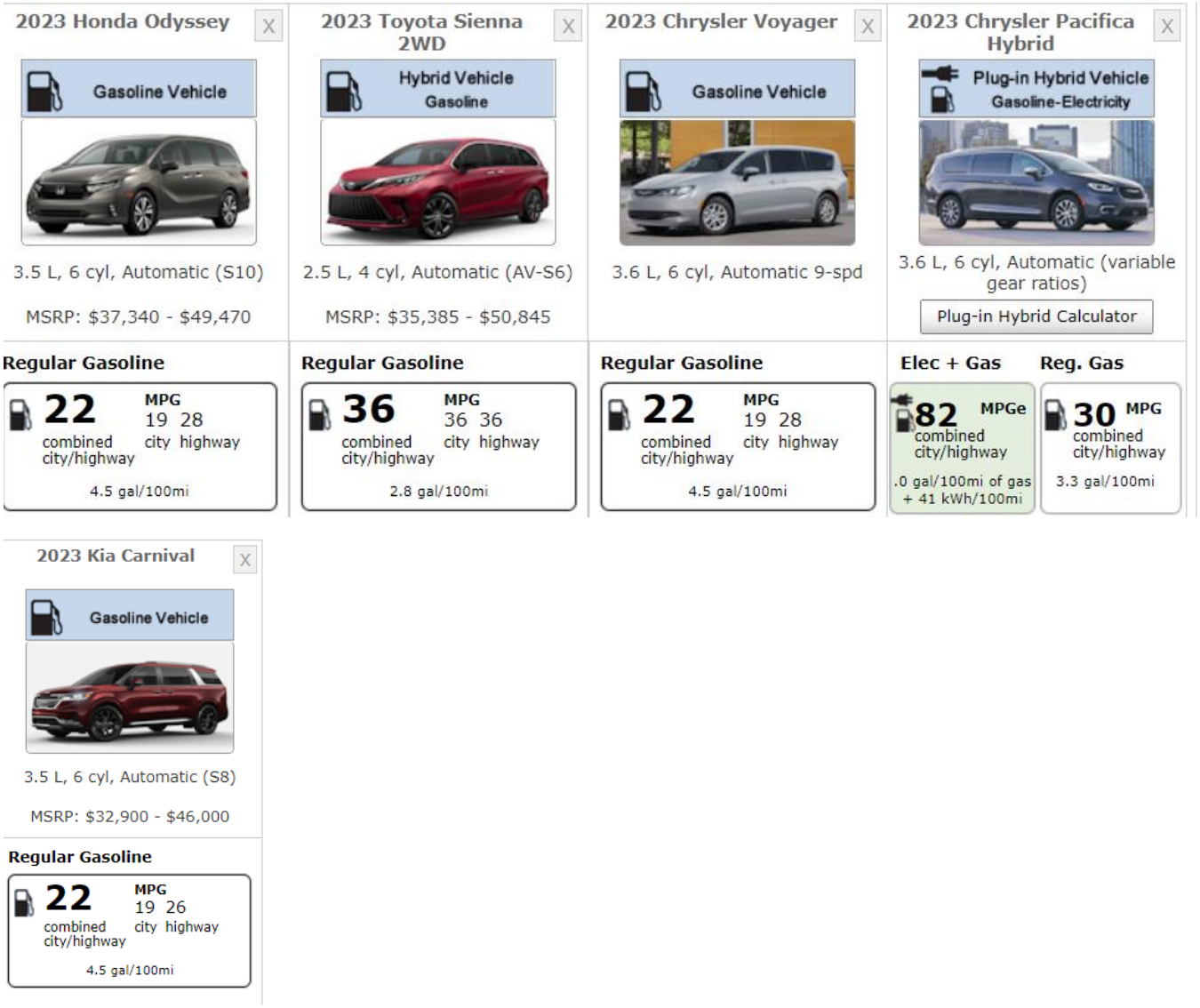
The passenger van fleet of Milwaukee county is operated by four departments: DHHS, District Attorney, Facilities Mail, and IMSD/NET WORK Applications and consists of 9 vehicles. These vans range in model year from 2014 to 2018, with the soonest likely replacement date of 2024. The oldest vehicle in this segment is a Dodge Caravan minivan. Table 7 below provides an overview of this fleet segment.

Table 7. Current Passenger Van Fleet

UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
152573	DHHS-BHD-CENTRAL ADMINSTRATION	2018	FORD	TRANS	2,131	168	10,657	12.7	2028	2033
152567	DHHS-BHD-WRAPAROUND SERV	2017	Dodge	CARV	2,674	169	16,041	15.8	2027	2032
152566	DHHS-OUTREACH SERVICES	2017	Dodge	CARV	3,604	232	21,623	15.6	2027	2032
152572	DHHS-OUTREACH SERVICES	2018	Dodge	CARAVAN	3,556	223	17,781	16.0	2028	2033
152549	DISTRICT ATTORNEY-GENERAL	2014	Dodge	CARV	2,977	163	26,790	18.2	2024	2029
152560	DISTRICT ATTORNEY-GENERAL	2016	Dodge	CARV	2,436	138	17,054	17.7	2026	2031
152569	FACILITIES MAIL	2018	Dodge	CARAVAN	4,097	211	20,487	19.4	2028	2033
152570	IMSD/NET WORK APPLICATIONS	2018	Dodge	CARAVAN	6,424	360	32,122	17.8	2028	2033
152571	IMSD/NET WORK APPLICATIONS	2018	Dodge	CARAVAN	2,340	144	11,701	16.2	2028	2033

In preparation for replacing the 2014 Dodge Caravan next year there are a decreasing number of options in this category, and may require an order to be placed this year in order to ensure delivery when needed. Analysis is provided to show a comparison of available options, however, based on the limited number of miles travelled and low odometer readings it would generally be recommended to maintain ownership of vehicles in this segment to closer to the maximum replacement dates which may expand options available.

A listing of sample vehicles and EPA fuel economy ratings is provided below. Analysis is based on manufacturer MSRP and combined fuel economy. As the average daily mileage is less than the 32 miles of electric range the 82 combined MPG value will be used for the Pacifica Hybrid.



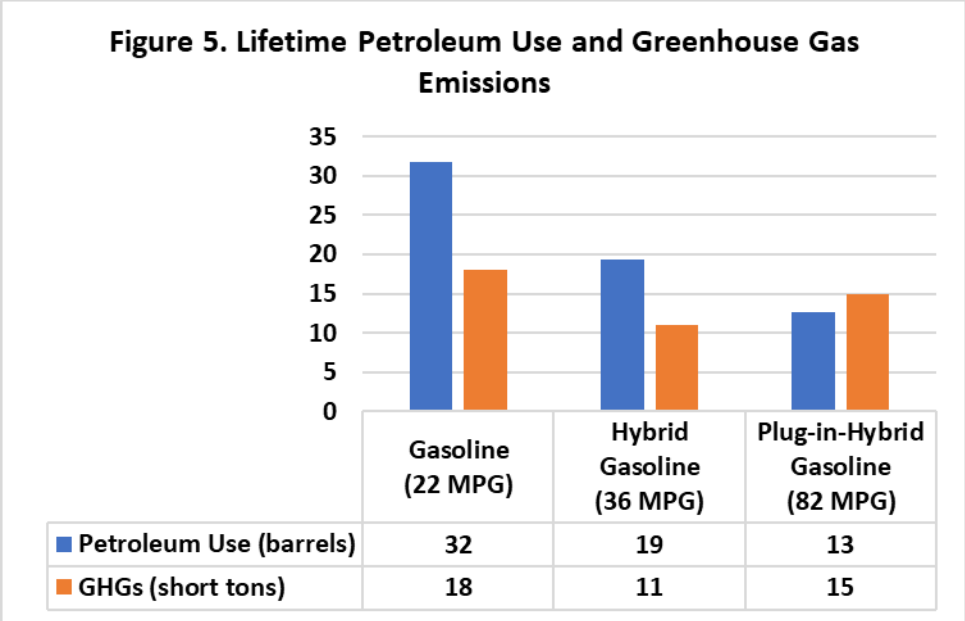
Calculating total cost of ownership was calculated for a 10 year ownership period. Evaluation of extending the ownership period to 15 years did not make significant changes in the evaluation or comparison. Table 8 provides total cost of ownership details.

Table 8. 10 Year Total Cost of Ownership Comparison Passenger Van Options					
	2023 Chrysler Voyager	Chrysler Pacifica Plug in Hybrid	Honda Odyssey	Kia Carnival	Toyota Sienna (Hybrid)
Price Per Vehicle	$35,495	$48,478	$37,490	$33,100	$36,135
Depreciation	$27,592	$37,685	$29,143	$25,731	$28,090
Fuel	$5,064	$3,821	$5,064	$5,064	$3,095
Diesel Exhaust Fluid	$0	$0	$0	$0	$0
Maintenance and Repair	$6,307	$5,505	$6,307	$6,307	$5,766
Insurance	$12,038	$14,807	$12,463	$11,527	$12,174
License and Registration	$3,370	$4,080	$3,370	$3,370	$4,080
Total Cost of Ownership	**$54,371**	**$65,897**	**$56,348**	**$51,999**	**$53,205**

The Chrysler Pacifica Plug in Hybrid cannot overcome its higher initial purchase price based on the mileage that is travelled annually. Conventional fueled options have minimal pricing differences compared to the hybrid Toyota Sienna. It is recommended that evaluation of pricing available through Vendornet when 2023 model year details are available. Also, in the next few months funding opportunities will have additional clarity related to available funding and qualifying vehicles.

As the fuel economy is the same for three of the 4 vehicles a comparison of emissions is provided for the conventional vans at 22 mpg, the hybrid Toyota Sienna at 36 mpg, and the Chrysler Pacifica plug in hybrid at 82 mpg. Details are provided in table 9 and figure 5 below.

Table 9. Lifetime Vehicle Operations Air Pollutants Comparison			
	Gasoline (22 MPG)	**Hybrid Gasoline (36 MPG)**	**Plug-in-Hybrid Gasoline (82 MPG)**
Petroleum Use (barrels)	32	19	13
GHGs (short tons)	18	11	15
CO (lb)	68	68	98
NOx (lb)	2	1	2
PM10 (lb)	2	2	2
PM2.5 (lb)	0	0	0
VOC (lb)	12	8	11
Sox (lb)	0	0	0



Selecting a hybrid option of any variety will considerably decrease the emissions that are generated by operation.

Vehicle Analysis #3: Passenger Cars

Milwaukee County operates 79 passenger cars with model years from 2010 to 2021, with 8 departments. This group of vehicles includes 16 Chevrolet Impalas, 62 Ford Fusions, and 1 Ford Escape. Based on a 10-year operational life 4 vehicles are 10 years old, 28 vehicles are 12 years old, and 9 vehicles are 13 years old. The following tables provide details about these vehicle groups.

Table 10. 10 Year Old Current Passenger Cars

UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
114705	BHD - MOBILE TEAM	2013	Chevrolet	IMPALA	6,422	321	64,224	20.0	2023	2028
114706	BHD - MOBILE TEAM	2013	Chevrolet	IMPALA	9,628	459	96,277	21.0	2023	2028
114704	DHHS - DELINQUENCY SVCS ADMIN	2013	Chevrolet	IMPALA	3,059	140	30,590	21.8	2023	2028
114703	DHHS-BHD-WRAPAROUND SERV	2013	Chevrolet	IMPALA	5,302	250	53,021	21.2	2023	2028

Table 11. 12 Year Old Current Passenger Cars										
UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
114206	BHD - MOBILE TEAM	2011	FORD	Fusion	7,398	193	88,779	38.4	2021	2026
114194	DHHS-BHD-WRAPAROUND SERV	2011	FORD	Fusion	8,063	215	96,757	37.6	2021	2026
114187	DISTRICT ATTORNEY-GENERAL	2011	FORD	Fusion	5,335	165	64,025	32.3	2021	2026
114204	DISTRICT ATTORNEY-GENERAL	2011	FORD	Fusion	6,034	176	72,408	34.4	2021	2026
114196	PARKS -CONCESSIONS	2011	FORD	Fusion	6,364	182	76,370	34.9	2021	2026
114179	PARKS-ADMINISTRATION	2011	FORD	Fusion	4,582	138	54,981	33.1	2021	2026
114181	POOL - VEHICLES/EQUIPMENT	2011	FORD	Fusion	2,237	48	26,849	47.1	2021	2026
114185	POOL - VEHICLES/EQUIPMENT	2011	FORD	Fusion	5,219	141	62,625	36.9	2021	2026
114183	SHERIFF ADMINISTRATION	2011	FORD	Fusion	4,809	161	57,713	29.9	2021	2026
114189	SHERIFF ADMINISTRATION	2011	FORD	Fusion	5,344	173	64,124	30.8	2021	2026
114192	SHERIFF ADMINISTRATION	2011	FORD	Fusion	7,620	233	91,445	32.8	2021	2026
114203	SHERIFF ADMINISTRATION	2011	FORD	Fusion	8,882	285	106,580	31.2	2021	2026
114184	SHERIFF EXPRESSWAY PATROL	2011	FORD	Fusion	9,320	280	111,837	33.3	2021	2026
114186	SHERIFF EXPRESSWAY PATROL	2011	FORD	Fusion	6,708	208	80,500	32.2	2021	2026
114195	SHERIFF-CRIMINAL JUSTICE	2011	FORD	Fusion	4,185	128	50,219	32.7	2021	2026
114193	SHERIFF-GENERAL INVEST	2011	FORD	Fusion	5,334	175	64,011	30.4	2021	2026
114197	SHERIFF-GENERAL INVEST	2011	FORD	Fusion	6,793	212	81,519	32.1	2021	2026
114199	SHERIFF-GENERAL INVEST	2011	FORD	Fusion	4,377	134	52,525	32.7	2021	2026
114208	SHERIFF-GENERAL INVEST	2011	FORD	Fusion	5,043	168	60,516	30.0	2021	2026
114209	SHERIFF-GENERAL INVEST	2011	FORD	Fusion	7,265	225	87,175	32.3	2021	2026
114178	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	6,295	205	75,539	30.6	2021	2026
114190	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	8,082	263	96,987	30.7	2021	2026
114191	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,174	282	110,083	32.5	2021	2026
114198	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	6,106	190	73,266	32.2	2021	2026
114202	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	13,893	439	166,714	31.7	2021	2026
114205	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,657	303	115,888	31.9	2021	2026
114207	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,598	306	115,171	31.4	2021	2026
114210	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	10,881	357	130,577	30.5	2021	2026

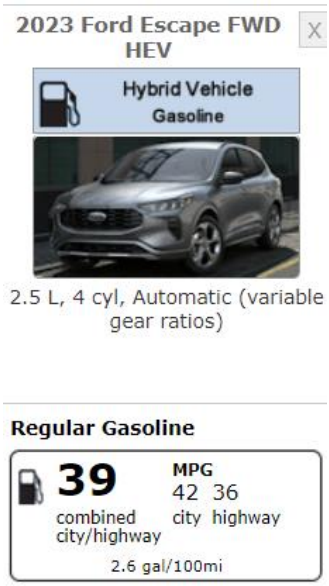
Table 12. 13 Year Old Current Passenger Cars										
UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
114698	BHD - MOBILE TEAM	2010	Chevrolet	IMPALA	6,604	295	85,851	22.4	2020	2025
114701	FACILITITES-ARCHITECT/ENG SVCS	2010	Chevrolet	IMPALA	2,551	119	33,165	21.5	2020	2025
114675	PARKS-FORESTRY	2010	Chevrolet	IMPALA	5,136	258	66,767	19.9	2020	2025
114679	PARKS-SECURITY	2010	Chevrolet	IMPALA	8,760	442	113,875	19.8	2020	2025
114696	POOL - VEHICLES/EQUIPMENT	2010	Chevrolet	IMPALA	6,142	144	79,841	42.6	2020	2025
114674	SHERIFF EXPRESSWAY PATROL	2010	Chevrolet	IMPALA	4,557	221	59,245	20.6	2020	2025
114689	SHERIFF-COURTS	2010	Chevrolet	IMPALA	5,136	256	66,773	20.1	2020	2025
114693	SHERIFF`S-CIVIL PROCESS	2010	Chevrolet	IMPALA	5,021	261	65,278	19.2	2020	2025
114699	SHERIFF`S-CIVIL PROCESS	2010	Chevrolet	IMPALA	7,225	366	93,929	19.8	2020	2025

Review of vehicles by age category indicates a wide range of odometer readings present. The vehicles that should be prioritized for replacement are those with the highest accumulated and annual mileage. This provides the greatest opportunity for a return on investment in alternative fuels. There are also a number of vehicles in these age categories that have low odometer readings. In the near term, these lesser used vehicles could be rotated to serve in higher mileage roles until replaced. Lower mileage vehicles in departments with multiple vehicles indicates that a more thorough review of checkout / assignment logs could provide opportunities for fleet downsizing. A downsized fleet would aggregate department mileage to fewer vehicles, helping them reach a replacement mileage by the end of their service lives, decreasing budgetary output for unneeded vehicles, and increasing the return on investment for those purchases. Table 13 provides a list of high mileage vehicles in this segment.

Table 13. Current Passenger Cars Over 90,000 Miles										
UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
114706	BHD - MOBILE TEAM	2013	Chevrolet	IMPALA	9,628	459	96,277	21.0	2023	2028
114194	DHHS-BHD-WRAPAROUND SERV	2011	FORD	Fusion	8,063	215	96,757	37.6	2021	2026
114679	PARKS-SECURITY	2010	Chevrolet	IMPALA	8,760	442	113,875	19.8	2020	2025
114192	SHERIFF ADMINISTRATION	2011	FORD	Fusion	7,620	233	91,445	32.8	2021	2026
114203	SHERIFF ADMINISTRATION	2011	FORD	Fusion	8,882	285	106,580	31.2	2021	2026
114184	SHERIFF EXPRESSWAY PATROL	2011	FORD	Fusion	9,320	280	111,837	33.3	2021	2026
114699	SHERIFF`S-CIVIL PROCESS	2010	Chevrolet	IMPALA	7,225	366	93,929	19.8	2020	2025
114190	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	8,082	263	96,987	30.7	2021	2026
114191	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,174	282	110,083	32.5	2021	2026
114202	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	13,893	439	166,714	31.7	2021	2026
114205	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,657	303	115,888	31.9	2021	2026
114207	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	9,598	306	115,171	31.4	2021	2026
114210	SHERIFF`S-CIVIL PROCESS	2011	FORD	Fusion	10,881	357	130,577	30.5	2021	2026
114225	SHERIFF`S-CIVIL PROCESS	2018	FORD	Fusion	18,042	516	90,210	35.0	2028	2033

One outlier is present, a 5 year old Ford Fusion with over 90,000 miles. It is likely to reach the 130,000 to 150,000 squad car replacement mileage prior to 2028.

In discussion with the fleet manager and changing market vehicle lineups indicated a preference for transition from full sized cars to SUVs. Reviewing the 2020 Vendornet documents there are a range of vehicles that fit this profile, including hybrid and full electric options. For uses that do not require as much space Chevrolet Bolts may also be appropriate. The following analysis provides cost savings comparisons between available options.



Analysis was performed for replacement of all 14 vehicles which have greater than 90,000 miles. Table 14 below provides total cost of ownership details.

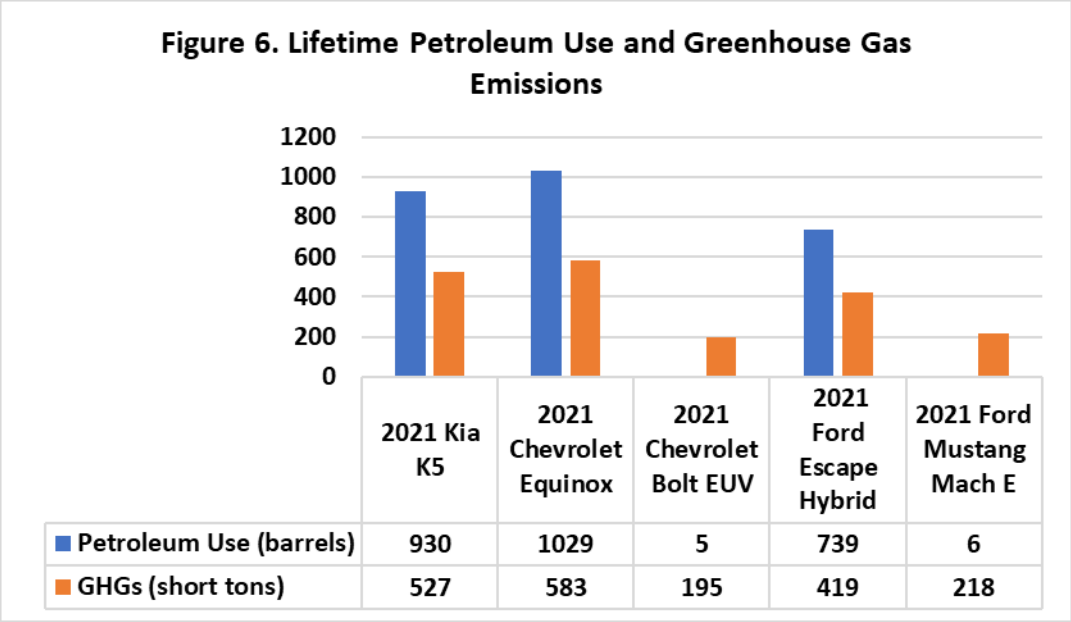
Table 14. 10 Year Total Cost of Ownership Comparison Passenger Car Options

	2021 Kia K5	2021 Chevrolet Equinox	2021 Chevrolet Bolt EUV	2021 Ford Escape Hybrid	2021 Ford Mustang Mach E
Price Per Vehicle	$23,160	$21,380	$29,692	$24,131	$43,626
Depreciation	$251,508	$232,680	$323,140	$262,619	$474,785
Fuel	$148,528	$164,442	$45,167	$118,061	$50,429
Diesel Exhaust Fluid	$0	$0	$0	$0	$0
Maintenance and Repair	$198,604	$198,604	$125,213	$181,560	$125,213
Insurance	$131,546	$126,381	$151,199	$134,595	$192,805
License and Registration	$11,265	$11,265	$24,518	$21,205	$24,518
Total Cost of Ownership	**$741,452**	**$733,372**	**$669,237**	**$718,040**	**$867,750**

By replacing the passenger cars with the highest mileage with Chevrolet Bolts provides the greatest savings over 10 years of over $70,000 compared to purchasing Kia K5s or $67,000 compared to Chevrolet Equinoxes. Alternatively, selecting a Ford Escape Hybrid would provide a savings of over $24,000 or $20,000 respectively. There is minimal difference in TCO between a K5 and Equinox, however the Equinox provides greater utility and a cost savings of approximately $3,000.

In regards to emissions either hybrid or full electric options provide significant reductions in emissions compared to conventional options. This can be reviewed in Table 15 and Figure 6 on the following page.

Table 15. Lifetime Vehicle Operations Air Pollutants Comparison					
	2021 Kia K5	2021 Chevrolet Equinox	2021 Chevrolet Bolt EUV	2021 Ford Escape Hybrid	2021 Ford Mustang Mach E
Petroleum Use (barrels)	930	1029	5	739	6
GHGs (short tons)	527	583	195	419	218
CO (lb)	2674	2674	0	2674	0
NOx (lb)	49	49	0	41	0
PM10 (lb)	90	90	86	90	86
PM2.5 (lb)	16	16	12	16	12
VOC (lb)	451	451	0	288	0
Sox (lb)	5	6	0	4	0



Vehicle Analysis #4: Squad Cars

Milwaukee County operates a fleet of 84 squad cars, consisting of Chevrolet Impalas and Tahoes, Dodge Chargers, and Ford Police Utilities. Using the requirements that vehicles that have above 130,000 miles should be considered for replacement, there are currently 15 that meet this criterion, these are listed in Table 16.

Table 16. Current Squad Cars										
UNIT	Department	Vehicle Model Year	Make	Model	Annual Miles	Annual Gallons	Odometer	Fuel Economy MPG	Earliest Replacement Year	Latest Replacement Year
150473	SHERIFF EXPRESSWAY PATROL	2016	Dodge	Charger	18,658	1,852	130,608	10.1	2026	2031
150475	SHERIFF EXPRESSWAY PATROL	2016	Dodge	Charger	23,377	2,042	163,636	11.4	2026	2031
150478	SHERIFF EXPRESSWAY PATROL	2016	Dodge	Charger	21,450	1,819	150,151	11.8	2026	2031
150499	SHERIFF EXPRESSWAY PATROL	2017	Dodge	Charger	23,911	2,086	143,467	11.5	2027	2032
150506	SHERIFF EXPRESSWAY PATROL	2019	Dodge	Charger	35,376	3,198	141,505	11.1	2029	2034
150507	SHERIFF EXPRESSWAY PATROL	2019	Dodge	Charger	37,820	3,167	151,278	11.9	2029	2034
150510	SHERIFF EXPRESSWAY PATROL	2019	Dodge	Charger	34,090	3,036	136,359	11.2	2029	2034
150513	SHERIFF EXPRESSWAY PATROL	2019	Dodge	Charger	33,896	2,677	135,582	12.7	2029	2034
150459	SHERIFF EXPRESSWAY PATROL	2014	Chevrolet	IMPALA	14,451	1,172	130,057	12.3	2024	2029
150504	SHERIFF AIRPORT SECURITY	2018	Chevrolet	Tahoe	28,879	3,106	144,397	9.3	2028	2033
150434	SHERIFF EXPRESSWAY PATROL	2013	Chevrolet	Tahoe	13,976	948	139,759	14.7	2023	2028
150442	SHERIFF EXPRESSWAY PATROL	2013	Chevrolet	Tahoe	16,136	1,731	161,362	9.3	2023	2028
150444	SHERIFF EXPRESSWAY PATROL	2013	Chevrolet	Tahoe	13,598	1,424	135,976	9.6	2023	2028
150446	SHERIFF EXPRESSWAY PATROL	2013	Chevrolet	Tahoe	16,356	1,762	163,555	9.3	2023	2028
150505	SHERIFF EXPRESSWAY PATROL	2018	Chevrolet	Tahoe	27,749	2,578	138,746	10.8	2028	2033

With a preference for SUVs as replacements a total cost of ownership and emissions analysis comparison was performed based on the Ford Police Utility in both conventional and hybrid form, and the Ford Mustang Mach E. Review of pricing and fuel economy of available models does not show a benefit in selecting a car over an SUV in this category. Latest available pricing, for model year 2021, was used in this analysis representing replacement of all 15 that could be considered for this year.

Table 17. 10 Year Total Cost of Ownership Comparison Squad Car Operations			
	Ford Police Utility	Ford Police Utility Hybrid	Ford Mustang Mach E
Price Per Vehicle	$32,718	$35,869	$43,626
Depreciation	$381,506	$418,248	$508,698
Fuel	$596,534	$507,688	$130,669
Diesel Exhaust Fluid	$0	$0	$0
Maintenance and Repair	$1,149,843	$1,051,161	$724,938
Insurance	$171,680	$181,760	$206,576
License and Registration	$14,200	$24,849	$28,399
Total Cost of Ownership	**$2,313,763**	**$2,183,707**	**$1,599,280**

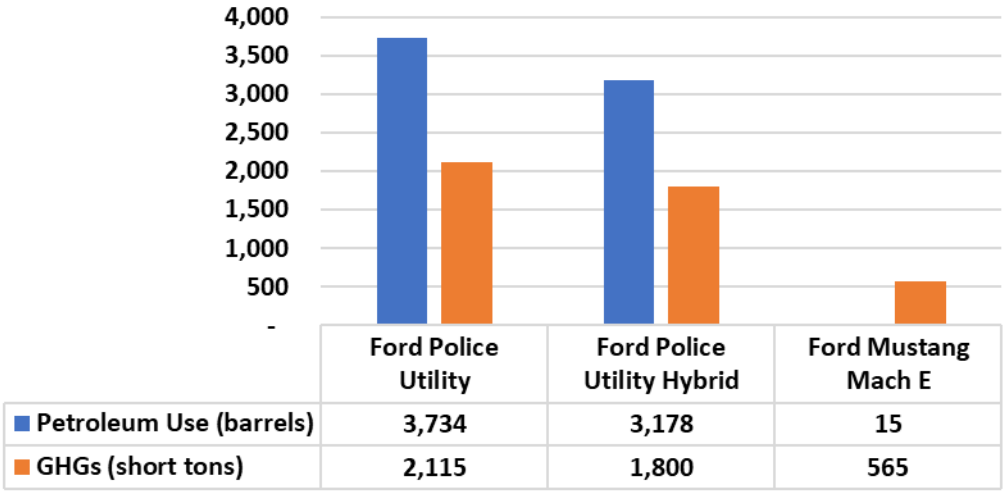
Over a 10 year operational period a switch to the Mustang Mach E could potentially save Milwaukee County close to $715,000. If vehicles return to central facilities and daily mileage ranges remain consistent overnight charging and current vehicle capabilities should be sufficient to meet department needs. Michigan State Patrol tested the past two years in comparison with traditional vehicles and a report can be found in the footnotes here.[10] Alternatively, by selecting the hybrid Police Utility can save over $130,000.

In regards to emissions a conversion to hybrid or electric would provide some to considerable reductions.

[10] Michigan Stat Police, *Police Vehicle Test Results,* https://www.michigan.gov/msp/divisions/training/precision-driving-unit/police-vehicle-test-results

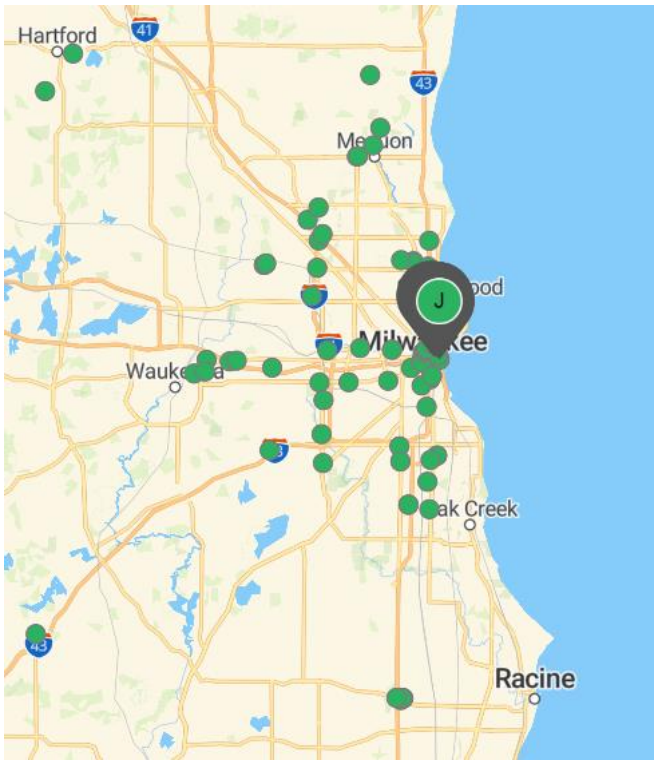
Table 18. Lifetime Vehicle Operations Air Pollutants Comparison Squad Cars			
	Ford Police Utility	Ford Police Utility Hybrid	Ford Mustang Mach E
Petroleum Use (barrels)	3,734	3,178	15
GHGs (short tons)	2,115	1,800	565
CO (lb)	7,773	7,773	-
NOx (lb)	144	121	-
PM10 (lb)	232	232	222
PM2.5 (lb)	46	46	32
VOC (lb)	1,133	716	-
Sox (lb)	20	17	-

Figure 7. Lifetime Petroleum Use and Greenhouse Gas Emissions



Existing Electric Vehicle Charging Infrastructure & Development

Milwaukee County has a significant amount of electric vehicle charging infrastructure already available for use for vehicles that are in the field.



In order to implement charging infrastructure at county owned facilities there are a number of steps required with opportunities for funding and collaboration if stations are available for public access.

The following are some resources to review to start the process of electric vehicle charging station infrastructure development. Additional details will be available when funding pathways from the Bipartisan Infrastructure Law, Inflation Reduction Act, and Wisconsin Electric Vehicle Infrastructure program become available. Please stay connected with Wisconsin Clean Cities in order to take advantage of these funding sources.

Charging Infrastructure Development Resources

- Alternative Fuels Data Center, *Developing Infrastructure to Charge Electric Vehicles*, https://afdc.energy.gov/fuels/electricity_infrastructure.html

- Alternative Fuels Data Center, *Charging Infrastructure Procurement and Installation*, https://afdc.energy.gov/fuels/electricity_infrastructure_development.html

- Alternative Fuels Data Center, *Charging Infrastructure Operation and Maintenance,* *https://afdc.energy.gov/fuels/electricity_infrastructure_maintenance_and_operation.html*

- U.S. Department of Transportation, *Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure,* https://www.transportation.gov/rural/ev/toolkit

- Joint Office of Energy and Transportation. *Home Page,* https://driveelectric.gov

Resources for Fleet Funding

- U.S Department of Energy Office of State and Community Energy Programs. Energy Efficiency and Conservation Block Grant Program, https://www.energy.gov/scep/energy-efficiency-and-conservation-block-grant-program

- IRS Commercial Clan Vehicle Credit. https://www.irs.gov/credits-deductions/commercial-clean-vehicle-credit