Washington State Department of Enterprise Services

Washington State Cabinet Agency Vehicle Fleet Electrification Forecast

Table of Contents

Executive Summary **1**
Vehicles 3
Class 1 – 2a Vehicles 3
Class 2b – 3 Vehicles 6
Class 4 – 8 Vehicles 8
Vehicle Charging 10
Level 2 Charger Needs Forecast 10
Level 3 Charger Needs Forecast 11

1.0 Fleet Forecast and Cost Model Development **12**
1.1 Model Background 12
1.2 Summary of Work Completed 13
1.2.1 Model Architecture and Modules 13

2. Fleet Forecasts **25**
2.1 Combined Fleet 25
2.1.1 Fleet Overview 25
2.1.2 Classes 1-2a 27
2.1.3 Classes 2b-3 29
2.1.4 Classes 4-8 31
2.2 Department of Enterprise Services (DES) 33
2.2.1 Fleet Overview 33
2.2.2 Classes 1-2a 35
2.2.3 Classes 2b-3 38
2.2.4 Classes 4-8 41
2.3 Washington State Patrol (WSP) 44
2.3.1 Fleet Overview 44
2.3.2 Classes 1-2a 46
2.3.3 Classes 2b-3 49
2.3.4 Classes 4-8 52
2.4 Washington State Department of Transportation (WSDOT) 55
2.4.1 Fleet Overview 55
2.4.2 Classes 1-2a 57

2.4.3 Classes 2b-3 60
2.4.4 Classes 4-8 63
2.5 Department of Corrections (DOC) 66
2.5.1 Fleet Overview 66
2.5.2 Classes 1-2a 68
2.5.3 Classes 2b-3 71
2.5.4 Classes 4-8 74
2.6 Department of Social and Health Services (DSHS) 77
2.6.1 Fleet Overview 77
2.6.2 Classes 1-2a 79
2.6.3 Classes 2b-3 82
2.6.4 Classes 4-8 85

3. Charging Infrastructure 88
3.1 Level 2 Charging Infrastructure 88
3.1.1 Overview 88
3.1.2 Level 2 Charger Cost and Distribution 89
3.1.3 Charger Site Selection and Fleet Management 91
3.2 Level 3 Charging Infrastructure 92
3.2.1 Overview 92
3.2.1 Charger Cost 93

4. Report Findings, Recommendations, and Strategies 94
4.1 Fleet Electrification Findings and Recommendations 94
4.1.1 Classes 1-2a 94
4.1.2 Classes 2b-3 94
4.1.3 Classes 4-8 94
4.2 Electric Vehicle Supply Equipment Findings and Recommendations 95
4.3 Additional recommendations and strategies to overcome electrification barriers to state vehicle fleets 96
4.3.1 Data Reporting and General Recommendations 96

Appendix A: State Level Summary Data 98
A.1 - Fleet Vehicle Counts by Classification 98
A.2 - Modeled Fleets Overall Class 1-2a Fleet Data 98
A.3 - Modeled Fleets Overall Class 2b-3 Fleet Data 99

A.4 - Modeled Fleets Overall Class 4-8 Fleet Data 99
A.5 - Modeled Fleets Overall Charging Data – New Level 2 Charging Port Needs by County 105
A.6 - Department of Health Environmental Health Disparities Map - Environmental Impact ……………………………………………………………………………………….....109

Appendix B - Fleet Summary Data 110
B.1 - Washington State Patrol Charging Data 111
B.1.1 - WSP Forecasted Level 2 Charger Needs 111
B.1.2 - WSP Forecasted Level 3 Charger Needs 112
B.2 - Department of Corrections Charging Data.. 113
B.2.1 - DOC Agency-Owned Forecasted Level 2 Charger Needs 113
B.2.2 - DOC Agency-Owned Forecasted Level 2 Charger Needs 115
B.3 - Department of Transportation Charging Data 116
B.3.1 – WSDOT Agency-Owned Forecasted Level 2 Charger Needs 116
B.3.2 - DSHS Agency-Owned Forecasted Level 2 Charger Needs 118
B.4 - Department of Social and Health Services Charging Data.................................... 119
B.4.1 - DSHS Agency-Owned Forecasted Level 2 Charger Needs 119
B.4.2 - DSHS Agency-Owned Forecasted Level 3 Charger Needs 121
B.5 - Department of Enterprise Services Charging Data 122
B.5.1 - DES Cabinet Fleet Forecasted Level 2 Charger Needs 122
B.5.2 - DES Cabinet Fleet Forecasted Level 3 Charger Needs 125

Appendix C - Assumptions 126
C.1 – Baseline Assumptions 126
C.2 – Modeled Scenario Assumptions 127
C.3 - Vehicle Availability Assumptions 129

Tables

Table 1: Class 1 Modeled BEV Availability Assumptions 3
Table 2: Class 2a Modeled BEV Availability Assumptions 3
Table 3: Class 1-2a Summary Data 4
Table 4: Class 2b and 3 Modeled BEV Availability Assumptions 6
Table 5: Class 2b and 3 Summary Data 6
Table 6: Class 4-8 Summary Data 8
Table 7: Class 4-8 Modeled BEV Availability Assumptions 8
Table 8: Cabinet Agency State Vehicle Fleet Electrification Goals in Executive Order 21-04 12
Table 9: Model Development Steps 13
Table 10: U.S. Environmental Protection Agency Gross Vehicle Weight Rating (GVWR) 14
Table 11: Mileage Percentile Table Sample from DES Model 15
Table 12: Modeled Class 1-3 ICE versus BEV Per Mile Operating Costs (2023) 18
Table 13: Modeled Class 4-8 ICE versus BEV Per Mile Operating Cost (2023) 18
Table 14: Modeled Forecasted Purchase Price Parity Year 19
Table 15: Modeled Vehicle Value Loss Per Year 20
Table 16: Modeled Charger Installation Lifetime Costs Breakdown (2023 Purchase Year) 24
Table 17: Modeled Overall Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted 26
Table 18: Class 1-2a Average Annual Miles, Age, and Count 27
Table 19: Modeled Class 1-2a Purchase Counts and Cost Forecasts – Class 1 Cost Parity Year Highlighted 28
Table 20: Class 2b – 3 Average Annual Miles, Age, and Count 29
Table 21: Modeled Class 2b-3 Purchase Counts and Cost Forecasts – Class 3 Cost Parity Year Highlighted 30
Table 22: Class 4-8 Average Annual Miles, Age, and Count 31
Table 23: Modeled Class 4-8 Purchase Counts and Cost Forecasts 32
Table 24: Modeled DES Cabinet Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted 34
Table 25: DES Cabinet Class 1-2a Vehicle Fleet Summary Information 35
Table 26: Modeled DES Cabinet Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted 36
Table 27: Modeled DES Cabinet Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles 37
Table 28: DES Cabinet Class 2b-3 Vehicle Fleet Summary Information 38
Table 29: Modeled DES Cabinet Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted 39
Table 30: Modeled DES Cabinet Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles 40
Table 31: Modeled DES Cabinet Classes 4-8 Vehicle Fleet Summary Information 41
Table 32: Modeled DES Cabinet Class 4-8 Vehicle Purchase Cost Forecast 42
Table 33: Modeled DES Cabinet Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles 43
Table 34: Modeled WSP Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted 45
Table 35: WSP Class 1-2a Non-Pursuit Vehicle Fleet Summary Information 46
Table 36: WSP Class 1-2a Pursuit Vehicle Fleet Summary Information 46
Table 37: Modeled WSP Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted 47
Table 38: WSP Class 2b-3 Vehicle Fleet Summary Information 49
Table 39: Modeled WSP Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted 50
Table 40: Modeled WSP Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles 51
Table 41: WSP Classes 4-8 Vehicle Fleet Summary Information 52

Table 42: Modeled WSP Class 4-8 Vehicle Purchase Cost Forecast....53
Table 43: Modeled WSP Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles 54
Table 44: Modeled WSDOT Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted....56
Table 45: WSDOT Class 1-2a Vehicle Fleet Summary Information....57
Table 46: Modeled WSDOT Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted....58
Table 47: Modeled WSDOT Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles 59
Table 48: WSDOT Class 2b-3 Vehicle Fleet Summary Information....60
Table 49: Modeled WSDOT Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted....61
Table 50: Modeled WSDOT Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles 62
Table 51: WSDOT Classes 4-8 Vehicle Fleet Summary Information....63
Table 52: Modeled WSDOT Class 4-8 Vehicle Purchase Cost Forecast 64
Table 53: Modeled WSP Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles 65
Table 54: Modeled DOC Agency-Owned Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted....67
Table 55: DOC Agency-Owned Class 1-2a Vehicle Fleet Summary Information 68
Table 56: Modeled DOC Agency-Owned Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted 69
Table 57: Modeled DOC Agency-Owned Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles....70
Table 58: DOC Agency-Owned Class 2b-3 Vehicle Fleet Summary Information 71
Table 59: Modeled DOC Agency-Owned Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted 72
Table 60: Modeled DOC Agency-Owned Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles....73
Table 61: DOC Agency-Owned Classes 4-8 Vehicle Fleet Summary Information 74
Table 62: Modeled DOC Agency-Owned Class 4-8 Vehicle Purchase Cost Forecast....75
Table 63: Modeled DOC Agency-Owned Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles....76
Table 64: Modeled DSHS Agency-Owned Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted....78
Table 65: DSHS Agency-Owned Class 1-2a Vehicle Fleet Summary Information....79
Table 66: Modeled DSHS Agency-Owned Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted 80
Table 67: Modeled DSHS Agency-Owned Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles..81
Table 68: DSHS Agency-Owned Class 2b-3 Vehicle Fleet Summary Information....82
Table 69: Modeled DSHS Agency-Owned Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted 83
Table 70: Modeled DSHS Agency-Owned Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles..84
Table 71: Modeled DSHS Agency-Owned Classes 4-8 Vehicle Fleet Summary Information 85
Table 72: Modeled DSHS Agency-Owned Class 4-8 Vehicle Purchase Cost Forecast....86
Table 73: Modeled DSHS Agency-Owned Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles....87
Table 74: Recommended Modeled Fleets Statewide Level 2 Charger Port Count and Cost Per Year....89
Table 75: Modeled Fleets Recommended Level 2 Charging Port Needs/Installations in the Top-5 Counties 90
Table 76: Modeled Fleets Recommended Statewide Level 3 Charger Count and Cost Per Year 93
Table 77: State Barriers to BEV adoption....96

Table of Acronyms

Acronym	Definition
DOC	Department of Corrections
DES	Department of Enterprise Services
AEO	Annual Energy Outlook
BEV	Battery Electric Vehicle
BNEF	Bloomberg New Energy Finance
CARS	Contract Automobile Request System
CHIPS	Creating Helpful Incentives to Produce Semiconductors
DoE	Department of Energy
DSHS	Department of Social and Health Services
DC	Direct Current
EVSE	Electric Vehicle Supply Equipment
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FFCM	Fleet Forecast and Cost Model
GVWR	Gross Vehicle Weight Rating
IRA	Inflation Reduction Act
IIJA	Infrastructure Investment and Jobs Act
ICE-	Internal Combustion Engine
ICCT	International Council on Clean Transportation
LDV	Light-Duty Vehicle
NREL	National Renewable Energy Laboratory
PHEV	Plug-In Hybrid Electric Vehicle
RCW	Revised Code of Washington
SUV	Sports Utility Vehicle
SEEP	State Efficiency and Environmental Performance
WSDOT	Washington State Department of Transportation
WSP	Washington State Patrol

Executive Summary

Governor Jay Inslee's November 3rd, 2021, Executive Order 21-04 established ambitious electrification goals for the vehicles operated by state executive and small cabinet agencies. These ambitions are pragmatic in their approach – replacing internal combustion engine vehicles (ICE) at the end of their service life with battery electric vehicle (BEV) alternatives *if* not exempted by State Efficiency and Environmental Performance (SEEP) criteria **(page 16)**. Only *full* BEVs count towards the Governor's goals, meaning plug-in hybrid electric vehicles (PHEV), hybrid vehicles, and flex-fuel vehicles do not count towards the fleet electrification goals. This report analyzes forecasted replacement schedules for vehicles in three weight class groupings using the Environmental Protection Agency's (EPA) Gross Vehicle Weight Rating (GVWR) classification system as mandated in the Executive Order. The Executive Order designates the following BEV share goals for state cabinet vehicle fleets:

Passenger vehicles and class 1 – 2a light duty trucks:

- 40% of fleets are BEVs by 2025;
- 75% of fleets are BEVs by 2030; and
- 100% of fleets are BEVs by 2035.

Class 2b and higher vehicles:

- 30% of class 2b-3 fleets and 50% of class 4-8 fleets are BEVs by 2030;
- 55% of class 2b-3 fleets and 75% of class 4-8 fleets are BEVs by 2035; and
- 100% of fleets are BEVs by 2040.

This report forecasts the possible BEV share by year for each of these weight classifications, based on existing fleet management practices and the application of SEEP exemption criteria for fleets under the management of the following departments: The Washington State Department of Enterprise Services (DES), The Washington State Department of Transportation (WSDOT), The Washington State Patrol (WSP), The Washington State Department of Corrections (DOC), and The Washington State Department of Social and Health Services (DSHS). This is not a comprehensive reporting of all state-owned vehicle data; the forecast is based on data reported by fleet managers on their owned vehicles through December 31, 2022 from the five agencies listed above. A small number of agency-owned vehicles were not included in this forecast. These include 122 agency-owned vehicles from four state agencies (DOL, ECY, LCB, and WMD). Most of these vehicles are located in Pierce, Thurston, and Spokane counties. Because the number of vehicles not included in the forecast is so small, this is unlikely to affect forecasted EVSE needs or costs. While DES does lease permanently assigned vehicles to both DSHS and DOC, both still operate a large volume of agency-owned vehicles. They are not exempted from the Revised Code of Washington (RCW) 42.19.600 as Washington State Patrol, Washington State Department of Transportation, and Washington State Department of Natural Resources are. The Washington State Department of Natural Resources is exempted from the Executive Order's goals since they are not a cabinet agency.

BEV adoption will carry significant financial benefits to the State of Washington, generating an estimated $374.8 Million in total vehicle operating cost savings **(Table 19, 21, and 23)** compared to ICE vehicles.

Versus an upper limit networked level 2 electrification cost forecast of $213.2 Million **(Table 74)**. The electrification needs forecast assumes a high 1:1 vehicle to charger ratio and no sharing of public charging resources. The significant predicted savings of ICE to BEV conversion are dependent upon the deployment of agency or state-owned resources due to the much higher charging costs associated with public charging infrastructure. The benefits are substantial in Washington due to electricity prices that are currently significantly lower than the national average and fuel prices that are substantially higher, thereby decreasing the number of miles needed to travel to recover the higher upfront costs of BEVs **(Fuel and Electricity Costs, page 18)**. Total fuel savings from the BEV transition will produce an estimated reduction in greenhouse gas emissions of 216,000 tons of carbon dioxide. Accounting for the social cost of carbon - using values from the Washington State Office of Fiscal Management - will generate an additional approximately $21 million in savings from the transition.

However, the State of Washington is unlikely to meet the BEV goals of Executive Order 21-04 in the forecast period due to the duration of vehicle service lives, BEV market availability, and vehicle usage profiles. Each of these factors were severely impacted by the COVID-19 pandemic. Many vehicles in operation have surpassed recommended age and mileage retirement criteria due to the 2-year moratorium on vehicle purchases imposed by the pandemic. This purchase delay has been compounded by supply chain issues, resulting in order times nearing 2-years in some cases. Finally, there is uncertainty concerning the appropriate size vehicle fleet once post COVD-19 work patterns are accounted, further delaying some vehicle replacement. Overall, Passenger Vehicles and class 1-2a trucks achieve 72% BEV share by 2035, while class 2b -3 achieve 80% by 2040, and class 4-8 28% by 2040 **(Table 19, 21, and 23)**. To support electrification, a high-level estimate of 8,425 new networked level 2 charging ports are needed or 832 new level 3 direct current (DC) fast charging ports **(Table 75 and 76)**.

While the ambitious nature of the state’s fleet transition anticipates important environmental and health benefits for our overburdened communities, the scope of this report is limited to state government. To further the realization of those anticipated benefits, the Interagency Electric Vehicle Coordinating Council is working towards a broader Transportation Electrification Strategy (TES) for all of Washington State. The EV Coordinating Council’s work in the future will add to this comprehensive statewide approach in electric vehicle transition.

The full list of modeled assumptions can be found in Appendix: C.2 – Modeled Scenario Assumptions and Appendix C.3 - Vehicle Availability Assumptions

Vehicles

Class 1 – 2a Vehicles

Class 1 vehicles have a GVWR of under 6,000 lbs. while class 2a have a GVWR of 6,001-8,500 lbs**. (Table 10). Table 1** and **Table 2** below provide examples of representative vehicles and the year that BEV models are expected to be available based on manufacturer press releases and other public statements **(Appendix: C.3 - Vehicle Availability Assumptions**). The modeled scenario assumes overall availability of BEVs, if available, as 75% in 2023, scaling to 100% by 2028 in 5% increments (**Appendix: C.2 – Modeled Scenario Assumptions).** This availability constraint is intended to capture known availability issues among BEVs already in production due to supply chain and production capacity constraints. Overall, there are 7,280 passenger vehicles and class 1 – 2a light-duty trucks in the modeled fleets or 72% of all eligible vehicles analyzed in this report. The Executive Order specifies "passenger vehicles and class 1 – 2a light trucks." The model analyzes passenger vehicles broken into weight classification and body style, for example sport- utility vehicle (SUV) class 1 and 2a. Class 1 would refer to a SUV on a car chassis, while 2a would refer to those on a light-duty truck chassis. For sake of consistency, references to class 1 – 2a are inclusive of passenger vehicles in this report.

Table 1: Class 1 Modeled BEV Availability Assumptions

Classification	Sedan 1	SUV 1	Van 1	Truck 1
Year	2023	2023	2026	2026
Vehicle Model Examples	Chevrolet, Bolt Nissan, Leaf	Ford, Mustang Mach-e Volkswagen, ID.4	Chrysler, Pacifica*	Ford, Ranger*
Presently Available	Yes	Yes	No	No

**See Appendix - C.3 - Vehicle Availability Assumptions for full list of models, release year, and source*

Table 2: Class 2a Modeled BEV Availability Assumptions

Classification	Truck 2a	SUV 2a	Pursuit (all classes)
Year	2023	2025	2026
Vehicle Model Examples	Ford, F-150 Lightning Chevrolet, Silverado EV*	Ford, Explorer* Chevrolet, Equinox*	Chevrolet, Blazer* Ford, F-150 Lightning Ford, Explorer* Chevrolet, Tahoe*
Presently Available	Yes, limited	No	Yes, limited

**See Appendix - C.3 - Vehicle Availability Assumptions for full list of models, release year, and source*

Class 1 – 2a cabinet agency vehicles analyzed in this report overall are expected to achieve 87% BEV share by 2035 **(page 99)**. Based on current vehicle fleet inventory data and replacement trends, DES and WSP fleets are forecasted to effectively meet BEV goals, achieving 96% and 99% electrification rates respectively by 2035 **(Table 3). I**n contrast, WSDOT, DOC, and DSHS fleets are forecasted to achieve much lower electrification rates of 70%, 42%, and 54% respectively**)** predominately due to lower annual miles traveled resulting in longer operational lifespans.

Table 3: Class 1-2a Summary Data

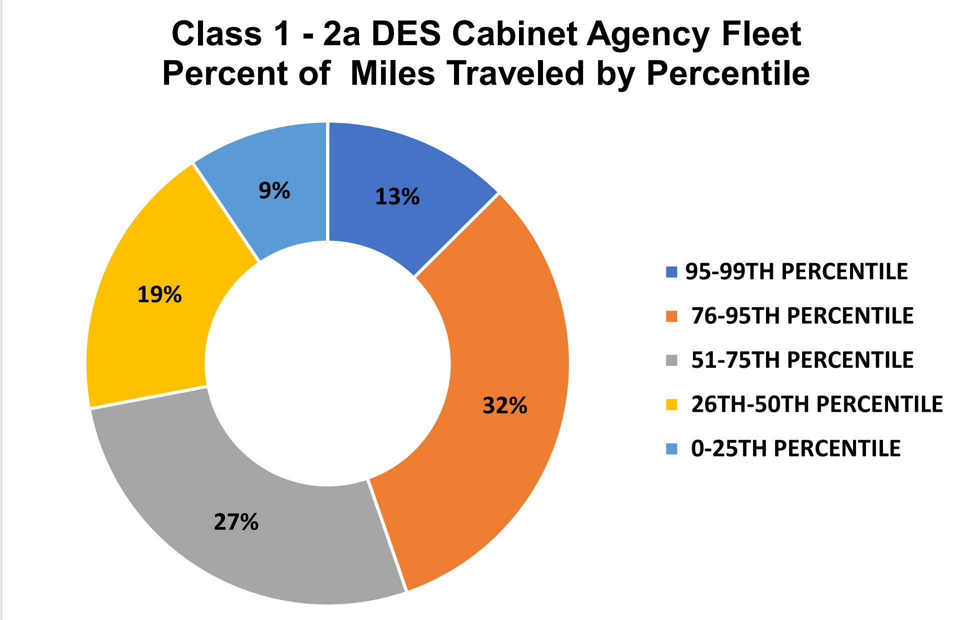
Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	10,020	12,335	7,554	6,954	5,003
Average Age	6.8	6.2	9.3	9.7	9.7
Count	3,715	1,530	1,156	582	297
2035 Forecasted BEV %	96%	99%	70%	42%	54%

**Agency owned vehicles*

Operational costs are comprised of fuel/electricity and maintenance costs on a per-mile basis. From an analysis of Washington State fuel and electricity rates paired with the average fuel economies of class 1 and 2a vehicles and their per mile average maintenance costs, BEVs have a per mile operational cost of 11 cents versus ICE vehicles' 28 cents per mile **(Table 12).** For example, a 2023 Chevrolet Bolt (BEV) upfront acquisition price is roughly $6,228 more than a 2023 Toyota Camry (ICE) according to the State of Washington's Contract Automobile Request System (CARS), resulting in a breakeven mileage of only 38,000 miles at 2023 costs. Over 100,000 miles, the Chevrolet Bolt would cost an estimated $17,000 less to operate. However, these savings depend upon the charging rates the state can secure via its owning and operations of charging infrastructure. From WSDOT fleet managers' experience, the costs of BEV operation are approximately 25 cents per mile when using publicly available EVSE. Under the same 100,000 mile scenario, a BEV using exclusively publicly available EVSE would save only $3,000.

Class 1 and 2a generate approximately $267.9 Million of the forecasted lifetime total vehicle operating cost savings **(Table 19)**. The modeled scenario is intentionally conservative to mitigate negative cost impacts of electrification and employs a cost parity year forecast for class 1 and 2a vehicles of 2028 and 2029 respectively, at the higher end of most forecasters' ranges. Given the substantial lifetime savings of BEVs versus ICE vehicles in class 1 and 2a, fleet managers could shorten duty cycles and pursue BEV replacements as availability constraints ease with the major forecasted production increases. However, given the disproportionate share of overall miles traveled by a comparatively few number of vehicles, 25% of vehicles account for 45% of overall miles traveled for the DES fleet **(Figure 1)**, savings and share of miles traveled by BEV could be greatly enhanced by targeting high usage vehicles for BEV replacement.

Figure 1: DES Cabinet Agency Fleet Class 1 – 2a Percent of Miles Traveled by Percentile



**Data availability constraints did not make similar analysis possible for the other fleets analyzed.*

To meet Executive Order electrification goals the State could accelerate retirement of ICE vehicles in the 5-years preceding the 2035 100% goal. This would require increasing annual procurement - from an average of 751 vehicles to approximately 944**.**

Class 2b – 3 Vehicles

Class 2b and 3 vehicles have a GVWR of 8,501-10,000 lbs. and 10,001-14,000 lbs. respectively (**Table 10**). Together, vehicles of these classifications represent 1,553 vehicles, or 15%, of the vehicle analyzed in this report. The modeled scenario assumes overall availability of BEVs, if available, as 75% in 2023 scaling to 100% by 2028 in 5% increments. This availability constraint is intended to capture known availability issues among BEVs already in production due to supply chain and production capacity constraints. **Table 4** below provides an overview of the modeled availability year and representative models.

Table 4: Class 2b and 3 Modeled BEV Availability Assumptions

Classification	Truck 2b	Van 2b	Class 3
Year	2028	2024	2025
Vehicle Model Examples	No Major Manufacturer Commitments	Ford, E-Transit Ram, ProMaster* Rivian, EDV 500/700 BrightDrop, Zevo 600	Rivian EDV 900
Presently Available	No	Yes, limited availability	No

**See Appendix - C.3 - Vehicle Availability Assumptions for full list of models, release year, and source*

According to the analysis in this study, Class 2b and 3 cabinet agency vehicles are forecasted to reach 80% electrification by 2040 **(Table 17)**. These vehicles are forecasted to generate $56.5 Million **(Table 21)** in savings over the purchased vehicles forecasted operational lifespans based on their respective fleet's operational profile and retirement assumptions. DES and WSP are forecasted to achieve 100% BEV by 2040 **(Table 5)**. WSDOT, DOC, and DSHS are forecasted to achieve 79%, 60%, and 75% respectively based on present fleet age and forecasted retirements.

Table 5: Class 2b and 3 Summary Data

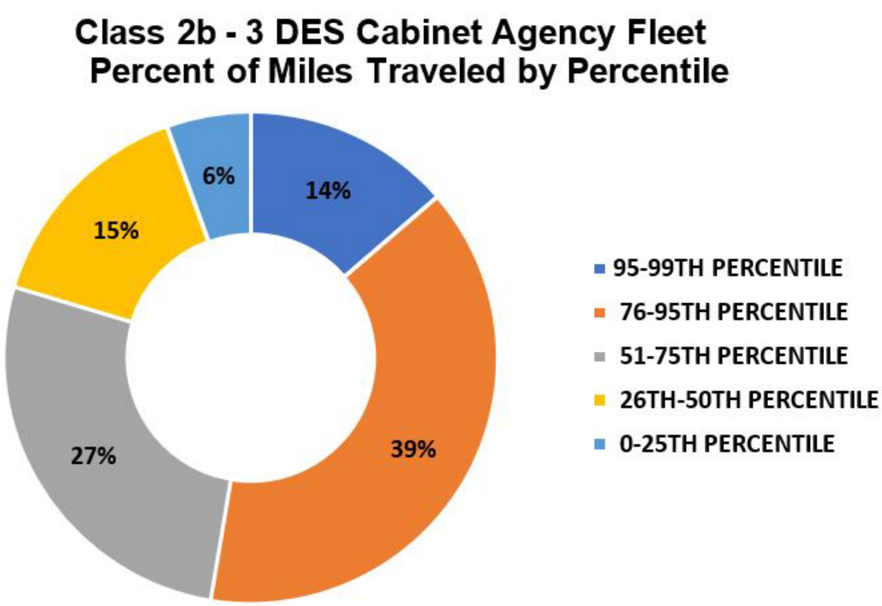
Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	9,557	9,824	13,846	4,882	4,532
Average Age	7.9	10.1	9.0	15.4	14.3
Count	292	68	676	299	225
2040 Forecasted BEV %	100%	100%	79%	60%	75%

**Agency owned vehicles*

Supplying trucks in classes 2b and 3 is a major source of uncertainty. Of the three manufacturers showing trucks available in these weight classifications on CARS in December 2022, (*Ford, General Motors, and Ram*), only General Motors has committed to producing BEV models, and it is estimated by 2035 **(Appendix - C.3 - Vehicle Availability Assumptions)**. For this reason, the forecasting model assumes there is no availability over the next five years for trucks in these classes. However, based off the massive commitments made to electrification by both government and industry, paired with the California Air Resource Board's ban on ICE vehicles by 2035, (*which Washington has adopted under Section 177 of the Federal Clean Air Act*), it is likely there will be BEVs in some capacity within the next 5 years in class 2b and 3 truck configurations.

However, class 2b and 3 vans are already on the market, albeit with availability constraints in the near term. Both Ford and GM, through their subsidiary BrightDrop, have class 2b vans on the market and Ram has announced a Fall 2023 launch of a BEV ProMaster van. While currently restricted to Amazon, Rivian's EDV series van is in production for 2b and 3 classes and will likely be made broadly available in the future. Like class 1 – 2a vehicles, targeting high usage vehicles *(depending upon availability)*, could increase miles traveled electrification rates and generate higher savings. For the DES fleet, class 2b and 3 vehicles in the 75^{th} percentile and higher, account for 54% of overall miles traveled **(Figure 2)**

Figure 2: DES Cabinet Agency Fleet Class 2b - 3 Percent of Miles Traveled by Percentile



**Data availability constraints did not make similar analysis possible for the other fleets analyzed.*

The lack of BEV availability in truck body styles is a major impediment to realizing BEV goals in the near term. Assuming broad availability of BEV options in the 2030s, the state could achieve 100% electrification goals by increasing replacements by 64 annually from 93 to 157.

Class 4 – 8 Vehicles

Class 4-8 vehicles range from 14,001 lbs. to 33,000+ lbs. **(Table 10)** and constitute 1,312 of the vehicles modeled or 13% of the overall modeled fleet. The modeled scenario assumes overall availability of BEVs, if available, as 75% in 2023 scaling to 100% by 2028 in 5% increments. This availability constraint is intended to capture known availability issues among BEVs already in production. WSDOT alone manages 83% of class 4-8 vehicles **(Figure 12).**

Table 6: Class 4-8 Summary Data

Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	7,621	5,630	3,561	5,278	5,254
Average Age	8.6	18.7	9.8	20.8	15.6
Count	33	16	1,116	109	64
2040 Forecasted BEV %	38%	49%	17%	5%	20%

**Agency owned vehicles*

Class 4 – 8 cabinet agency vehicles are expected to achieve 28% electrification by 2040 **(Table 17)**. These vehicle classifications face major cost barriers to electrification, due to very low average miles traveled for these classifications. **(Cost Based Exemptions, pg. 16)**. Electrification of these vehicles generate an estimated $50.4 Million in savings **(Table 23)** due to their very high per mile cost differentials and long expected services lives.

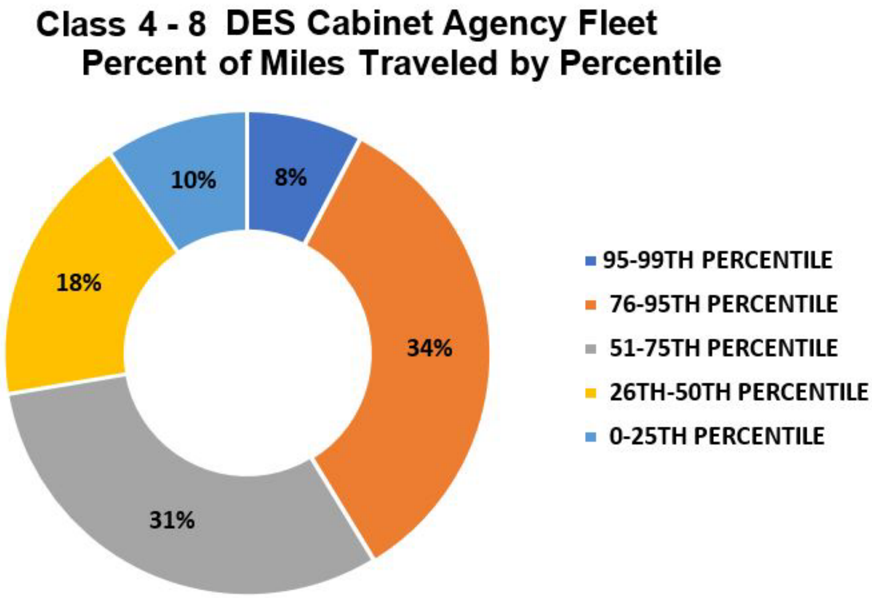
Table 7: Class 4-8 Modeled BEV Availability Assumptions

Classification	Class 4-6	Class 7-8
Year	2025	2025
Vehicle Model Examples	Rivian, EDV 900 (2024)* BYD 6F	Kenworth T680E
Presently Available	Yes, limited availability	Yes, limited availability

**See Appendix - C.3 - Vehicle Availability Assumptions for full list of models, release year, and source*

Unlike class 1-3, class 4-8 vehicles are not expected to achieve purchase cost parity due to the massive batteries needed to power these large vehicles, thereby increasing the number of miles these vehicles must travel to become cost-effective. However, given the often-unique nature of the service roles in these classes of cabinet agency owned vehicles (i.e. snowplows or drill rigs in WSDOT's fleet), they travel much fewer miles than lighter classification vehicles, making it very difficult to recover the higher upfront capital cost. The top 25% of vehicles account for 42% of overall miles traveled (**Figure 3).**

Figure 3: DES Cabinet Agency Fleet Class 4 – 8 Percent of Miles Traveled by Percentile



**Data availability constraints did not make similar analysis possible for the other fleets analyzed.*

Class 4 vans and box trucks are eligible for replacement on SEEP and availability grounds beginning in 2025. Class 4 and higher trucks in towing roles are availability exempt while most class 6 and higher are cost exempt for the duration of the forecast, predominately due to very low average mileage traveled in these classifications, particularly in the WSDOT fleet. While SEEP exemptions may be used once, the modeled long-forecasted life span of these vehicles results in the second replacement cycle falling outside of the 18-year forecast for almost all the vehicles modeled.

Fleet operators could pursue two strategies to achieve electrification objectives. First, consolidate roles where possible to increase annual miles traveled to increase the aggregate per mile savings, increasing the cost competitiveness of BEV options. Second, defer replacements, if possible, in the to medium term to increase the number of vehicles available for replacement in the 2035-2040 period. If costs decrease and availability increase more than forecasted, fleet operators could position themselves for a sprint to electrification from 2035-2040.

Vehicle Charging

The modeled charging forecast scenario **does not account for existing public charging resources or the potential to take advantage of future publicly available charging infrastructure**. Level 2 and 3 charger cost data was developed to establish the potential cost of meeting charger needs using *either* level 2 or 3 charging infrastructure exclusively for state cabinet fleet vehicles. Therefore, the charging costs presented should be interpreted as a worst-case cost scenario. The modeled outcome is intended to establish the scale of charging capacity needs and identify the areas where these investments will need to be prioritized. The most cost-efficient deployment will take advantage of public charging resources, deploy level 2 charging to contexts where multiple vehicles can share a single port with level 3 charging located to fill critical network and operational gaps.

Level 2 Charger Needs Forecast

Over the 18-year forecast period 8,425 new networked charger port installations and 5,216 networked charger port replacements are anticipated, costing an estimated $213.2 Million **(Table 74)**. Five counties, Thurston, King, Pierce, Spokane, and Yakima are expected to account for 65.8% of total charger installations based on the current distribution of vehicles statewide **(Table 75)**. Charging ports were modeled in 1, 2, 4, and 6-port installations. All charger installations are assumed to have two ports, excluding single port installations which were only modeled for WSP vehicles due to the high share of 'take-home' vehicles. Two port charger installation are much more economical in terms of unit cost, site preparation, and operational costs. Six ports are the upper modeled installation size since this is typically a threshold for broader improvements in electrical infrastructure to support charging needs. A complete county breakdown of level 2 charger needs can be found in the **Appendix – A.5 - Modeled Fleets Overall Charging Data.**

One networked level 2 charger installation is assumed for each BEV ICE replacement. The 1:1 vehicle to charger ratio is considered best practice for fleets where electrification rates are low, vehicles would not be moved from a port at the conclusion of its charging, and charger management processes are not yet established. While a 1:1 ratio is high in the long-term, it provides a worst-case scenario for budget planning. As lessons are learned in the near- and medium-term concerning charging management and publicly available charging infrastructure becomes available, agencies will be able to increase the ratio of vehicles to chargers and decrease charging infrastructure expenditures. In limited contexts, level 1 chargers may be sufficient when paired with public charging resources. However, for modeling purposes, only level 2 and 3 are analyzed in this report. Operating level 2 chargers at higher ratios paired with the long charge times of 4-10 hours from empty, can add significant operational complexities associated with swapping vehicles.[1] However, as level 2 charging becomes more broadly available at public locations and level 3 charging expands, the need for dedicated charging capacity will decrease long-term. This forecast is the upper bound of level 2 charger infrastructure needs for ICE with BEV replacements. Each charger is assumed to be a higher cost networked charger to capture usage data and enable future operational flexibility in terms of swapping vehicles at end of charging or making state owned resources available to other BEV operators.

An 'BEV hub model' is proposed for implementation to balance charger installation capacity with overall fleet turnover, to optimize investments and avoid the challenges of installing charging infrastructure at employee's residences **(see section 3.1 Level 2 Charging Infrastructure)**. Only level 2 chargers are assumed to operate at hubs since each charger would be associated with one vehicle. The modeled hubs are six level 2

[1] U.S. Department of Transportation. https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds%23:~:text=Level%202,empty%20in%201%2D2%20hours

ports or fewer. Six ports are considered a threshold for broader infrastructure improvements, which incur highly variable costs. The only fleet modeling take home vehicles is the Washington State Patrol. There may be contexts where pairing level 2 and 3 charger investments make sense based on a charging location or fleet needs. However, for the purpose of this analysis, and developing installation cost estimates, level 2 and 3 chargers are kept separate. Level 2 chargers are assumed to have a 10-year operational lifespan, in line with other charger costs assessments and industry guidance.[2, 3] The modeled costs include a 5-year initial warranty with an annual estimated maintenance and operations cost for the remaining 5-years. A full break down of costs are provided in **Table 16.**

Level 3 Charger Needs Forecast

A 10:1 vehicle to charging port ratio is assumed for level 3 chargers, resulting in 416 new chargers (832-ports) and 219 replacement chargers (438-ports) over the forecast period, costing an estimated $116.5 Million **(Table 76)**. Level 3 charging infrastructure has a significantly different deployment criteria compared to level 2 chargers and have much higher costs from both an installation and site preparation standpoint. Level 3 chargers also have significantly greater revenue generation opportunities due to the high level of demand for rapid charging infrastructure more generally. This forecast is generated as a function of the overall fleet size and estimates the cost to provide one charging port for every ten vehicles. Siting precise locations for these chargers and analyzing collocating level 3 with level 2 chargers is beyond the scope of this analysis.

Level 3 chargers are assumed to have a 10-year operational lifespan, in line with other charger costs assessments and industry guidance. [4, 5] The modeled costs include a 5-year initial warranty with an annual estimated maintenance and operations cost for the remaining 5-years. Costs are broken down further in **Table 16.**

[2] Avista Corp.: https://www.myavista.com/-/media/myavista/content-documents/energy-savings/electricvehiclesupplyequipmentpilotfinalreport.pdf
[3] Greater New York Insurance: https://www.gny.com/products/electric-vehicle-charging-stations
[4] Avista Corp.: https://www.myavista.com/-/media/myavista/content-documents/energy-savings/electricvehiclesupplyequipmentpilotfinalreport.pdf
[5] Greater New York Insurance: https://www.gny.com/products/electric-vehicle-charging-stations

1.0 Fleet Forecast and Cost Model Development

1.1 Model Background

The Fleet Forecast and Cost Model (FFCM) identifies the number of ICE vehicles eligible at the end of their useful life to be replaced with BEVs. The eligibility of vehicles to be replaced is determined by the application of the **State Efficiency and Environmental Performance (SEEP) – Vehicle Purchase Exemption Criteria (page 16)**. Based on established eligibility, the FFCM analyzes the difference in upfront acquisition purchase price between ICE and BEV vehicles, the estimated lifetime operating cost of an ICE and a BEV vehicle, and the level 2 and 3 charging infrastructure needed to support BEV vehicles. The FFCM is tailored to the five state agency vehicles fleets that self-reported their agency owned and managed vehicle fleet data and are held to the electrification goals outlined in Executive Order 21-04 **(Table 8).**

Table 8: Cabinet Agency State Vehicle Fleet Electrification Goals in Executive Order 21-04

Passenger Vehicles and Class 1-2a	Class 2b and Class 3	Classes 4-8
40% by 2025	30% by 2030	50% by 2030
75% by 2030	55% by 2035	75% by 2035
100% by 2035	100% by 2040	100% by 2040

While DES does lease permanently assigned vehicles to both DSHS and DOC, both still operate a large volume of agency-owned vehicles. They are not exempted from RCW 42.19.600 as Washington State Patrol, Washington State Department of Transportation, and Washington State Department of Natural Resources are. The five fleets listed were independently modeled to generate unique electrification forecasts for each. Each fleet was requested to provide vehicle age, make, model, and annual miles traveled information as a minimum. Some fleets provided annual vehicle miles traveled, maintenance, fuel, and operational costs for 2018-2022.

- Department of Enterprise Services (DES)
- Washington State Patrol (WSP)
- Washington State Department of Transportation (WSDOT)
- Department of Social and Health Services (DSHS)
- Department of Corrections (DOC)

1.2 Summary of Work Completed

The project team employed a 5-step approach to develop the Fleet Forecast and Cost Model (FFCM). Key steps and accomplishments are described in the **Table 9** below.

Table 9: Model Development Steps

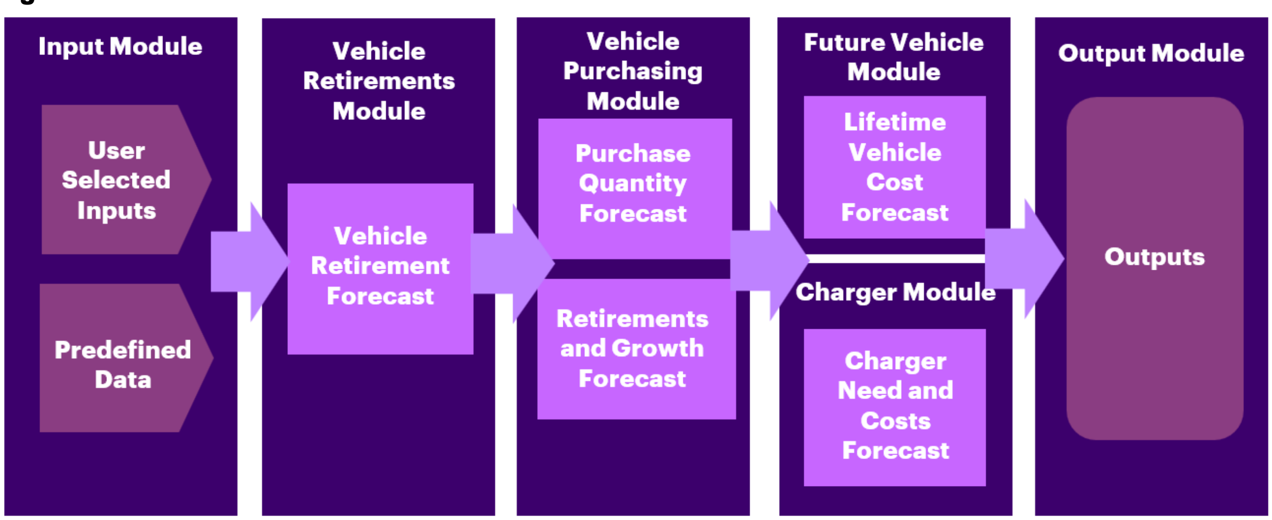
Key Step	Accomplishments
1. Existing Fleet Inventory and FFCM Output Requirements	• Defined framework for analysis and developed necessary data metrics • Mapped use case and data to FFCM design
2. Design FFCM Architecture	• Designed FFCM to reflect Washington specific operational and usage criteria
3. Develop FFCM	• Created FFCM employing State, Federal, and commercial data sources
4. FFCM Review and Data Output	• Validated FFCM with internal BEV experts
5. Report Out	• Authored FFCM Report to Legislature

1.2.1 Model Architecture and Modules

The FFCM is comprised of discrete modules that are combined to generate fleet composition, costs, and charger requirements outputs together through the overall model architecture illustrated below. The modules achieve four goals:

1. Identify year of vehicle retirement and classification of the replacement vehicle.
2. Estimate the lifetime ownership costs for ICE and BEV alternatives for each vehicle purchase.
3. Apply State Efficiency and Environmental Performance Non-BEV Purchase Exemption Criteria.
4. Estimate level 2 and 3 charger needs and total lifetime costs through the forecast period.

Figure 4: Model Architecture



1.2.1.1 Fleet Forecasting Modules

Establishing a vehicle's classification and forecasted year of retirement is the basis for generating fleet purchase forecasts. Vehicle classifications data enable forecasting vehicle purchase and lifetime operating costs and the application of retirement criteria. The forecasted year of retirement of a vehicle enables establishing whether a vehicle has a BEV alternative available and calculating the projected purchase and lifetime cost differences between ICE and BEV alternatives. Per the Executive Order, the model does not analyze farm tractors/farm vehicles as defined in RCW 46.04.180 and 46.04.181, off road vehicles as defined in RCW 46.04.546, and low speed vehicles.

Vehicle Retirements Module

Vehicle Classification

Executive Order 21-04 uses the U.S. Environmental Protection Agency's Gross Vehicle Weight Rating (GVWR) system **(Table 10)** to prescribe class based electrification BEV fleet share goals by year. Vehicles are classified by GVWR and body style if Class 1-2b. Vehicles are assigned a classification based on existing fleet inventories provided by fleet operators for each of the five fleets analyzed in this report.

Table 10: U.S. Environmental Protection Agency Gross Vehicle Weight Rating (GVWR)

GVWR (lbs.)	EPA Classification	Body Style	Modeled Classifications	Representative Vehicle Models
<6,000 lbs.	Class 1	Sedan, SUV, Van, Truck, Pursuit SUV	Sedan 1, SUV 1, Van 1, Truck 1, Pursuit SUV 1	Chevrolet Bolt, Ford Escape, Chrysler Pacifica, Ford Ranger, Ford Explorer Pursuit
6,001 – 8,500 lbs.	Class 2a	SUV, Truck, Pursuit SUV, Pursuit Truck	SUV 2a, Truck 2a, Pursuit SUV 2a, Pursuit Truck 2a	Chevrolet Tahoe, Ford F-150, Chevrolet Tahoe, Ford F-150
8,501 – 10,000 lbs.	Class 2b	Van, Truck	Van 2b, Truck 2b	Ford Transit, F-250
10,001 – 14,000 lbs.	Class 3	N/A	Class 3	Ford Transit, F-350
14,001 – 16,000 lbs.	Class 4	N/A	Class 4	Isuzu NPR
16,001 – 19,5000 lbs.	Class 5	N/A	Class 5	Isuzu NPR
19,501 – 26,000 lbs.	Class 6	N/A	Class 6	Kenworth T180
26,001 – 33,000 lbs.	Class 7	N/A	Class 7	Kenworth T380
>33,001 lbs.	Class 8	N/A	Class 8	Kenworth T680

Source: Department of Energy – https://afdc.energy.gov/data/10380

Retirement Year

The FFCM employs two distinct retirement forecasting methods to establish vehicle retirement year. The fleets managed by DES and WSP use vehicle age and mileage to establish an existing vehicle's forecasted retirement year while the fleets managed by WSDOT, DSHS, and DOC employ only age to estimate a vehicle's retirement year. The methods are titled: Age and Mileage Retirement Forecast Method and Age Only Retirement Forecast Method.

Age and Mileage Retirement Forecast Method

The Age and Mileage Retirement Forecast Method, applied to WSP and DES fleet vehicles, retires vehicles after either an age or mileage criteria are met. Using historical mileage and age data provided by DES and WSP, a percentile distribution is generated for each vehicle classification.

Example 1: High Annual Mileage: A Sedan 1 classified vehicle, in the 99th percentile, will travel nearly 71,000 miles per year, resulting in its retirement after two years, under a 100,000-mile condition.

Example 2: Low Annual Mileage: A Sedan 1 classified vehicle in the 50th percentile, travels 8,250 miles per year, which would result in its retirement at year 13, under the 100,000- mile condition. However, using the age criteria, this vehicle would be replaced at year 10 with approximately 83K miles driven.

Adjustments from COVID-19 impacts: Fleet use was impacted during the COVID-19 pandemic. Adjusting data to account for changes in travel behavior during the COVID-19 pandemic, is acutely important in projecting future fleet travel volumes. To account for depressed mileages between 2020-2022, the DES and WSP fleet models forecast future annual miles traveled as the average of 2019 and 2022 vehicle miles traveled data. The assumption is travel volume will increase due to the lifting of the Governor's COVID emergency order but will not return to pre-pandemic travel volumes due to flexible work schedules.

Table 11: Mileage Percentile Table Sample from DES Model

Metric (miles)	Sedan 1	SUV 1	SUV 2a	Truck 1	Truck 2a	Truck 2b
Average	9,736	10,969	10,665	7,763	12,200	11,123
25th Percentile	5,143	7,062	7,028	2,852	6,275	5,379
50th Percentile	8,250	10,578	10,338	6,517	10,679	11,083
75th Percentile	11,870	14,879	14,953	10,692	16,907	14,911
95th Percentile	19,210	23,418	23,240	20,410	26,586	25,600
99th Percentile	70,948	30,685	35,976	23,308	35,063	27,968

Age Only Retirement Forecast Method

WSDOT, DSHS, and DOC fleets reported mileage data through odometer readings and vehicle age, resulting in calculating annual mileage. Additionally, some fleets had difficulty collecting odometer readings since COVID. Therefore, estimating annual miles by percentile and analyzing pre and post COVID was not viable based on the data provided by these fleets. Furthermore, typically these fleets travel fewer miles on average and operate older vehicle fleets compared to DES and WSP. Consequently applying a strict age-based retirement criteria based on department policy, typically 10-years, results in a disproportionate share of retirements early in the forecast period due to the higher share of vehicles ten years of age or greater currently in inventory in the WSDOT, DSHS, and DOC fleets **(Table 18, 20, and 22)**. Concurrently, low annual miles traveled resulted in exceedingly long usage-based service lives. To generate a retirement forecast, approximates existing fleet management practices, vehicle retirements occur at a rate that maintains the existing fleet's average age for WSDOT, DSHS, and DOC fleets. WSDOT's, DSHS's, and DOC's end of life vehicle surplus tables are calibrated to each of their fleet's average age by weight classification. Each fleet modeled imposes mandatory retirement at age 31 for vehicle classes 1-3 and 41 for class 4 and higher.[6] Mandatory retirement age thresholds were established from an analysis of the modeled fleets. Vehicles beyond these ages are outliers within the fleets and often fill special roles.

Vehicle Purchasing Module

The vehicle purchasing module is comprised of two parts: the **Purchase Quantity Forecast** and the **State Efficiency and Environmental Performance (SEEP) – Vehicle Purchase Exemption Criteria**. The Purchase Quantity Forecast employs the retirement module's predicted retirements, paired with overall growth assumptions, to establish the number of vehicles purchased each year. The application of SEEP Purchase Exemption Criteria determines whether the vehicle being replaced is BEV eligible.

Purchase Quantity Forecast

Annual vehicle purchases are the sum of the forecasted vehicle retirements as the Executive Order's scope extends only to "procure BEVs to replace ICE vehicles that have reached the end of their useful life." All fleets are modeled to maintain present fleet counts and classification composition. However, based on guidance from WSP fleet managers, sedans in pursuit roles are forecasted to be replaced by SUVs based on current department purchasing policy.

Application of State Efficiency and Environmental Performance (SEEP) – Vehicle Purchase Exemption Criteria

Five SEEP Vehicle Purchase Exemption Criteria are applied in FFCM. The SEEP criteria are cost, prohibitive upfits, emergency response, vehicle availability, and vehicle range. If an ICE vehicle is determined to be exempt from BEV replacement under any of these criteria, it is replaced with the most fuel-efficient non-BEV vehicle available in that car class. SEEP exemptions are a one-time award determined on a per vehicle basis at the time of procurement or replacement. Given the modeled conditions of BEV availability and price, vehicle replacements granted an exemption for classes 1-4 would not have a basis for exemption at the time of their future replacement. However, class 5-8 vehicles due to their light usage and forecasted price premium, could result in situations in the future where a vehicle exempted based on SEEP criteria once, still fails SEEP criteria at the time of its future replacement. However, this second replacement falls outside of the 18-year purchase forecast period of the model due to the modeled lifespan of class 5 and higher vehicles.

Cost Based Exemptions

Vehicles are ineligible for BEV procurement if their lifetime cost is more than 10% greater than the lifetime cost of a comparable ICE vehicle. Cost excludes vehicles from BEV replacement when a vehicle will not travel a sufficient distance over its predicted lifespan to recover its higher upfront costs through lower operational costs **(Table 12 and 13)**. In this model, the cost-based exemption is applied by excluding a classification of vehicles from BEV purchase if more than half of the vehicles of that classification is forecasted to exceed the 10% threshold. For example, if 51% of the hypothetical class 5 BEV vehicle purchases in 2025 are predicted to exceed the lifetime costs of ICE vehicles filling those same roles, none of the vehicle purchases for that forecast year would be BEV. The basis being, if bought at random, the vehicle is more likely than not to exceed the SEEP cost threshold.

[6] International Association of Energy Economics: https://www.iaee.org/en/publications/ejarticle.aspx?id=3032

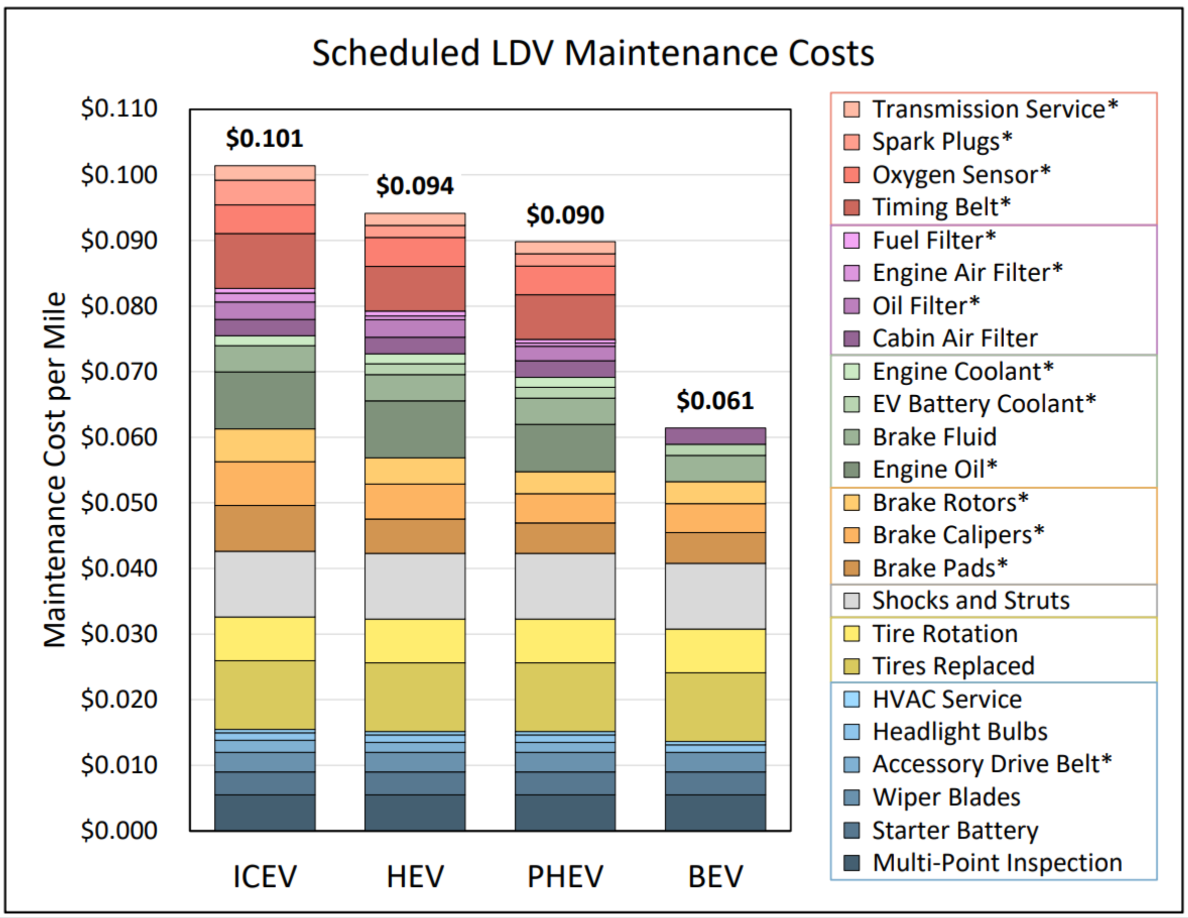
Lifetime Cost Factors

Lifetime cost is comprised of vehicle value at time of surplus disposal (recovery value), fuel costs, maintenance costs, and administrative costs. These values are calculated for each year of a vehicle's predicted service. Values for each year are adjusted to relevant forecasts in fuel prices, vehicle efficiency, vehicle acquisition costs, and administrative overhead.

Maintenance Costs

BEVs simpler motors and drivetrains result in significantly lower per mile maintenance costs. Based on the Department of Energy's (DoE) Argonne National Laboratories' 2021 Report: *Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains*, light-duty BEVs pay $0.061 per mile in scheduled maintenance versus ICE vehicles $0.101 rate, as shown in the figure below. This per mile cost rate is applied to vehicles class 1-3 in the FFCM. These per mile rates were confirmed independently for the DES fleet based upon the annual maintenance costs data provided by fleet managers for the past 5-years.

Figure 5: Department of Energy – Per Mile Light-Duty Vehicle (LDV) Maintenance Costs



Service intervals that vary by powertrain
Source: Department of Energy: Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains, pg. 83

Medium and heavy duty, classes 4-8 vehicles, experience similar maintenance cost advantages. According to The Department of Energy's National Renewable Energy Laboratory's (NREL) 2021 Report: *Spatial and Temporal Analysis of the Total Cost of Ownership for Class 8 Tractors and Class 4 Parcel Delivery Trucks*, Class 4 diesel vehicles experience per mile operational and maintenance costs of $0.118 per mile compared to BEV's $0.076 per mile while Class 8 vehicles costs are $0.152 and $0.098 per mile respectively. Class 4 per mile rates are used for classes 4-6 in the model while class 8 rates are used for classes 7 and 8.

Fuel and Electricity Costs

BEVs per mile operating costs are significantly lower the ICE vehicles. The FFCM employs per mile energy consumption rates from The Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2022 Light-Duty Vehicle Miles per Gallon by Technology Type. According to AEO's 2023 forecast year, BEVs purchased in this year will travel 2.3 times further using the same amount of energy. This advantage translates into savings via electricity being significantly cheaper in Washington than an equivalent amount of gasoline. Washington is amongst the most favorable locations nationally for BEV ownership due to electricity prices being recurrently lower than the national average, attributable to Washington generating 67% of its electricity from cheap hydroelectric sources, the largest share nationally.[7] Hydropower is almost one-third the cost of fossil sources and nearly half that of nuclear.[8] In contrast, Washington has higher gas prices than the national average due to levying the fifth most in taxes and fees, being one of three states with a low carbon fuel standard, and the West Coast's relative market isolation from the rest of the United States due to the lack of pipeline connections.[9,10,11] For the most recent month of EIA data, November 2022, Washington's electricity rates in cents per kilowatt hour were 9.09 versus 12.46 nationally.[12] In contrast, Washington's fuel prices were $4.665 per gallon versus $3.799 nationally.[13] The combined fuel and maintenance savings per mile are summarized by class in the **(Table 12 and 13)** below for 2023. AEO's forecasted annualized percentage increase for electricity, gas, and diesel is employed throughout the forecast **Appendix – C.2 – Modeled Scenario Assumptions.** The modeled per mile costs for BEVs assumes the exclusive use of state-owned facilities. If publicly available chargers are used, costs would increase substantially.

Table 12: Modeled Class 1-3 ICE versus BEV Per Mile Operating Costs (2023)

Class	Class 1			Class 2a – 3		
Cost Factor	ICE	BEV	BEV Savings	ICE	BEV	BEV Savings
Maintenance	$0.10	$0.06	$0.04	$0.10	$0.06	$0.04
Fuel	$0.17	$0.05	$0.12	$0.19	$0.06	$0.14
Total	**$0.27**	**$0.11**	**$0.16**	**$0.30**	**$0.12**	**$0.18**

Table 13: Modeled Class 4-8 ICE versus BEV Per Mile Operating Cost (2023)

Class	Class 4-6			Class 7-8		
Cost Factor	ICE	BEV	BEV Savings	ICE	BEV	BEV Savings
Maintenance	$0.12	$0.08	$0.04	$0.15	$0.10	$0.05
Fuel	$0.43	$0.09	$0.34	$0.74	$0.18	$0.56
Total	**$0.55**	**$0.16**	**$0.38**	**$0.89**	**$0.28**	**$0.61**

[7] EIA: https://www.eia.gov/state/print.php?sid=WA
[8] EIA: https://www.eia.gov/electricity/annual/html/epa_08_04.html
[9] EIA: https://www.eia.gov/tools/faqs/faq.php?id=10&t=5
[10] Bloomberg: https://news.bloomberglaw.com/environment-and-energy/low-carbon-fuel-standards-hit-snags-beyond-west-coast-states
[11] ABC News: https://abcnews.go.com/Business/story?id=88275&page=1
[12] EIA: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a
[13] EIA: https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_m.htm

Vehicle Acquisition/Purchasing Costs

ICE vehicles are presently substantially cheaper at the point of purchase across all vehicle classifications. However, purchase cost parity will likely occur between 2026 and 2028 for class 1-2a, 2027 and 2029 for class 2b, and 2028 to 2030 for class 3 **(Table 14)**. The lower and upper limits for BEV purchase price parity are based on information published by Bloomberg New Energy Finance (BNEF) and the International Council on Clean Transportation (ICCT). BNEF is an industry leader in research and analysis on the trends driving the transition to a lower carbon economy forecasting battery prices. ICCT is an independent nonprofit organization whose mission is to improve environmental performance and energy efficiency in transportation through providing unbiased research and technical and scientific analysis to regulators globally. Both are considered leaders in forecasting for trends in low-carbon energy generation and transportation.

BNEF and ICCT both use battery costs for the basis of price parity. BNEF posits that when the $100-per-kilowatt-hour threshold is reached, BEV will be less than their ICE equivalents at the point of purchase for light-duty vehicles. In contrast, ICCT applies battery cost forecasts to vehicle classifications by body style and range.[14] ICCT's 300-mile range forecast is used by the FFCM with parity occurring between 2028 and 2030 depending on model. BNEF does not scale relative to vehicle classification in their forecast.[15] Therefore, the FFCM combines BNEFs 2026 parity year with ICCT scaling.[16]

Table 14: Modeled Forecasted Purchase Price Parity Year

Class	BNEF	ICCT
Class 1	2026	2028
Class 2a-2b	2027	2029
Class 3	2028	2030

The FFCM scales purchase prices linearly from 2023 purchase price to the purchase price parity year. After parity is reached, the price of BEVs is decreased by 1% over the preceding year before receiving a 2% increase to reflect the annualized average new vehicle price increase over the last ten years as calculated by the Federal Reserve Bank of St. Louis.

The State of Washington's Contract Automobile Request System (CARS) is the main source of vehicle purchase prices. Purchase costs are the average of the vehicles listed in the CARS contract with a given classification. For the basis of modeling, up fit and modification costs are excluded from the forecasted vehicle acquisition cost. Some vehicles from the model are excluded from purchase cost calculations due to their distortionary effect. For example, the Tesla 3 is excluded from the average purchase price calculation for BEV sedans since the Chevrolet Bolt is typically purchased at high volume within Washington State.

Class 4-8 vehicle's forecasted costs are provided by the same Department of Energy' 2021 report that provides per mile operational cost information: *Spatial and Temporal Analysis of the Total Cost of Ownership for Class 8 Tractors and Class 4 Parcel Delivery Trucks*. This is due to the current lack of BEV options in the CARS platform.

[14] Environment Defense Fund: *Electric Vehicle Market Update.* https://blogs.edf.org/climate411/files/2022/04/electric_vehicle_market_report_v6_april2022.pdf
[15] ICCT. https://theicct.org/wp-content/uploads/2022/10/ev-cost-benefits-2035-oct22.pdf
[16] BNEF. https://about.bnef.com/blog/race-to-net-zero-the-pressures-of-the-battery-boom-in-five-charts/

Vehicle Retirement Costs

Once vehicles reach the end of their service life, the recovery value is determined as a percentage based on their age and the original purchase cost. Due to the lack of used BEV sales attributable to their recent adoption, the FFCM model uses the same recovery rate for ICE vehicles and BEVs. While there is concern battery degradation will result in BEVs losing value rapidly as they age, or need expensive battery replacement, degradation is slower than often thought. According to research published by the Department of Energy in 2014, battery service lives should extend to 12-15 years if used in a moderate climate.[17] Tesla reports that of its over one million BEVs currently on the road that have traveled between 150,000 and 200,000 miles, average battery degradation is less than 15%. Given the long-observed lifespans of early BEV batteries, the significant improvements since, and predicted continued improvements, automakers foresee batteries outlasting the useful life of the vehicles.[18, 19] **Table 15** is applied to all vehicle classifications. It is developed from research of the used vehicle market in the United States and input from Washington State managed fleet managers based on their expected sale price of a vehicle after ten years' service relative to the purchase cost paid by the State.

Table 15: Modeled Vehicle Value Loss Per Year

Year	Value Loss per Year
1	20%
2-9	15%
10-16	10%
16+	10% of original purchase price

Prohibitive Upfits

Vehicles that require upfits or modifications that cannot be completed in BEV options are exempt from the Executive Order. Prohibitive upfit exemptions are applied predominately to the WSDOT fleet in the FFCM due to the high number of purpose-built vehicles. Examples of vehicles exempted are street sweepers, vacuum trucks, and drilling rigs. Additionally, these vehicles special usage criteria do not lend themselves to the same retirement assumptions since they are used in very specific contexts.

Emergency Response

Vehicles serving in emergency response roles are exempted from BEV purchase if using a BEV would pose a concern to public safety. Pursuit vehicles are exempted from BEV purchase for the first three years in the FFCM. Pursuit vehicles are class 1 to 2a vehicles serving in law enforcement roles that have specific performance metrics to receive a pursuit rating. Presently there are no pursuit qualified BEV vehicles in the SUV 1 or SUV 2a classes on the market. While the Ford F-150 Lightning does come in a Special Service Vehicle configuration, it is not pursuit qualified and is currently of limited availability.

Vehicle Availability

An ICE vehicle that is eligible to be replaced with a BEV, is exempted from a BEV purchase if there is not a comparable BEV option available in CARS at the time of purchase and the use or need of the vehicle cannot

[17] Department of Energy. https://www.nrel.gov/docs/fy15osti/64622.pdf
[18] Tesla. https://www.tesla.com/ns_videos/2019-tesla-impact-report.pdf
[19] Forbes. https://www.forbes.com/sites/carltonreid/2022/08/01/electric-car-batteries-lasting-longer-than-predicted-delays-recycling-programs/?sh=3be0746a5332

wait until the next available manufacturing order/delivery dates. Availability is a major impediment to achieving BEV goals. The scarcity of availability is due to both supply chain constraints and the lack of vehicles that have come to market and the projected scarcity of BEV options in the near term as automakers retool factories and battery production is expanded. This is less of an issue for sedans and class 1 SUVs vehicle where multiple options are already in production **(Appendix – C.3 - Vehicle Availability Assumptions).** However, it is a critical issue for vans, trucks, and large SUVs. The FFCM captures these constraints in two ways. First, for vehicle classifications where no model currently exists or is not available for purchase due to exclusive partnerships, for example, Amazon's with Rivian for the RD series van, an availability year based on manufacturer press releases is employed. Second, over the next 5-years the FFCM adopts a scaled approach to available classes, assuming 75% of ICE vehicles retiring in 2023 will be replaceable with a BEV. This assumption increases by 5% annually until 100% is achieved in in 2028 **(Appendix – C.2 – Modeled Scenario Assumptions)**.

Trucks (categorized as class 2b-3) are subject to severe availability constraints. There are no BEV trucks presently in production. However, Chevrolet has stated their entire line of Heavy-Duty trucks will be BEV available by 2035.[20] In contrast, Ford's CEO has stated these vehicles would likely be amongst the last to electrify and hydrogen may be more suitable.[21] This applies *only* to the truck configurations and is due to BEV range being severely curtailed under towing conditions.[22] However, BEV options for box truck and delivery vans (categorized as class 4-6) are already in production or entering production and offer substantial performance advantages over ICE equivalents.[23]

The FFCM assumes no class 2b truck availability for the first five years while class 3-6 are modeled as available starting in 2025, excluding WSDOT. WSDOT's very high share of trucks in these classifications resulted in exempting class 3 and 4 vehicles from BEV for the first five years, too. However, for the other fleets where vans comprise a much greater share of class 3 and 4, these classes are not exempted from BEV purchase. Truck replacement exempted on basis of availability within these classifications are assumed to be captured by the scaled availability factor applied to the first five years of the forecast period.

Vehicle Range

The final SEEP exemption criteria for purchasing a non-BEV vehicle option that is integrated into the FFCM model is vehicle range. Replacement vehicles are exempted from BEV purchase if the vehicle's primary duty station is not within 1 hour or 60 miles round-trip of a DC fast charger, both state and publicly available, *and* other charging methods are not sufficient to regularly charge the vehicle between standard operational uses or in the field. The FFCM assumes one level 2 charger deployment per BEV. Therefore, all replacement vehicles eligible for BEV replacement also assumes these vehicles have access to charging capabilities sufficient to recharge the vehicle between standard operational uses. The FFCM exempts ICE vehicles from being replaced with a BEV, if the BEV cannot meet the daily operational needs of its assignment. Already available and future public charging infrastructure is excluded from analysis. The model establishes what the future charging needs are within each county for state-owned vehicles. Actual charging needs are likely to be less than modeled.

[20] Car and Driver. https://www.caranddriver.com/news/a38696855/general-motors-electric-heavy-duty-trucks/
[21] Jalopnik. https://jalopnik.com/fords-super-duty-wont-be-going-electric-for-a-very-long-1849610263
[22] Kelley Blue Book. https://www.kbb.com/car-news/how-far-can-an-electric-truck-tow/
[23] Environmental Defense Fund: *Electric Vehicle Market Update.*
https://blogs.edf.org/climate411/files/2022/04/electric_vehicle_market_report_v6_april2022.pdf

The FFCM assumes 220 workdays per year, based on the number of sick, vacation, and built in holidays state employee receives, to calculate daily average range needs. The range threshold applied is 80% the range of a Ford F-150 Lightning or Chevrolet Bolt. The 80% trip planning range provides a conservative approach to route planning that accommodates the negative potential impacts on range of driver comfort controls, accessory outputs, and weather/temperature. The 2022 F-150 Lightning has a maximum range of 230 miles and the 2022 Chevrolet Bolt has a maximum range of 259-miles. The 184-mile range significantly exceeds the 99th percentile for class 2a trucks in the DES fleet, which is calculated to be 159-miles per day, while the Chevrolet Bolt exceeds the 98th percentile amongst sedans of 193 miles per day. Only sedans in the 99th percentile for the DES fleet are estimated to exceed the recommended range of *a currently available BEV.* Additionally, the 99th percentile for travel in WSP's pursuit vehicle classification is 176 miles per day. The extremity of this number shows range is not typically an operational constraint for nearly any vehicles presently operated in the DES fleet or WSP fleets. Range constraints will become less relevant to drivers as vehicles achieve greater ranges and access to DC fast charging infrastructure improves.

Vehicle Charger Module

The Vehicle Charger Module is composed of the Charger Demand Forecast and the Charger Cost Forecast. The Charger Demand Forecast uses BEV replacements and existing fleet BEV numbers to estimate the number of level 2 and 3 chargers needed in a forecast year **(Table 74 and 76).** The Charger Cost Forecast estimates the lifetime costs of a level 2 and 3 charger installation based on a 10-year operational lifespan **(Table 16)**.[24]

Charger Demand Forecast

Charger demand is calculated based off the number of overall increases of BEVs in the modeled fleets and the forecasted charging needs to support BEVs already in operation. A 1:1 vehicle to level 2 network charging port ratio is used by the FFCM. The 1:1 vehicle to network charger port ratio is considered best practice for fleets where electrification rates are low, vehicles would not be moved from a port at the conclusion of its charging, and charger management processes are not yet established. As electrification progresses, lower ratios could be attainable as charging sharing is maximized and leveraged. The FFCM employs a 10-year charger lifespan based on industry guidance for both level 2 and 3 chargers.[25] Finally, level 3 chargers are modeled as a single two port bollard installation. The number of level 3 (DC fast chargers) needed is based on a 10:1 BEV to level 3 fast charger port ratio. Charger needs are calculated exclusively as a function of modeled state BEV counts. Depending on fleet vehicle stored location and travel routes, there may be opportunities to leverage public charging infrastructure or deploy level 3 charging ports in lieu of level 2 charging ports. This analysis focuses on the current deployment of vehicles by location to identify the total charging needs to support BEV state cabinet agency fleet operations.

Charger Cost Forecast

The charger cost forecast is made up of charger purchase, operational costs, and charger site preparation costs **(Table 16).** All chargers are assumed to be networked, subscribed to a communication plan for the duration of operations and subscribed to a maintenance and warranty program for the first 5-years. After the

[24] Avista Corp.. https://www.myavista.com/-/media/myavista/content-documents/energy-savings/electricvehiclesupplyequipmentpilotfinalreport.pdf
[25] Atlas Public Policy. https://atlaspolicy.com/wp-content/uploads/2020/04/Public-EV-Charging-Business-Models-for-Retail-Site-Hosts.pdf

first 5-years, annual maintenance and operations costs are estimated on a per-port basis based on Avista Corp.'s Report: *Electric Vehicles Supply Equipment Final Report.*

Charger Purchase and Operational Costs

The Charger Cost Forecast uses the State of Washington's Electric Vehicle Supply Equipment (State Contract 04016 EVSE) contract with Puget Sound Solar LLC for baseline unit, maintenance, operations, and service costs. Avista Corp.'s report provides charger maintenance and operations costs outside of the initial 5-year warranty, maintenance, and operations contract provided by Puget Sound Solar on a per port basis. These estimates are based on projects recently completed with networked charging stations including lifetime estimated communications, warranty, and maintenance and operations costs. There is significant uncertainty concerning charger cost forecasts, which is illustrated by other countries experiences. For example, from 2016 to 2019, the cost of level 3 chargers fell by 67% in China with widespread deployment.[26] A relatively high 1% annualized increase is employed in the FFCM for the component purchase and lifetime operations of charging infrastructure, which reflects a decline in real terms.

The 1% annualized cost increase is generated from a review of the historical trends and potential future changes concerning three primary cost inputs for chargers: unit cost, telecommunications, and maintenance & operations. Assuming electrification, telecommunication, and labor costs for chargers track the annualized rate of change of these inputs, charger unit lifetime costs should decrease in real-terms over the forecast period. The compounded annual rate of change of the Consumer Price Index for Computers, Peripherals, and Smart Home Assistants in the U.S. has averaged -5%, over the last ten years. While Telephone Services have decreased by .6%, and Unit Labor Costs increased by 2.3% over the last 10-years. However, the 10-year average masks the significantly different cost growth environment experienced in the past two years. Concurrently, the combined impacts of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act, Inflation Reduction Act (IRA), and the Infrastructure Investment and Jobs Act (IIJA), all of which will impact charger costs, are uncertain. It is more likely than not the huge amount of direct support for BEV and their associated infrastructure will result in major purchase and operational cost decreases in the future, like the forecasted drop in BEV costs. These savings may be offset by increases in labor costs if employment remains strong despite rising interest rates. Alternatively, the aggressive pace of rate hikes may soften labor markets resulting in lower labor cost increases. Given the significant long-term uncertainty, a moderate increase in absolute terms, but decline in real-terms, 1% is employed. However, the likely dramatic market shift to BEVs and the massive federal support, a dramatic decline like that chronicled in China is possible.

Charger Site Preparation Costs

Due to the range of EVSE site installation costs attributable to site location and existing infrastructure, the FFCM uses average site preparation costs developed from the Avista Corp. Report: *Electric Vehicles Supply Equipment Final Report.* The Avista Corp report summarizes installation costs for 110 networked home level 2 chargers, 59 networked level 2 commercial chargers, and 7 commercial networked level 3 chargers in the greater Spokane region. Site preparation costs are scaled to 2023 prices, and forecasted through 2040, using WSDOT's Construction Cost's Forecast's 3.07% annualized cost increase.

[26] Rocky Mountain Institute: https://rmi.org/the-united-states-needs-more-fast-chargers-china-can-show-how/

Table 16: Modeled Charger Installation Lifetime Costs Breakdown (2023 Purchase Year)

Model	ChargePoint (Level 2) CT4011-GW1 Single Port – Bollard	ChargePoint (Level 2) CT 4023-GW1 Dual Port – Bollard	ChargePoint Express (Level 3) 250 CPE250 Dual Port – Bollard
Unit Cost	$6,193	$8,914	$50,790
Site Preparation Costs (1-time)	$1,579	$8,224	$96,188
Maintenance and Warranty	$2,541	$2,541	$15,787
Service Plan	$2,638	$2,638	$9,598
Installation	$1,200	$1,200	$4,219
Post-Warranty Maintenance and Operations	$3,247	$6,495	$16,778
Total	**$17,418**	**$30,011**	**$193,359**

**State of Washington's Electric Vehicle Supply Equipment (Contract 04016 EVSE) contract with Puget Sound Solar LLC provides unit, maintenance, operations, and service costs. Avista Corp.'s research provides site-preparation and post-warranty M&O.*

Charger Assumptions

The FFCM makes several major assumptions concerning charger lifetime, costs, and count. All chargers modeled are network chargers connected for the duration of their service life. Site preparation costs occur once per charger installation and no site preparation costs are included at the time of charger replacement. Charger installations are a mix of 1, 2, 4, and 6 port installations for level 2 chargers, while level 3 chargers are only dual port installations. Single port installations are only employed for the WSP due to the prevalence of take-home vehicles in their modeled fleet. Installations of 2, 4, and 6 ports are assumed to be dual port bollards. Six charging ports is the upper limit modeled because this is considered a threshold for incurring broader improvement in electrical infrastructure. Based on the six-port upper threshold, no panel or grid constraints are assumed. Further assumptions can be found in **Appendixes C.1, C.2, and C.3** .

2. Fleet Forecasts

2.1 Combined Fleet

2.1.1 Fleet Overview

The Washington State cabinet vehicle fleet is forecasted to achieve 83% electrification across all classes by 2040, led by class 1-2a vehicles (**Figure 6).** The major barriers to electrification are slow fleet turnover, lack of BEV options for class 2b-4 trucks, and cost-based exemptions for classes 7-8. While the lack of available pursuit options slows electrification initially amongst those vehicles managed by DES and WSP in the near-term, their short duty cycles caused by their high usage rates means they do not negatively impact the realization of the 2035 goal in these fleets. However, in modeled fleets with lower usage rates and longer lifespans (WSDOT, DSHS, and DOC), ICE vehicles mean they stay in their fleets far longer than they do in DES and WSP fleets. All vehicle purchases modeled are replacement of vehicles at the end of their operational lifespans. A summary of fleetwide BEV % share by forecast year is provided in **Table 17.**

Figure 6: Modeled Washington State Overall BEV Share

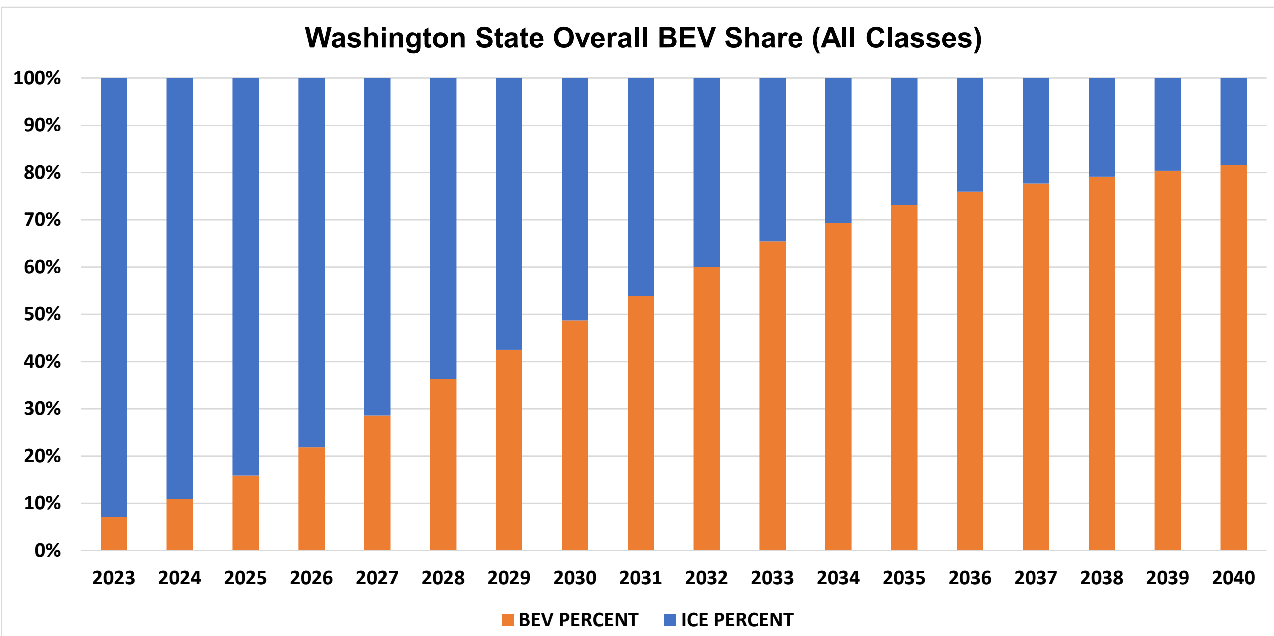


Table 17: Modeled Overall Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

Year	Classes 1-2a			Classes 2b-3			Classes 4-8			All Classes		
	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %
2023	727	6,553	10%	0	1,560	0%	0	1,338	0%	727	9451	7%
2024	1,076	6,204	15%	32	1,528	2%	0	1,338	0%	1108	9070	11%
2025	1,515	5,765	21%	98	1,462	6%	8	1,330	1%	1621	8557	16%
2026	2,067	5,213	28%	154	1,406	10%	19	1,319	1%	2330	7848	23%
2027	2,686	4,594	37%	219	1,341	14%	30	1,308	2%	3024	7154	30%
2028	3,340	3,940	46%	332	1,228	21%	57	1,281	4%	3816	6362	37%
2029	3,848	3,432	53%	441	1,119	28%	83	1,255	6%	4461	5717	44%
2030	4,363	2,917	60%	540	1,020	35%	110	1,228	8%	5102	5076	50%
2031	4,790	2,490	66%	619	941	40%	137	1,201	10%	5634	4544	55%
2032	5,299	1,981	73%	724	836	46%	172	1,166	13%	6283	3895	62%
2033	5,709	1,571	78%	843	717	54%	203	1,135	15%	6841	3337	67%
2034	6,016	1,264	83%	914	646	59%	230	1,108	17%	7247	2931	71%
2035	6,312	968	87%	981	579	63%	260	1,078	19%	7638	2540	75%
2036	6,524	756	90%	1,043	517	67%	285	1,053	21%	7852	2326	77%
2037	6,622	658	91%	1,099	461	70%	315	1,023	24%	8035	2143	79%
2038	6,698	582	92%	1,154	406	74%	338	1,000	25%	8191	1987	80%
2039	6,766	514	93%	1,196	364	77%	359	979	27%	8320	1858	82%
2040	6,827	453	94%	1,241	319	80%	377	961	28%	8444	1734	83%

2.1.2 Classes 1-2a

The persistence of mature vehicles is the primary obstacle to achieving BEV electrification goals in Class 1-2a vehicles, reaching 87% electrification by 2035 **(Figure 7)**. Many of these vehicles have two lifetimes where, at the time of retirement for most vehicles, they are shifted to roles where they provide excess capacity or are used in ways considered ill-suited for new vehicle purchases. For example, WSP pursuit vehicles will retire, and their surplus 'disposal' will be moving them into the WSP motor pool. The proportion of vehicles removed after one duty cycle is reflected in the younger average age of the modeled agencies' fleets **(Table 18)**. For example, WSP and DES are approximately three years younger on average than WSDOT, DSHS, and DOC.

Figure 7: Modeled Statewide Class 1-2a Vehicle Turnover and BEV Share

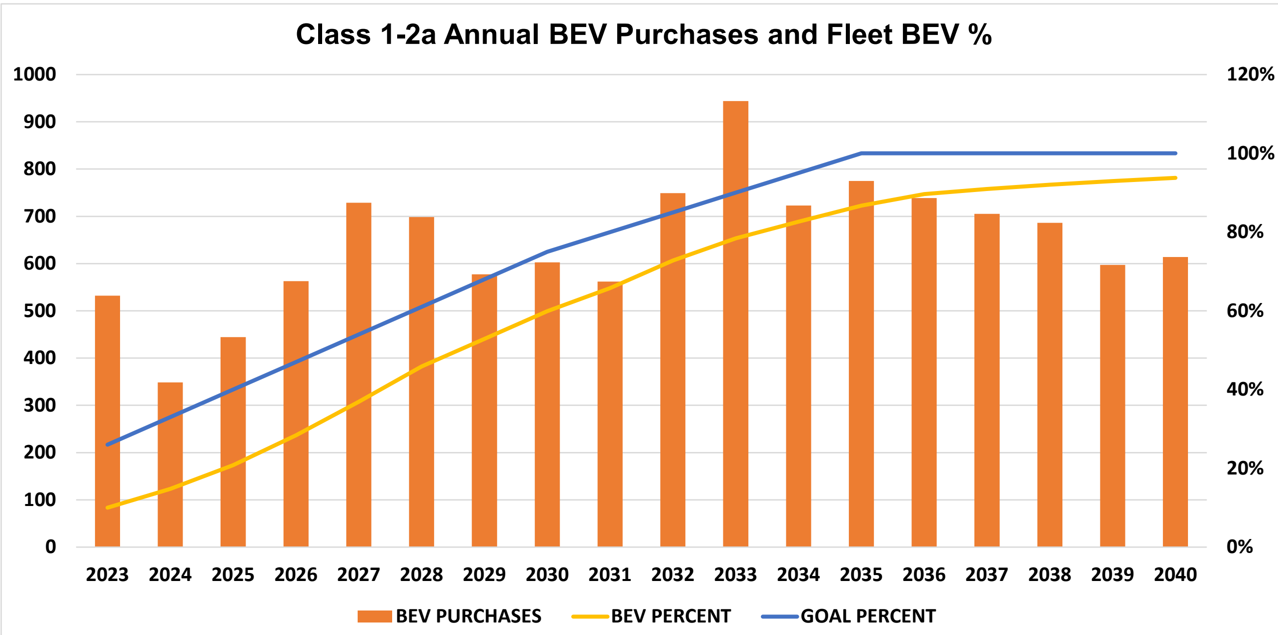


Table 18: Class 1-2a Average Annual Miles, Age, and Count

Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	10,020	12,335	7,554	6,954	5,003
Average Age	6.8	6.2	9.3	9.7	9.7
Count	3,715	1,530	1,156	582	297

Over the forecast period (2023-2040), a total of 13,014 vehicle replacement purchases are forecasted, split between 1,425 ICE vehicles and 11,589 BEV vehicles in classes 1-2a **(Table 19)**. Due to the assumption of achieving price parity in 2028-2029, and the forecasted price decline in BEVs, procuring BEVs will cost approximately $13.8 Million less than ICE vehicles through 2040. However, operational savings for BEVs begin accruing at the start of the forecast, resulting in a forecasted $267.9 Million lifetime savings over ICE alternatives. These savings do not include the corresponding charging costs needed to support their operation.

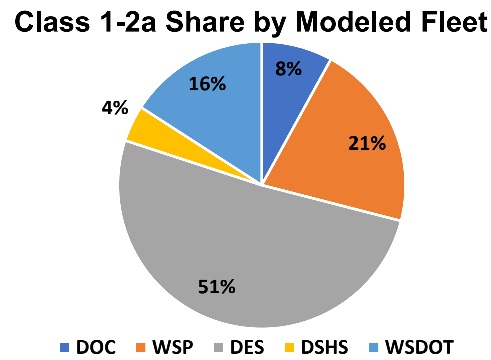


Figure 8: Class 1-2a Share by Fleet

BEV's greater efficiency gives them a major comparative advantage on a per mile operational bases that is amplified by Washington's low electricity prices and high gas prices, discussed previously in **Fuel and Electricity Costs**. The lack of available class 1 trucks and vans and class 2a SUVs is a major barrier in the near term to BEV adoption as is general availability of vehicles, captured by a 5-year availability phasing from 75% in 2023 to full availability by 2028. The purchase of ICE vehicle replacements in the near term in these classes, paired with broader availability constraints results in ICE vehicles lingering in the fleet.

Table 19: Modeled Class 1-2a Purchase Counts and Cost Forecasts – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			BEV Eligible Purchase Cost Difference	Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	Total Vehicles	ICE	BEV Eligible		ICE Fleet	BEV Fleet	
2023	977	445	532	$5,051,199	$25,368,293	$21,003,754	$4,364,539
2024	731	383	348	$2,541,974	$18,112,618	$14,185,301	$3,927,317
2025	843	399	444	$2,540,509	$23,276,523	$17,676,981	$5,599,543
2026	724	161	563	$2,210,645	$33,048,244	$23,937,453	$9,110,791
2027	767	38	729	$1,712,458	$42,699,699	$28,977,824	$13,721,876
2028	698	0	698	$149,918	$42,418,204	$27,805,316	$14,612,888
2029	577	0	577	-$442,074	$36,731,622	$23,305,138	$13,426,484
2030	603	0	603	-$891,508	$40,410,663	$25,157,595	$15,253,069
2031	562	0	562	-$1,085,364	$38,139,719	$23,637,046	$14,502,673
2032	749	0	749	-$1,612,797	$46,908,282	$29,078,838	$17,829,443
2033	944	0	944	-$2,382,047	$57,615,388	$35,966,190	$21,649,198
2034	723	0	723	-$2,221,856	$47,537,947	$29,165,234	$18,372,712
2035	775	0	775	-$2,745,208	$51,448,385	$31,556,373	$19,892,012
2036	739	0	739	-$2,989,105	$50,102,357	$30,814,051	$19,288,306
2037	705	0	705	-$3,137,886	$48,634,669	$29,080,414	$19,554,255
2038	686	0	686	-$3,434,622	$48,574,115	$29,029,879	$19,544,236
2039	597	0	597	-$3,314,189	$43,660,892	$25,599,591	$18,061,300
2040	614	0	614	-$3,760,167	$45,971,665	$26,758,812	$19,212,852
TOTAL	**13,014**	**1,425**	**11,589**	**-$13,810,120**	$740,659,285	$472,735,792	$267,923,493

2.1.3 Classes 2b-3

The lack of truck model availability, paired with the long service lifespans expected of class 2b-3 vehicles, are the major impediments to realizing BEV goals **(Table 20).** Overall, the class 2b-3 modeled fleet is forecasted to reach 80% electrification by 2040 **(Figure 9)** The only manufacturer of the three manufacturers of class 2b and 3 trucks currently listed in the CARS contract that has announced BEV plans, General Motors, has committed to BEV offerings in this range by 2035.[27] While the startups Bollinger and Atlis motors have committed to bringing BEV options to market in this classification range much sooner, neither have entered production and general availability will likely remain significantly constrained if they do.[28][29] However, Ford and Ram have announced BEV offerings `in these weight classifications for vans that would generate major lifetime cost savings.[30]

Figure 9: Modeled Statewide Class 2b-3 Vehicle Turnover and BEV Share

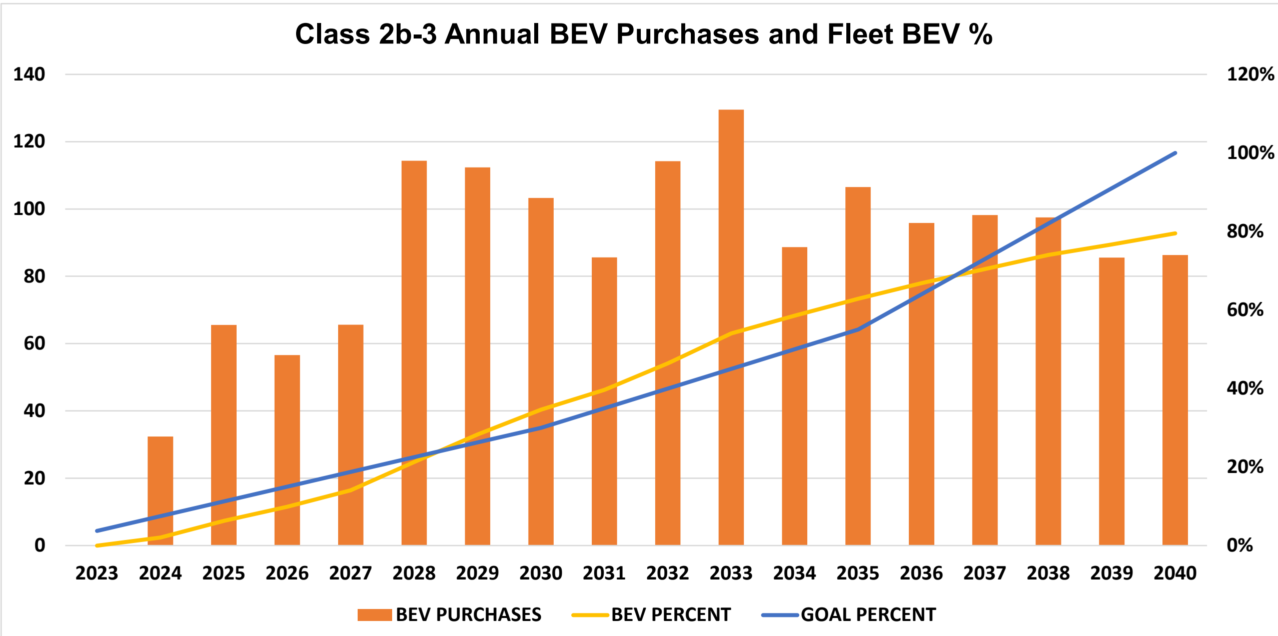


Table 20: Class 2b – 3 Average Annual Miles, Age, and Count

Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	9,557	9,824	13,846	4,882	4,532
Average Age	7.9	10.1	9.0	15.4	14.3
Count	292	68	676	299	225

[27] Car and Driver: https://www.caranddriver.com/news/a38696855/general-motors-electric-heavy-duty-trucks/
[28] Atlis Motors: https://www.atlismotorvehicles.com/
[29] Bollinger Motors: https://bollingermotors.com/b1-b2/
[30] Environmental Defense Fund: https://blogs.edf.org/climate411/files/2022/04/electric_vehicle_market_report_v6_april2022.pdf

The lack of availability in the near term is a major impediment to electrification for class 2b-3 vehicles. Even with scaled major availability constraints, electrification of this fleet would result in savings of $56.5 Million over the lifetime of the vehicles procured during the forecast period. The scaling employed is 75% scaling to 100% by 2028 **(Table 21)**. These savings do not include the corresponding charging costs needed to support their operation.

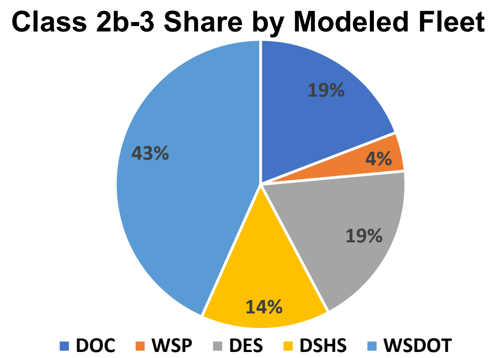


Figure 10: Class 2b-3 Share by Fleet

Table 21: Modeled Class 2b-3 Purchase Counts and Cost Forecasts – Class 3 Cost Parity Year Highlighted

	Vehicles Purchased			BEV Eligible Purchase Cost Difference	Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
Year	Total Vehicles	ICE	BEV Eligible		ICE Fleet	BEV Fleet	
2023	151	151	0	$0	$0	$0	$0
2024	98	66	32	$498,862	$2,532,109	$1,876,517	$655,592
2025	125	60	66	$779,408	$4,275,731	$3,310,608	$965,123
2026	114	58	57	$508,280	$3,957,389	$2,845,040	$1,112,348
2027	119	54	66	$404,569	$4,411,079	$3,090,270	$1,320,809
2028	114	0	114	$366,806	$9,973,529	$6,075,558	$3,897,971
2029	112	0	112	$63,916	$9,841,620	$5,747,667	$4,093,953
2030	103	0	103	-$83,519	$9,550,384	$5,384,245	$4,166,139
2031	86	0	86	-$123,202	$8,435,027	$4,643,043	$3,791,984
2032	114	0	114	-$210,809	$10,212,816	$5,840,402	$4,372,414
2033	130	0	130	-$297,368	$10,972,736	$6,329,925	$4,642,811
2034	89	0	89	-$243,846	$8,592,615	$4,741,201	$3,851,414
2035	107	0	107	-$340,667	$9,572,028	$5,404,925	$4,167,103
2036	96	0	96	-$352,451	$8,915,521	$4,968,511	$3,947,010
2037	98	0	98	-$408,527	$9,010,741	$5,040,347	$3,970,394
2038	98	0	98	-$453,714	$9,319,002	$5,143,928	$4,175,074
2039	86	0	86	-$442,662	$8,119,194	$4,470,362	$3,648,832
2040	86	0	86	-$492,468	$8,323,718	$4,565,268	$3,758,450
TOTAL	**1,926**	**388**	**1,538**	**-$827,392**	**$136,015,239**	**$79,477,818**	**$56,537,421**

2.1.4 Classes 4-8

Class 4-8 vehicles face the most difficult route to achieving electrification objectives due to availability, high purchase costs, and low utilization levels observed in the fleets analyzed **(Table 22)**. They are expected to reach 28% electrification, predominately due to class 4 ICE to BEV conversions, by 2040 **(Figure 11)** Limited average mileages particularly for class 7-8 vehicles, is a major factor behind lagging electrification rates. Low mileage results in vehicles not traveling sufficient miles to recover the significantly higher upfront costs via lower operational costs.

Figure 11: Modeled Statewide Class 4-8 Vehicle Turnover and BEV Share

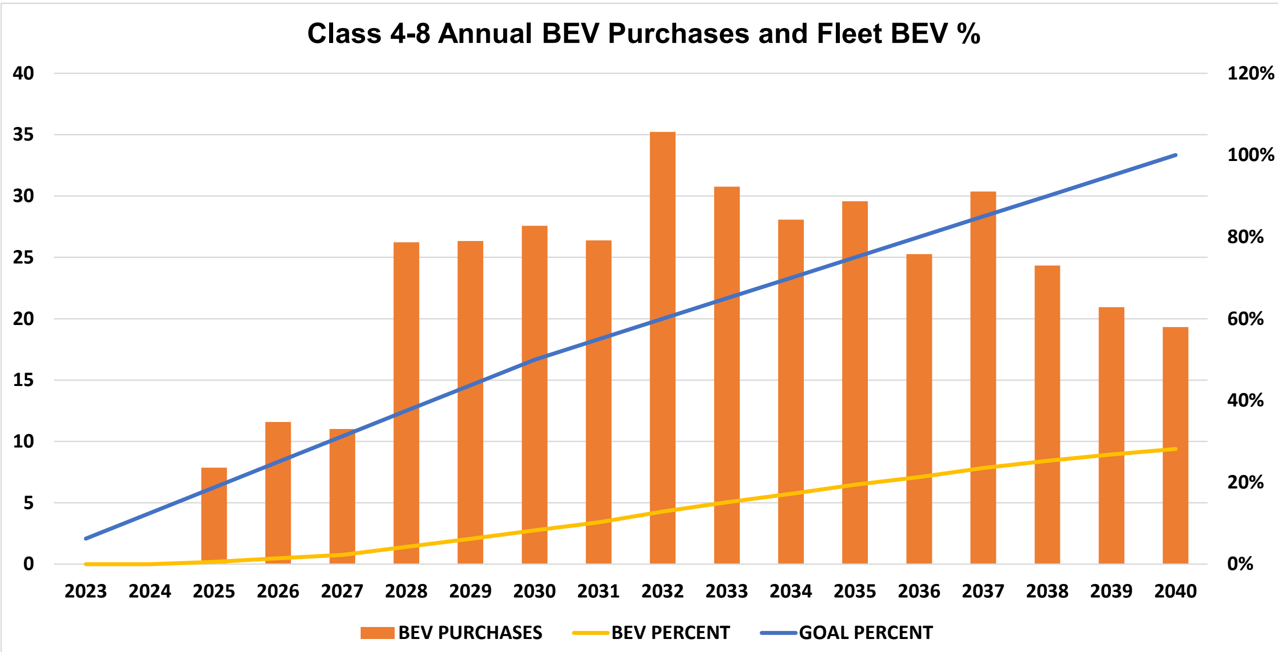


Table 22: Class 4-8 Average Annual Miles, Age, and Count

Fleet	DES	WSP	WSDOT	DOC*	DSHS*
Average Annual Mileage	7,621	5,630	3,561	5,278	5,254
Average Age	8.6	18.7	9.8	20.8	15.6
Count	33	16	1,116	109	64

The major per-mile operational cost differences paired with very long expected operational lifetimes delivers major cost savings among eligible vehicles. However, cost eligibility constraints due to low usage paired with BEVs forecasted price premium results in continued forecasted ICE procurements. Overall, BEV to ICE conversions among eligible vehicles are expected to generate $50.4 Million in vehicle costs saving over the lifetime of the vehicles purchased during the forecast period **(Table 23).** These savings do not include the corresponding charging costs needed to support their operation.

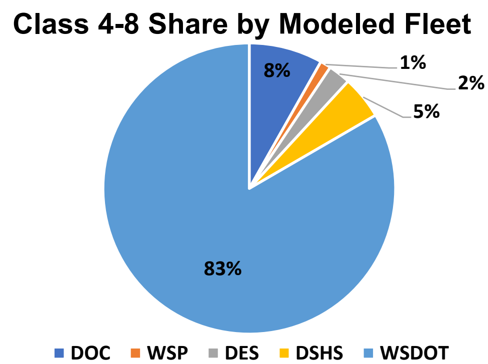


Figure 12: Class 4-8 Share by Fleet

Table 23: Modeled Class 4-8 Purchase Counts and Cost Forecasts

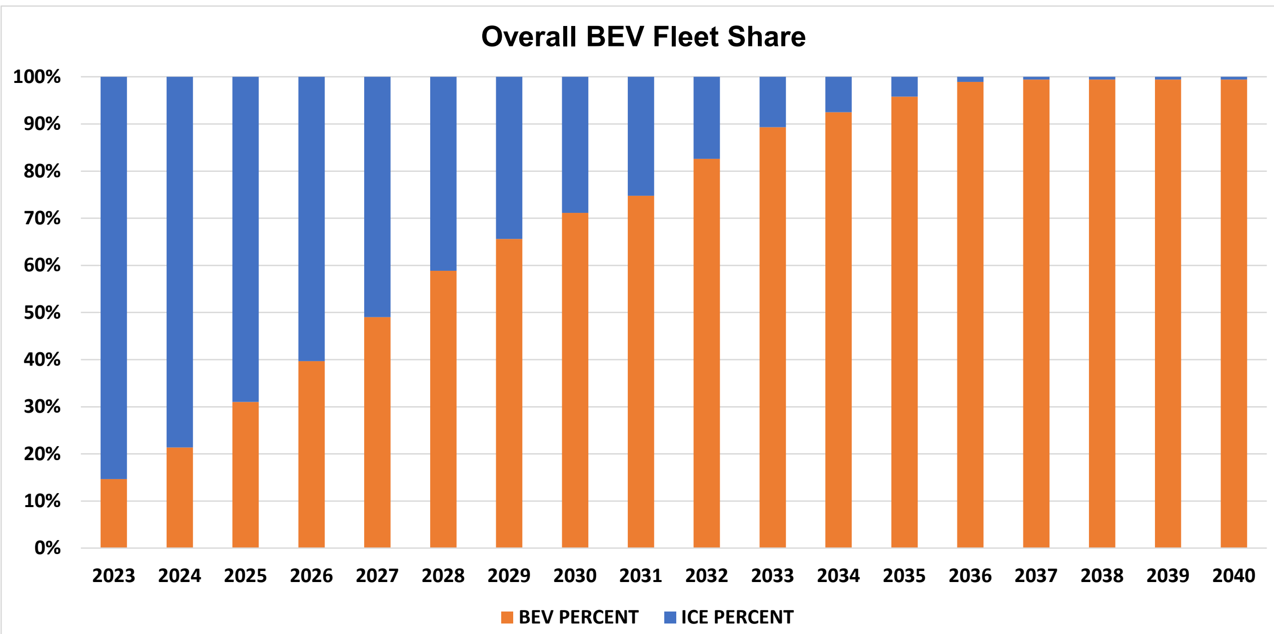
Year	Vehicles Purchased			BEV Eligible Cost Difference	Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	Total Vehicles	ICE	BEV Eligible		ICE Fleet	BEV Fleet	
2023	62	62	0	$0	$0	$0	$0
2024	54	54	0	$0	$0	$0	$0
2025	58	51	8	$263,635	$3,065,526	$2,208,372	$857,154
2026	66	54	12	$536,895	$5,482,946	$4,105,245	$1,377,701
2027	68	57	11	$324,790	$4,174,410	$3,063,688	$1,110,721
2028	72	46	26	$338,571	$7,303,120	$4,161,603	$3,141,517
2029	72	46	26	$514,454	$8,534,189	$5,156,387	$3,377,801
2030	74	47	28	$412,222	$8,453,022	$5,032,540	$3,420,482
2031	74	47	26	$387,349	$8,017,292	$4,606,830	$3,410,462
2032	82	47	35	$687,732	$13,427,281	$8,249,279	$5,178,002
2033	77	47	31	$477,578	$9,760,029	$6,089,740	$3,670,290
2034	74	46	28	$572,648	$9,555,349	$5,693,488	$3,861,861
2035	75	46	30	$514,072	$10,636,767	$6,464,010	$4,172,758
2036	70	44	25	$479,740	$8,840,710	$5,238,018	$3,602,693
2037	73	43	30	$756,472	$12,003,670	$7,804,382	$4,199,288
2038	66	41	24	$469,760	$8,727,094	$5,198,975	$3,528,119
2039	61	40	21	$374,435	$7,102,524	$4,266,984	$2,835,540
2040	58	39	19	$323,393	$6,779,729	$4,155,653	$2,624,077
TOTAL	1,237	856	381	$7,433,748	$131,863,659	$81,495,194	$50,368,466

2.2 Department of Enterprise Services (DES)

2.2.1 Fleet Overview

The Washington State Department of Enterprise Services (DES) is one of the top four professionally managed fleets for Washington State alongside the Department of Natural Resources (DNR), Washington State Patrol (WSP), and Department of Transportation (DOT). DES' Fleet Operations program provides professional fleet management services to 84 cabinet agencies, boards, commissions, and institutes of higher education in the State of Washington. DES manages a fleet size of 4,040 vehicles permanently assigned/leased to cabinet agencies at the time of data collection (December 31, 2022), and that are subject to the Executive Order. Of this modeled fleet, 158 vehicles are already BEVs, or approximately 4%. DES manages predominately light-duty vehicles, of these 4,040 vehicles only 82 are class 4 and higher. The modeled criterion for retirement is 10-years or 100,000 miles for classes 1-2 and 20-years or 200,000 miles for classes 4-8. DES is expected to achieve 99.8% electrification across all vehicles by 2040 **(Figure 13).**

Figure 13: Modeled DES Combined BEV Fleet Share



DES comes close to realizing BEV fleet share goals established in the Executive Order, achieving 96% BEV share in classes 1 and 2a by 2035, 100% by 2040 in classes 2b and 3, and 86% by 2040 for classes 4-8. Overall, 99.8% of the fleet can be BEV by 2040 under the modeled conditions **(Table 24)**. DES's high BEV rate is attributable to retiring vehicles younger than other fleets and managing very few SEEP cost exempt class 7 and 8 vehicles.

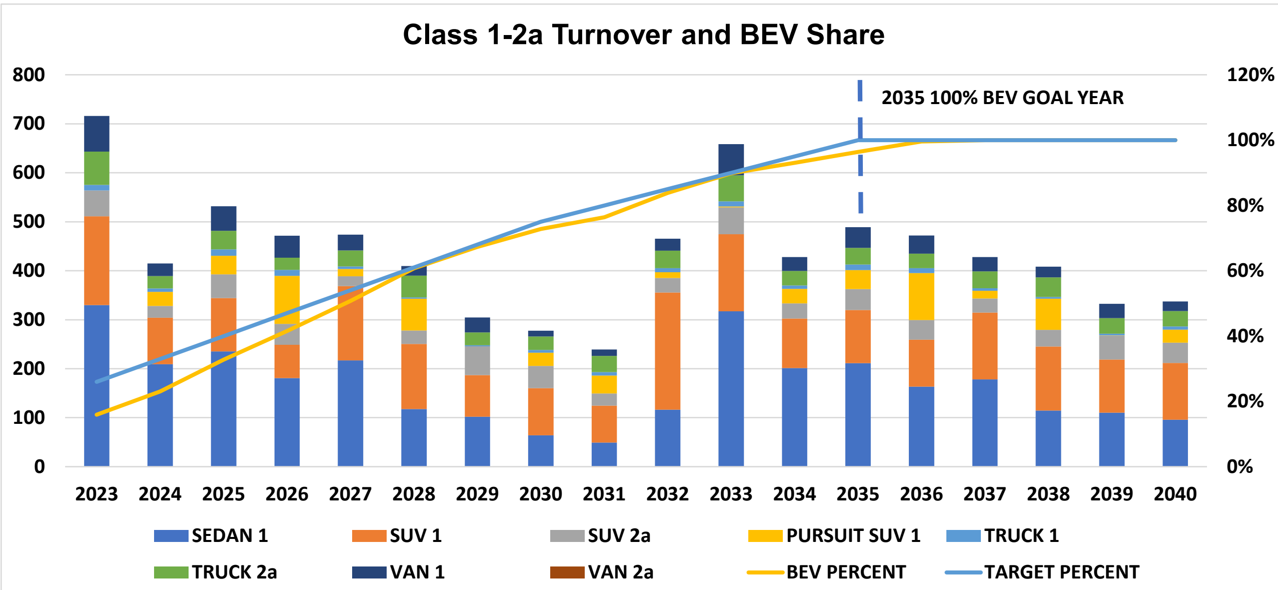
Table 24: Modeled DES Cabinet Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

Year	Classes 1-2a			Classes 2b-3			Classes 4-8			All Classes		
	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %
2023	592	3,123	16%	0	292	0%	0	33	0%	592	3,448	15%
2024	855	2,860	23%	7	285	2%	0	33	0%	863	3,177	21%
2025	1,217	2,498	33%	37	255	13%	0	33	0%	1,254	2,786	31%
2026	1,543	2,172	42%	60	232	21%	1	32	3%	1,693	2,347	42%
2027	1,886	1,829	51%	93	199	32%	3	30	8%	2,070	1,970	51%
2028	2,256	1,459	61%	118	174	40%	5	28	15%	2,467	1,573	61%
2029	2,499	1,216	67%	149	143	51%	7	26	21%	2,743	1,297	68%
2030	2,703	1,012	73%	168	124	58%	8	25	24%	2,967	1,073	73%
2031	2,837	878	76%	179	113	61%	8	25	24%	3,112	928	77%
2032	3,114	601	84%	217	75	74%	13	20	39%	3,432	608	85%
2033	3,338	377	90%	263	29	90%	15	18	45%	3,704	336	92%
2034	3,456	259	93%	272	20	93%	16	17	48%	3,831	209	95%
2035	3,579	136	96%	281	11	96%	20	13	60%	3,966	74	98%
2036	3,699	16	100%	287	5	98%	23	10	69%	4,009	31	99%
2037	3,715	0	100%	292	0	100%	26	7	78%	4,031	9	99.8%
2038	3,715	0	100%	292	0	100%	27	6	82%	4,032	8	99.8%
2039	3,715	0	100%	292	0	100%	27	6	82%	4,032	8	99.8%
2040	3,715	0	100%	292	0	100%	28	5	86%	4,034	6	99.8%

2.2.2 Classes 1-2a

Class 1 and 2a vehicles are forecasted to fall 4% short of their 2035 100% BEV target. This is due to availability constraints in 2026 and 2027, resulting in achieving 100% electrification by 2037 **(Figure 14)**.

Figure 14: Modeled DES Cabinet Vehicle Class 1-2a Vehicle Turnover and BEV Share



The DES cabinet fleet is both young, predominately class 1-2a vehicles, and highly utilized resulting in a fleet capable of rapidly shifting to electrification **(Table 25).** Under the modeled scenario, replacing ICE vehicles with BEV alternatives in 2023 would cost an estimated $4.3 Million more in purchasing costs **(Table 26)**, but would net an estimated savings of $2.6 Million over the vehicles lifetimes **(Table 27).**

Table 25: DES Cabinet Class 1-2a Vehicle Fleet Summary Information

Classification	Sedan 1	SUV 1	SUV 2a	Pursuit SUV 1	Truck 1	Truck 2a	Van 1
Annual Average Miles Forecast	9,736	10,969	10,665	6,377	7,763	12,200	9,727
Average Age	7.5	6.0	5.7	5.7	8.9	6.4	8
Count	1,420	1,033	320	319	66	280	277

Due to class 1 and 2a vehicles forecasted to achieve purchase price parity in 2028 and 2029 respectively, BEV appear to be cheaper at the point of purchase from 2029 on. Overall, BEVs are forecasted to cost roughly $4 Million less to procure than ICE alternatives through 2040 **(Table 26)**.

Table 26: Modeled DES Cabinet Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	716	282	434	$27,799	$37,795	$12,071,532	$16,412,365	$4,340,833
2024	415	152	263	$27,911	$35,682	$7,346,086	$9,391,624	$2,045,537
2025	531	166	366	$29,689	$35,576	$10,862,482	$13,016,445	$2,153,963
2026	472	135	336	$31,467	$35,112	$10,578,189	$11,803,638	$1,225,449
2027	474	24	450	$30,997	$33,293	$13,953,566	$14,986,988	$1,033,422
2028	410	0	410	$33,351	$33,580	$13,658,863	$13,752,903	$94,039
2029	305	0	305	$34,145	$33,478	$10,405,407	$10,202,265	-$203,142
2030	278	0	278	$34,797	$33,542	$9,657,532	$9,309,284	-$348,248
2031	239	0	239	$36,141	$34,480	$8,645,278	$8,248,019	-$397,258
2032	465	0	465	$33,974	$32,053	$15,811,034	$14,917,152	-$893,882
2033	658	0	658	$35,695	$33,348	$23,503,649	$21,958,494	-$1,545,155
2034	428	0	428	$36,433	$33,687	$15,588,084	$14,413,282	-$1,174,803
2035	489	0	489	$37,747	$34,560	$18,452,732	$16,894,531	-$1,558,201
2036	472	0	472	$39,719	$35,995	$18,750,978	$16,992,833	-$1,758,145
2037	428	0	428	$38,309	$34,374	$16,389,298	$14,705,773	-$1,683,525
2038	408	0	408	$40,747	$36,208	$16,629,970	$14,777,364	-$1,852,606
2039	332	0	332	$40,930	$36,033	$13,602,803	$11,975,582	-$1,627,221
2040	337	0	337	$41,854	$36,468	$14,116,880	$12,300,115	-$1,816,765
TOTAL	7,857	758	7,099			$250,024,361	$246,058,656	-$3,965,706

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

While BEVs have higher upfront acquisition costs, even in the least favorable year, 2023, they are still estimated to provide major cost savings over the course of the vehicles service life. It is estimated on a per vehicle basis, BEVs in the DES cabinet vehicle fleet purchased in 2023 will cost an average $6,000 less per vehicle over their operational lifespan than ICE vehicles with savings growing to over $23,000 per vehicle in 2040. Total savings through the forecast period are approximately $122.5 Million **(Table 27)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 27: Modeled DES Cabinet Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles

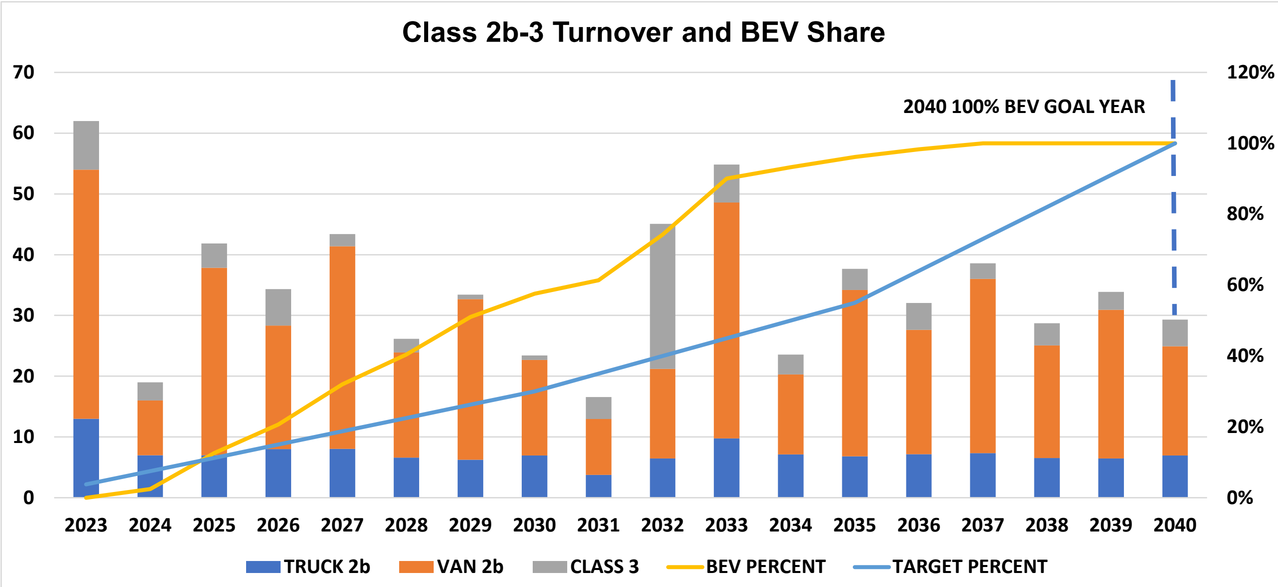
Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.27	$0.11	$44,399	$38,320	$19,280,476	$16,640,322	$2,640,154
2024	$0.27	$0.11	$46,416	$38,263	$12,216,724	$10,070,829	$2,145,895
2025	$0.28	$0.11	$47,868	$37,863	$17,513,870	$13,853,124	$3,660,746
2026	$0.28	$0.11	$49,563	$38,690	$16,661,473	$13,006,492	$3,654,981
2027	$0.28	$0.11	$48,442	$34,798	$21,806,465	$15,664,700	$6,141,764
2028	$0.29	$0.11	$50,984	$35,431	$20,880,846	$14,510,707	$6,370,139
2029	$0.29	$0.11	$52,117	$35,103	$15,882,195	$10,697,171	$5,185,024
2030	$0.29	$0.11	$53,095	$35,433	$14,735,837	$9,833,899	$4,901,937
2031	$0.29	$0.11	$54,191	$36,219	$12,963,015	$8,663,908	$4,299,107
2032	$0.30	$0.11	$52,777	$34,097	$24,561,746	$15,867,972	$8,693,773
2033	$0.30	$0.11	$53,901	$35,001	$35,491,463	$23,046,621	$12,444,842
2034	$0.31	$0.11	$54,861	$35,476	$23,472,893	$15,178,640	$8,294,253
2035	$0.31	$0.11	$56,275	$36,215	$27,510,333	$17,703,934	$9,806,400
2036	$0.31	$0.11	$58,288	$37,685	$27,517,048	$17,790,550	$9,726,498
2037	$0.32	$0.11	$57,711	$36,084	$24,689,600	$15,437,213	$9,252,387
2038	$0.33	$0.11	$60,408	$37,906	$24,654,121	$15,470,338	$9,183,783
2039	$0.33	$0.11	$61,234	$37,520	$20,350,845	$12,469,545	$7,881,300
2040	$0.34	$0.11	$62,509	$38,103	$21,083,569	$12,851,541	$8,232,028
TOTAL					$381,272,519	$258,757,506	$122,515,013

**Includes vehicle recovery value at time of surplus*

2.2.3 Classes 2b-3

Class 2b and 3 vehicles are forecasted to meet their 100% BEV share by 2040 goal **(Figure 15)**. This is based on the major assumption of truck 2b and 3 availability occurring by 2028. Even with a delay to 2030, the 10-year retirement criteria would still enable achieving 100% BEV by 2040 for the DES cabinet vehicle fleet.

Figure 15: Modeled DES Cabinet Class 2b-3 Vehicle Turnover and BEV Share



BEV alternatives are presently more expensive at the time of vehicle purchase compared to the ICE vehicles they replace, averaging over $15,000 in 2024 **(Table 29)**. However, even at this much higher price point, a BEV is estimated to cost marginally less than an ICE vehicle over its service lifespan due to their high usage profiles **(Table 28 and 30).** The BEV cost advantage only continues to grow as they achieve forecasted cost parity in 2029 and 2030 then become cheaper at the point of purchase thereafter.

Table 28: DES Cabinet Class 2b-3 Vehicle Fleet Summary Information

Classification	TRUCK 2b	VAN 2b	CLASS 3
Annual Miles Forecast (2024)	11,123	9,100	9,470
Average Age	7.5	7.5	9.8
Count	57	186	49

Over the forecast period, replacing ICE vehicles with BEVs will result in greater costs of roughly $220,000 through 2040. Although price parity occurs in 2030, the savings experienced after are not sufficient to make up for the substantially higher acquisition purchase prices early in the forecast period.

Table 29: Modeled DES Cabinet Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	62	62	0	$0	$0	$0	$0	$0
2024	19	12	7	$32,553	$47,946	$234,382	$345,212	$110,830
2025	42	12	30	$33,747	$45,815	$999,047	$1,356,306	$357,259
2026	34	11	24	$34,967	$43,952	$828,711	$1,041,669	$212,958
2027	43	10	34	$34,828	$41,015	$1,168,986	$1,376,685	$207,699
2028	26	0	26	$36,576	$39,548	$956,765	$1,034,503	$77,739
2029	33	0	33	$36,743	$36,788	$1,227,732	$1,229,225	$1,493
2030	23	0	23	$37,938	$36,859	$888,632	$863,370	-$25,262
2031	17	0	17	$39,420	$37,967	$653,225	$629,146	-$24,079
2032	45	0	45	$41,580	$39,775	$1,874,797	$1,793,378	-$81,420
2033	55	0	55	$40,252	$37,955	$2,207,645	$2,081,636	-$126,010
2034	24	0	24	$41,701	$38,937	$982,797	$917,664	-$65,133
2035	38	0	38	$41,774	$38,596	$1,574,071	$1,454,350	-$119,721
2036	32	0	32	$43,052	$39,399	$1,379,354	$1,262,311	-$117,043
2037	39	0	39	$43,345	$39,239	$1,672,186	$1,513,814	-$158,372
2038	29	0	29	$44,745	$40,128	$1,285,210	$1,152,618	-$132,591
2039	34	0	34	$45,232	$40,143	$1,533,030	$1,360,530	-$172,500
2040	29	0	29	$46,746	$41,099	$1,371,001	$1,205,386	-$165,615
TOTAL	624	106	517			$20,837,571	$20,617,803	-$219,768

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

BEV replacement vehicles will result in major lifetime savings for classes 2b and 3 due to their per mile operational costs being less than half those of an ICE in 2023, rising to nearly one third by 2040. Class 2b and 3 BEV replacement vehicles will result in lifetime operational savings of approximately $8.5 Million for vehicles purchased between 2023 through 2040. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 30: Modeled DES Cabinet Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles

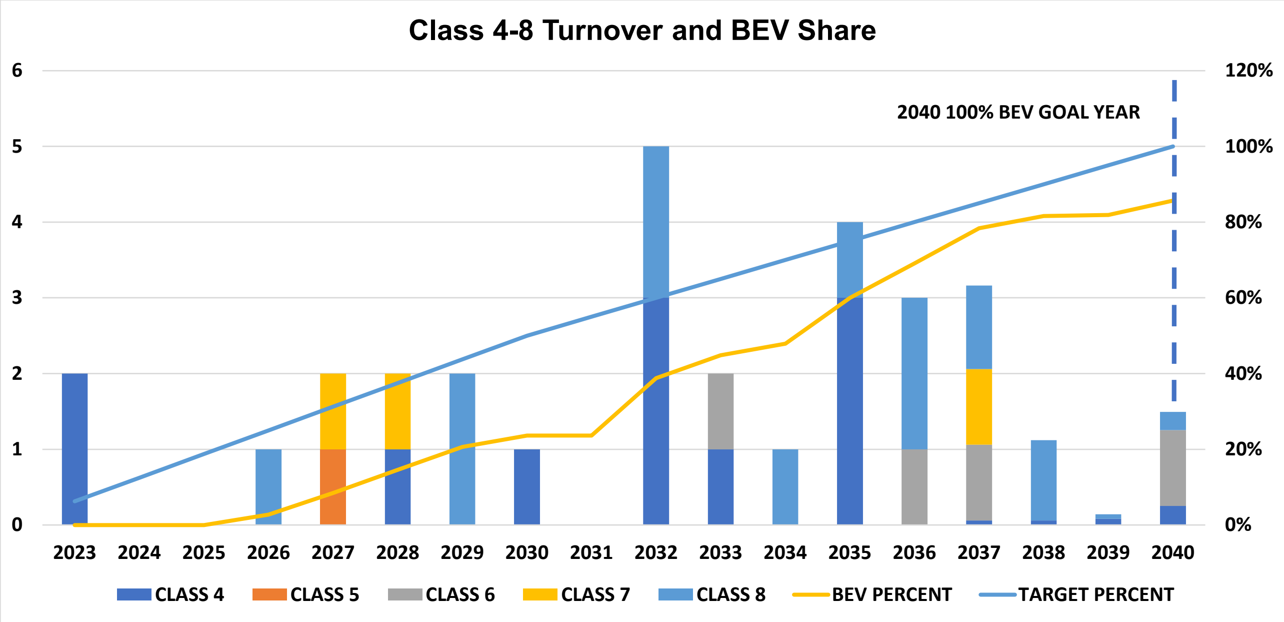
Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.29	$0.12	$45,867	$45,737	$0	$0	$0
2024	$0.30	$0.12	$49,203	$45,001	$354,260	$324,010	$30,250
2025	$0.30	$0.12	$47,809	$42,932	$1,415,326	$1,270,972	$144,354
2026	$0.31	$0.12	$50,284	$42,042	$1,191,726	$996,385	$195,341
2027	$0.31	$0.12	$49,173	$39,532	$1,650,482	$1,326,883	$323,600
2028	$0.32	$0.12	$50,990	$38,553	$1,333,794	$1,008,463	$325,331
2029	$0.32	$0.12	$50,462	$36,194	$1,686,119	$1,209,400	$476,720
2030	$0.32	$0.12	$52,368	$36,546	$1,226,639	$856,040	$370,599
2031	$0.33	$0.12	$54,960	$37,995	$910,725	$629,609	$281,116
2032	$0.33	$0.12	$59,140	$40,419	$2,666,520	$1,822,439	$844,081
2033	$0.34	$0.12	$55,056	$37,653	$3,019,579	$2,065,083	$954,496
2034	$0.34	$0.12	$57,509	$38,793	$1,355,357	$914,267	$441,090
2035	$0.35	$0.12	$56,764	$38,215	$2,138,908	$1,439,999	$698,909
2036	$0.35	$0.13	$58,806	$39,154	$1,884,089	$1,254,456	$629,633
2037	$0.36	$0.13	$58,577	$38,786	$2,259,836	$1,496,342	$763,495
2038	$0.36	$0.13	$60,938	$39,852	$1,750,325	$1,144,673	$605,652
2039	$0.37	$0.13	$61,179	$39,732	$2,073,491	$1,346,632	$726,859
2040	$0.38	$0.13	$63,799	$40,890	$1,871,145	$1,199,242	$671,904
TOTAL					$28,788,323	$20,304,893	$8,483,430

**Includes vehicle recovery value at time of surplus*

2.2.4 Classes 4-8

Class 4-8 vehicles are not expected to reach their BEV goal, forecasted to reach 86% of the 100% goal by 2040 **(Figure 16)**. This is due to the long service lives of these vehicles, resulting in ICE vehicles purchased in the first 3-years of the forecast lingering into the 2040s when applying a 20-year or 200,000-mile retirement criteria. Additionally, class 5 and 7 are exempt based on cost.

Figure 16: Modeled DES Cabinet Class 4-8 Vehicle Turnover and BEV Share



Class 4, 6, and 8 vehicles are eligible for BEV replacement under SEEP cost criteria over the forecast period. Their moderately high usage levels, 20-years or 200,000-mile retirement threshold and lower purchase costs makes them eligible for replacement **(Table 31)**.

Table 31: Modeled DES Cabinet Classes 4-8 Vehicle Fleet Summary Information

Classification	Class 4	Class 5	Class 6	Class 7	Class 8
Annual Miles Forecast	7,005	745	9,353	3,695	9,735
Average Age	11.7	16	4.5	12.3	5.9
Count	11	1	4	3	14

BEVs are expected to cost approximately $867,000 more at the point of acquisition purchase overall over the forecast period for vehicles in class 4 compared to ICE options **(Table 32)**. Overall, 29 of the 31 vehicles forecasted for procurement will be BEV purchase eligible after the application of SEEP guidance.

Table 32: Modeled DES Cabinet Class 4-8 Vehicle Purchase Cost Forecast

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Costs Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	2	2	0	$0	$0	$0	$0	$0
2024	0	0	0	$0	$0	$0	$0	$0
2025	0	0	0	$0	$0	$0	$0	$0
2026	1	0	1	$189,388	$258,198	$170,449	$232,378	$61,928
2027	2	0	2	$45,558	$54,893	$86,561	$104,297	$17,736
2028	2	0	2	$28,888	$30,189	$57,775	$60,378	$2,603
2029	2	0	2	$195,686	$261,150	$391,373	$522,299	$130,927
2030	1	0	1	$58,005	$61,160	$58,005	$61,160	$3,155
2031	0	0	0	$0	$0	$0	$0	$0
2032	5	0	5	$115,735	$142,805	$578,675	$714,027	$135,353
2033	2	0	2	$94,784	$113,021	$189,568	$226,041	$36,474
2034	1	0	1	$206,183	$266,069	$206,183	$266,069	$59,886
2035	4	0	4	$96,006	$114,099	$384,024	$456,395	$72,371
2036	3	0	3	$185,100	$233,948	$555,301	$701,845	$146,544
2037	3	0	3	$118,026	$147,559	$373,154	$466,526	$93,372
2038	1	0	1	$206,166	$258,885	$231,156	$290,265	$59,109
2039	0	0	0	$126,600	$153,096	$17,903	$21,650	$3,747
2040	1	0	1	$138,428	$167,821	$206,943	$250,884	$43,941
TOTAL	31	2	29			$3,507,070	$4,374,216	$867,146

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Replacing ICE vehicles with BEV alternatives is forecasted to generate savings totaling nearly $4.5 Million over the forecast period **(Table 33)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 33: Modeled DES Cabinet Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.70	$0.22	$0	$0	$0	$0	$0
2024	$0.70	$0.22	$0	$0	$0	$0	$0
2025	$0.70	$0.22	$0	$0	$0	$0	$0
2026	$0.71	$0.22	$354,500	$278,409	$319,050	$250,568	$68,482
2027	$0.72	$0.22	$186,214	$126,359	$353,807	$240,082	$113,725
2028	$0.74	$0.22	$232,987	$100,195	$465,975	$200,390	$265,585
2029	$0.75	$0.22	$371,411	$281,697	$742,823	$563,395	$179,428
2030	$0.77	$0.22	$142,689	$76,642	$142,689	$76,642	$66,047
2031	$0.78	$0.22	$0	$0	$0	$0	$0
2032	$0.80	$0.22	$536,283	$362,675	$2,681,414	$1,813,374	$868,040
2033	$0.82	$0.22	$202,088	$127,860	$404,176	$255,719	$148,457
2034	$0.83	$0.22	$401,151	$287,338	$401,151	$287,338	$113,812
2035	$0.85	$0.23	$560,674	$367,591	$2,242,695	$1,470,363	$772,332
2036	$0.87	$0.23	$679,421	$469,708	$2,038,262	$1,409,124	$629,138
2037	$0.89	$0.23	$535,994	$339,785	$1,694,608	$1,074,270	$620,338
2038	$0.91	$0.23	$584,185	$372,605	$654,995	$417,769	$237,226
2039	$0.93	$0.23	$591,662	$374,298	$83,669	$52,931	$30,738
2040	$0.95	$0.23	$692,385	$457,233	$1,035,081	$683,541	$351,540
TOTAL					$13,260,394	$8,795,506	$4,464,888

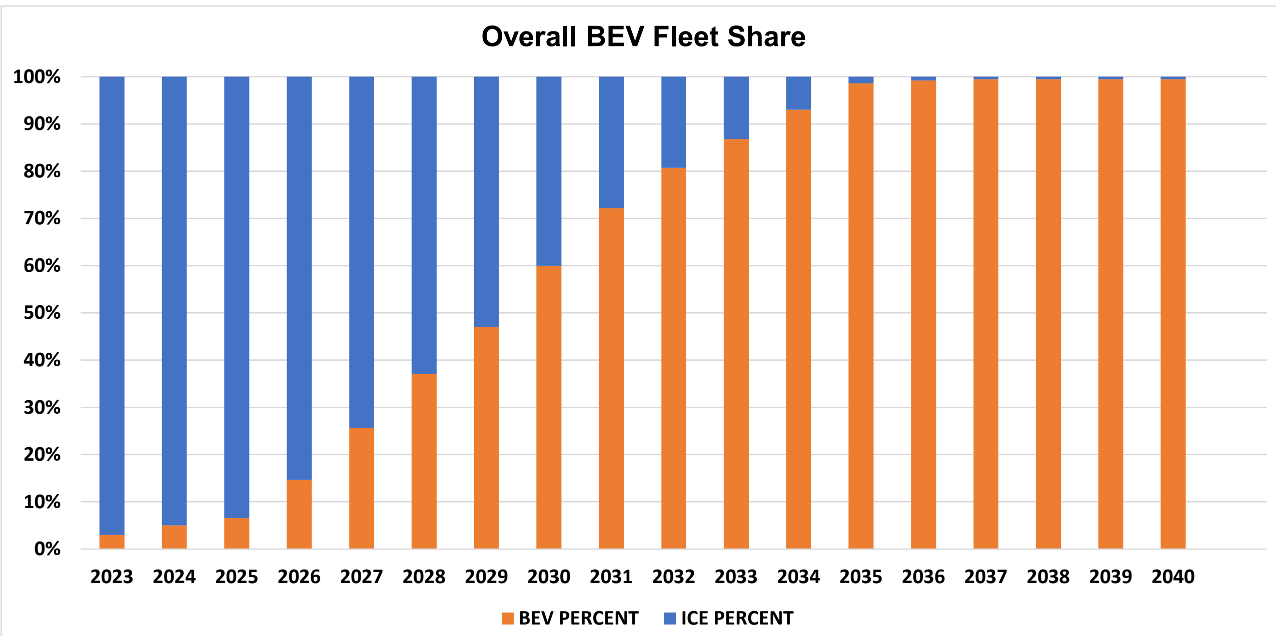
**Includes vehicle recovery value at time of surplus*

2.3 Washington State Patrol (WSP)

2.3.1 Fleet Overview

Washington State Patrol (WSP) presently manages a fleet of 1,614 vehicles subject to the Executive Order. Of the existing fleet, only 1 is presently a BEV. The WSP fleet is anomalous from other fleets since it is comprised primarily of vehicles serving in pursuits roles and 90-95% of vehicles return overnight to officers' homes. The modeled criterion for retirement specified by fleet managers is 10-years or 140,000 miles for light-duty vehicles, classes 1-3, and 20-years or 200,000 miles for classes 4-8. Pursuit classified vehicles are exempt from BEV replacement for the first three years of the forecast due to the lack of present availability and the absence of explicit timelines of availability. Sedans presently serving in pursuit roles are replaced by class 1 pursuit SUVs based on current department replacement guidance. A pursuit SUV 1 is equivalent to a Ford Explorer, while a pursuit SUV 2a is equivalent to a Chevrolet Tahoe. Overall, the fleet is set to achieve 99.5% electrification by 2040 **(Figure 17).**

Figure 17: Modeled WSP Combined BEV Fleet Share



Under the modeled conditions, WSP comes very close to realizing BEV fleet share goals, forecasted to reach 99% by 2035 for classes 1 and 2a while achieving it for classes 2b-3 by 2040. However, WSP is unlikely to meet electrification goals for class 4-8 vehicles **(Table 34)**. WSP's very high utilization rates results in high vehicle turnover, creating recurrent opportunities for vehicle classes 1-3 to electrify.

Several factors may result in slower electrification rates in the near term than modeled in. First, the bulk of 2023 orders have already been placed. Due to constrained BEV availability, they are ICE models, preempting most of the modeled BEV conversion opportunities for 2023. Second, while pursuit models are modeled as available beginning in 2026, WSP's pursuit vehicles have greater range needs than police vehicles. WSP vehicles must have a range capable of responding to a statewide emergency in a reasonable time factor, under full vehicle load, at high-speed, in all weather conditions, along with other agency approved capabilities. While major manufacturer's have announced pursuit rated BEVs entering service, there is uncertainty as to whether these will meet WSP's range needs.

Table 34: Modeled WSP Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

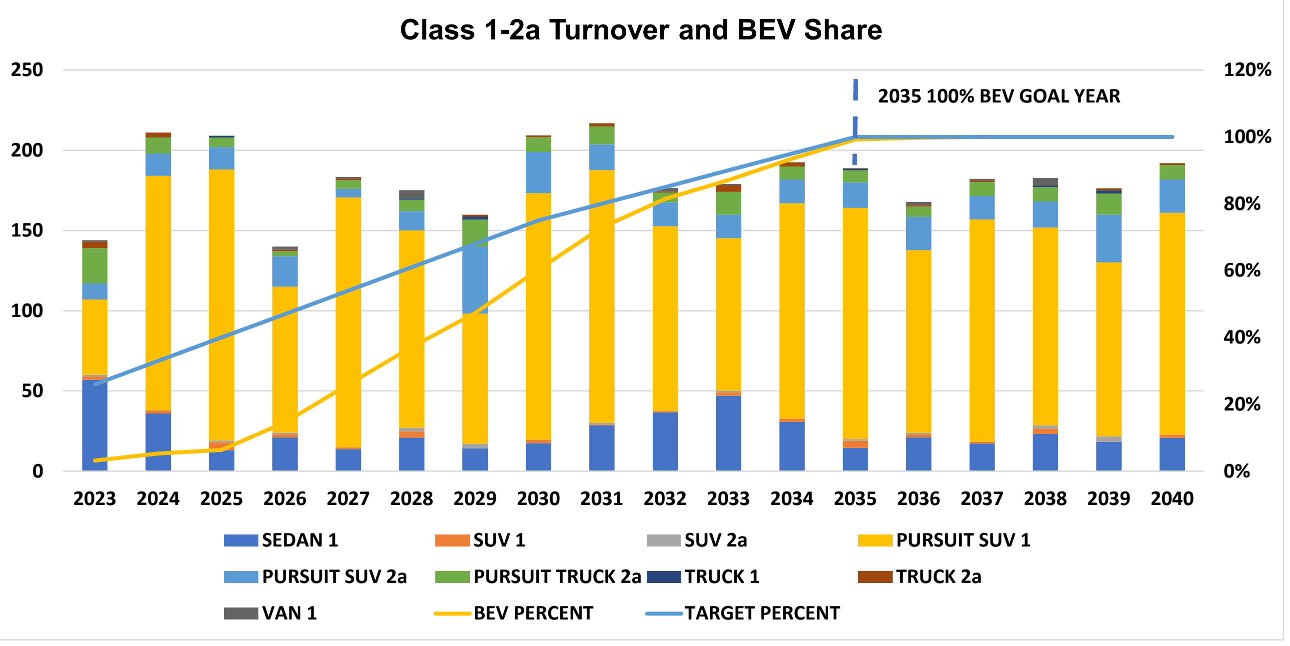
Year	Class 1-2a			Class 2b-3			Class 4-8			ALL CLASSES		
	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV COUNT	ICE COUNT	BEV %
2023	48	1,482	3%	0	68	0%	0	16	0%	48	1566	3%
2024	81	1,449	5%	0	68	0%	0	16	0%	81	1533	5%
2025	97	1,433	6%	8	60	11%	1	15	5%	106	1508	7%
2026	223	1,307	15%	12	56	18%	1	15	5%	236	1378	15%
2027	396	1,134	26%	17	51	25%	1	15	5%	414	1200	26%
2028	568	962	37%	27	41	40%	3	13	18%	598	1016	37%
2029	724	806	47%	33	35	48%	3	13	18%	760	854	47%
2030	923	607	60%	41	27	61%	4	12	24%	968	646	60%
2031	1,115	415	73%	45	23	66%	5	11	30%	1,165	449	72%
2032	1,246	284	81%	52	16	76%	5	11	31%	1,303	311	81%
2033	1,333	197	87%	61	7	90%	8	8	51%	1,402	212	87%
2034	1,430	100	93%	64	4	94%	8	8	51%	1,502	112	93%
2035	1,518	12	99%	66	2	97%	8	8	52%	1,592	22	99%
2036	1,526	4	100%	68	0	100%	8	8	52%	1,602	12	99%
2037	1,530	0	100%	68	0	100%	8	8	53%	1,606	8	99.5%
2038	1,530	0	100%	68	0	100%	9	7	53%	1,607	7	99.5%
2039	1,530	0	100%	68	0	100%	9	7	54%	1,607	7	99.5%
2040	1,530	0	100%	68	0	100%	9	7	55%	1,607	7	99.5%

WSP's BEV adoption will likely follow a less gradual trajectory than modeled due to vehicle training needs. Since WSP trains officers using the vehicle models they will serve in, BEV adoption will necessitate a minimum purchase of 12 additional vehicles to begin training for a vehicle platform transition. Additionally, the adoption of these training vehicles will precede broader adoption in the pursuit fleet. Like the greater range requirements necessary for WSP vehicles to respond to statewide emergences, training vehicles must be able to support pursuit needs for 2-hours without needing recharging. Finally, pool vehicle assignments are often supported by retired pursuit vehicles, which may elongate the service life of some ICE vehicles.

2.3.2 Classes 1-2a

Class 1-2a vehicles are only forecasted to fall 1% below their BEV target and reach 100% by 2036 **(Figure 18)**. The very high annual miles traveled by these vehicles results in few vehicles reaching the 10-year retirement criteria, resulting in ICE replacement opportunities occurring at a much faster rate than any of the other fleets surveyed. However, the high turnover in pursuit vehicles masks longer duty cycles among vehicles in non-pursuit roles **(Table 35)**. To achieve electrification goals, these vehicles will likely need to be retired earlier than is the current practice.

Figure 18: Modeled WSP Class 1-2a Vehicle Turnover and BEV Share



Of the 1,614 vehicles under management, 1,013 are pursuit SUV 1 classified, which have an average age of only 5.1 years **(Table 36)**. Due to the pursuit vehicle exemption for the first three years the increased expense of BEVs is muted compared to other fleets since when pursuit options become available, they will be much closer in price to ICE alternatives compared to BEVs replacing eligible vehicles early in the forecast **(Table 37)**. Procuring BEVs in place of ICE vehicles is expected to save nearly $7.5 Million through 2040.

Table 35: WSP Class 1-2a Non-Pursuit Vehicle Fleet Summary Information

Classification	Sedan 1	SUV 1	SUV 2a	Truck 1	Truck 2a	Van 1
Annual Miles Forecast	10,928	10,703	7,881	4,385	9,679	6,952
Average Age	9.2	9.4	11	10.3	7.6	13.4
Count	228	18	9	4	13	11

Table 36: WSP Class 1-2a Pursuit Vehicle Fleet Summary Information

Classification	Pursuit SUV 1	Pursuit SUV 2a	Pursuit Truck 2a
Annual Miles Forecast	15,703	11,927	14,022
Average Age	5.1	6.5	7.8
Count	1,013	156	78

Table 37: Modeled WSP Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	144	97	47	$27,529	$33,949	$1,300,766	$1,604,092	$303,326
2024	211	178	33	$28,171	$33,524	$924,011	$1,099,580	$175,568
2025	209	193	16	$28,102	$33,836	$453,849	$546,458	$92,609
2026	140	14	126	$43,631	$49,166	$5,497,543	$6,194,878	$697,335
2027	183	9	174	$45,215	$48,184	$7,874,523	$8,391,523	$517,000
2028	175	0	175	$45,013	$45,256	$7,882,273	$7,924,882	$42,609
2029	160	0	160	$48,476	$47,664	$7,746,302	$7,616,671	-$129,631
2030	209	0	209	$48,581	$46,771	$10,162,266	$9,783,585	-$378,682
2031	217	0	217	$48,309	$46,026	$10,474,742	$9,979,681	-$495,061
2032	176	0	176	$47,871	$45,148	$8,445,629	$7,965,294	-$480,335
2033	179	0	179	$47,462	$44,347	$8,490,964	$7,933,744	-$557,220
2034	192	0	192	$50,583	$46,758	$9,734,041	$8,998,099	-$735,942
2035	189	0	189	$52,961	$48,466	$10,008,550	$9,159,017	-$849,533
2036	168	0	168	$53,711	$48,685	$9,011,155	$8,168,045	-$843,110
2037	182	0	182	$55,223	$49,531	$10,058,863	$9,022,076	-$1,036,787
2038	183	0	183	$55,092	$48,930	$10,066,497	$8,940,572	-$1,125,925
2039	176	0	176	$57,813	$50,899	$10,188,633	$8,970,032	-$1,218,601
2040	192	0	192	$58,515	$50,943	$11,236,296	$9,782,176	-$1,454,120
TOTAL	3,286	491	2,795			$139,556,904	$132,080,402	-$7,476,502

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

High vehicle usage results in massive savings for BEV ICE vehicle replacements. Following the pursuit exemptions period, per vehicle lifetime savings of BEV versus ICE jump to approximately $21,000 in 2026 increasing to $38,000 for vehicles purchased in 2040 **(Table 29)**. Over their lifetimes, vehicles purchased between 2023 and 2040 in the WSP modeled fleet are expected to save $85.2 Million over ICE alternatives. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 29: Modeled WSP Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles

	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
Year	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.27	$0.11	$55,244	$41,083	$2,610,288	$1,941,152	$669,135
2024	$0.27	$0.11	$66,808	$49,024	$2,191,301	$1,607,993	$583,307
2025	$0.28	$0.11	$70,746	$50,584	$1,142,543	$816,938	$325,604
2026	$0.28	$0.11	$69,914	$48,634	$8,809,220	$6,127,863	$2,681,357
2027	$0.28	$0.11	$72,911	$47,663	$12,698,044	$8,300,877	$4,397,167
2028	$0.29	$0.11	$71,167	$45,070	$12,462,202	$7,892,194	$4,570,008
2029	$0.29	$0.11	$72,205	$45,179	$11,538,236	$7,219,556	$4,318,680
2030	$0.29	$0.11	$75,738	$46,474	$15,842,962	$9,721,572	$6,121,390
2031	$0.29	$0.11	$75,172	$45,536	$16,299,508	$9,873,498	$6,426,010
2032	$0.30	$0.11	$74,611	$45,326	$13,163,264	$7,996,664	$5,166,600
2033	$0.30	$0.11	$72,235	$43,158	$12,922,806	$7,720,917	$5,201,889
2034	$0.31	$0.11	$78,119	$46,438	$15,033,121	$8,936,523	$6,096,598
2035	$0.31	$0.11	$81,352	$47,928	$15,373,798	$9,057,325	$6,316,472
2036	$0.31	$0.11	$81,751	$48,206	$13,715,604	$8,087,618	$5,627,987
2037	$0.32	$0.11	$83,948	$48,553	$15,291,130	$8,843,945	$6,447,185
2038	$0.33	$0.11	$83,169	$47,974	$15,196,800	$8,765,870	$6,430,931
2039	$0.33	$0.11	$85,378	$48,848	$15,046,424	$8,608,616	$6,437,808
2040	$0.34	$0.11	$88,325	$49,851	$16,960,492	$9,572,499	$7,387,993
TOTAL					$216,297,743	$131,091,620	$85,206,123

**Includes vehicle recovery value at time of surplus*

2.3.3 Classes 2b-3

WSP's class 2b and 3 vehicles are expected to reach their 100% electrification goals by 2040 due to the 10-year retirement criteria enabling full fleet turnover of ICE truck 2b vehicles purchased through 2030 **(Figure 19)**. This is likely a more aggressive turnover cycle than current practice as represented by the relatively high average ages in **(Table 38)**.

Figure 19: Modeled WSP Class 2b-3 Vehicle Turnover and BEV Share

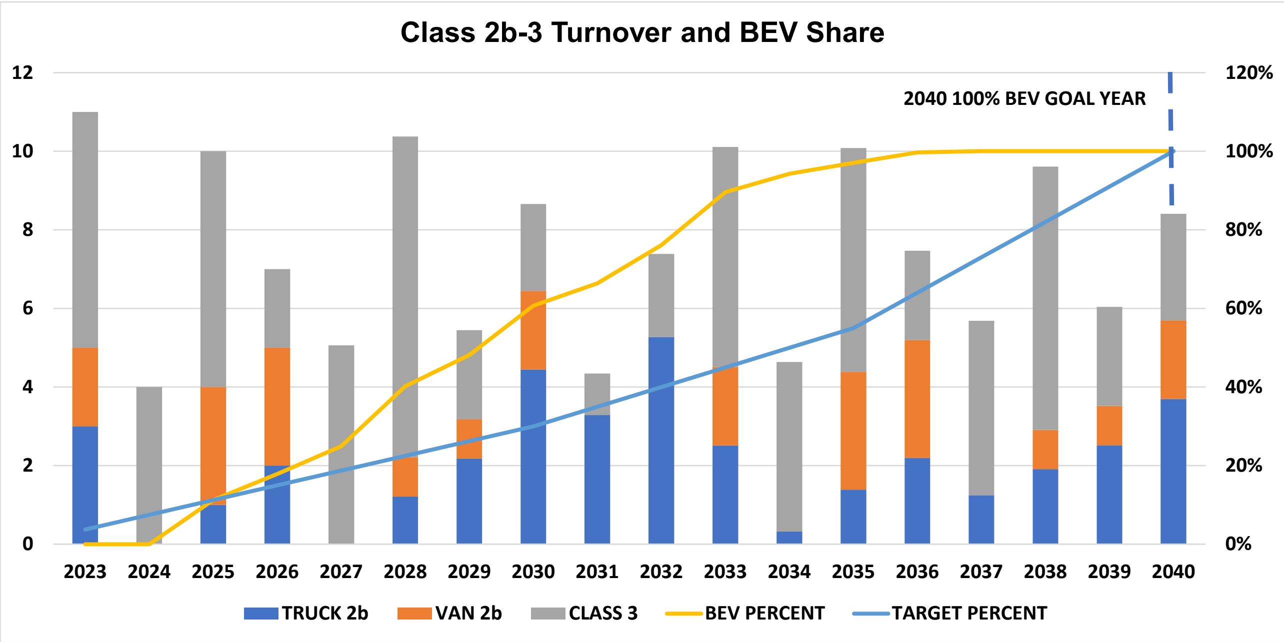


Table 38: WSP Class 2b-3 Vehicle Fleet Summary Information

Classification	Truck 2b	Van 2b	Class 3
Annual Miles Forecast	11,907	4,694	10,333
Average Age	9.0	17.5	8.2
Count	21	12	35

BEV alternatives are much more expensive on average at the point of purchase for the WSP fleet. No vehicles are eligible for BEV replacement in 2024 and 2025 after the application of SEEP total lifetime operating costs and availability exemptions **(Table 39)**.

Table 39: Modeled WSP Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		Bev Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	11	11	0	$0	$0	$0	$0	$0
2024	4	4	0	$0	$0	$0	$0	$0
2025	10	2	8	$36,348	$47,104	$278,066	$360,343	$82,278
2026	7	3	5	$35,795	$44,561	$161,076	$200,523	$39,447
2027	5	0	5	$39,455	$45,479	$189,683	$218,646	$28,962
2028	10	0	10	$39,597	$43,333	$410,769	$449,526	$38,757
2029	5	0	5	$39,532	$40,374	$215,232	$219,812	$4,580
2030	9	0	9	$39,911	$39,051	$345,493	$338,046	-$7,447
2031	4	0	4	$41,571	$40,045	$180,588	$173,957	-$6,631
2032	7	0	7	$42,469	$40,518	$313,707	$299,294	-$14,413
2033	10	0	10	$42,959	$40,690	$434,239	$411,299	-$22,941
2034	5	0	5	$45,223	$42,560	$209,737	$197,382	-$12,355
2035	10	0	10	$44,307	$41,138	$446,721	$414,771	-$31,949
2036	7	0	7	$44,322	$40,632	$330,950	$303,394	-$27,556
2037	6	0	6	$47,742	$43,532	$271,519	$247,573	-$23,946
2038	10	0	10	$48,099	$43,385	$462,103	$416,819	-$45,284
2039	6	0	6	$48,294	$43,005	$291,718	$259,772	-$31,946
2040	8	0	8	$48,762	$42,946	$409,987	$361,094	-$48,894
TOTAL	135	20	115			$4,951,588	$4,872,251	-$79,337

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Over the forecast period, the procurement of BEVs for classes 2b and 3 is expected to result in savings of roughly $79,000 due the forecasted decline in BEV purchasing price. Over the forecast period, BEVs are estimated to generate savings of $2.3 Million **(Table 40)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 40: Modeled WSP Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.29	$0.12	$51,996	$48,695	$0	$0	$0
2024	$0.30	$0.12	$56,654	$49,042	$0	$0	$0
2025	$0.30	$0.12	$53,692	$46,615	$410,744	$356,607	$54,136
2026	$0.31	$0.12	$53,296	$44,399	$239,833	$199,795	$40,038
2027	$0.31	$0.12	$59,899	$46,356	$287,971	$222,861	$65,111
2028	$0.32	$0.12	$59,603	$44,533	$618,305	$461,977	$156,328
2029	$0.32	$0.12	$59,719	$42,218	$325,139	$229,851	$95,288
2030	$0.32	$0.12	$60,170	$41,190	$520,867	$356,564	$164,303
2031	$0.33	$0.12	$65,083	$42,966	$282,725	$186,645	$96,080
2032	$0.33	$0.12	$66,087	$43,383	$488,164	$320,456	$167,708
2033	$0.34	$0.12	$63,305	$42,616	$639,899	$430,765	$209,133
2034	$0.34	$0.12	$67,274	$44,675	$312,001	$207,195	$104,806
2035	$0.35	$0.12	$63,744	$42,734	$642,690	$430,856	$211,834
2036	$0.35	$0.13	$63,450	$42,207	$473,779	$315,155	$158,624
2037	$0.36	$0.13	$71,224	$45,853	$405,066	$260,774	$144,292
2038	$0.36	$0.13	$70,790	$45,486	$680,103	$436,995	$243,108
2039	$0.37	$0.13	$71,491	$45,263	$431,839	$273,408	$158,431
2040	$0.38	$0.13	$71,681	$45,107	$602,691	$379,257	$223,434
TOTAL					$7,361,817	$5,069,161	$2,292,655

**Includes vehicle recovery value at time of surplus*

2.3.4 Classes 4-8

Class 4-8 vehicles are not forecasted to reach their goal BEV share, achieving 55% electrification by 2040 **(Figure 20)**. WSP operates the fewest number of class 4-8 vehicles among the fleets modeled, with the 16 total vehicles split evenly between class 4 and 8 **(Table 41)**.

Figure 20: Modeled WSP Class 4-8 Vehicle Turnover and BEV Share

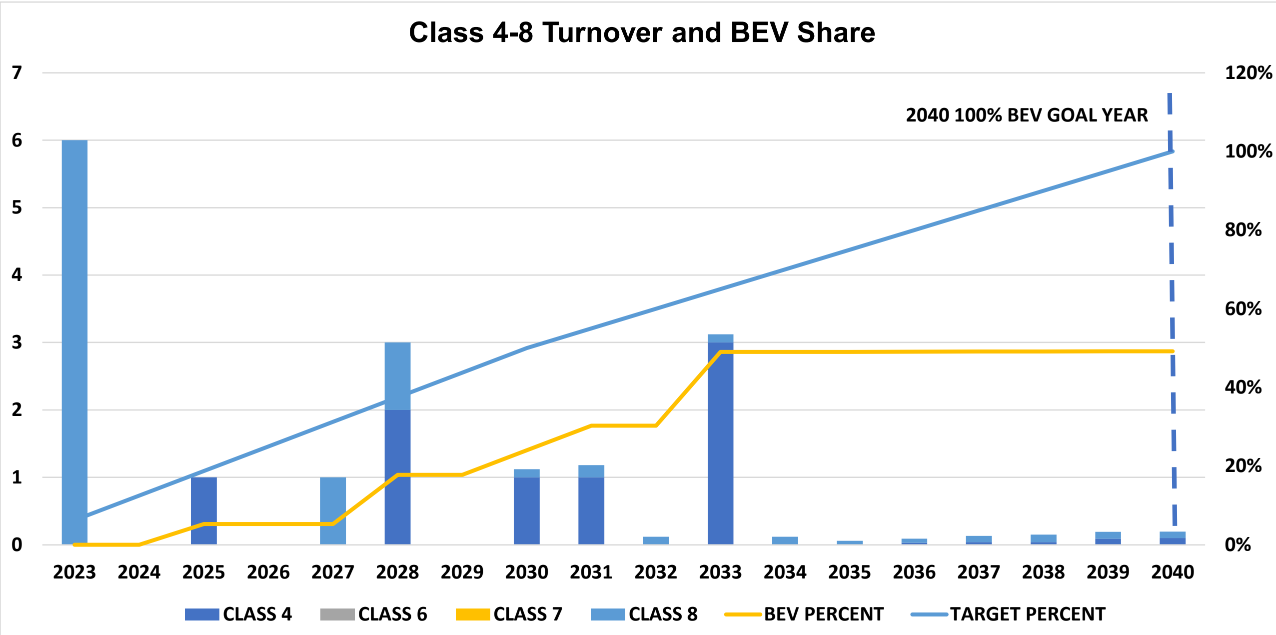


Table 41: WSP Classes 4-8 Vehicle Fleet Summary Information

Classification	Class 4	Class 5	Class 6	Class 7	Class 8
Annual Miles Forecast	6,399				4,861
Average Age	11.3				26.1
Count	8				8

The entirety of the class 4 vehicle fleet is forecasted to convert from ICE to BEV alternatives over the forecast period **(Table 42)**. Due to the very few annual miles traveled by class 8 vehicles, they are cost exempt for the beginning of the forecast period but become eligible for BEV replacement as purchase costs decline later this decade. Overall BEVs are forecasted to cost approximately $79,000 more at the time of purchase than ICE vehicles.

Table 42: Modeled WSP Class 4-8 Vehicle Purchase Cost Forecast

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	6	6	0	$0	$0	$0	$0	$0
2024	0	0	0	$0	$0	$0	$0	$0
2025	1	0	1	$56,302	$59,206	$47,856	$50,325	$2,469
2026	0	0	0	$0	$0	$0	$0	$0
2027	1	1	0	$0	$0	$0	$0	$0
2028	3	1	2	$57,775	$60,378	$115,550	$120,757	$5,207
2029	0	0	0	$0	$0	$0	$0	$0
2030	1	0	1	$58,005	$61,160	$58,005	$61,160	$3,155
2031	1	0	1	$58,120	$61,551	$58,120	$61,551	$3,430
2032	0	0	0	$201,984	$264,101	$24,483	$32,012	$7,529
2033	3	0	3	$64,010	$70,206	$199,789	$219,128	$19,340
2034	0	0	0	$206,183	$266,069	$24,992	$32,251	$7,259
2035	0	0	0	$208,282	$267,053	$12,623	$16,185	$3,562
2036	0	0	0	$159,820	$199,860	$14,529	$18,169	$3,640
2037	0	0	0	$165,198	$205,906	$21,693	$27,038	$5,345
2038	0	0	0	$173,072	$215,147	$26,223	$32,598	$6,375
2039	0	0	0	$142,009	$173,262	$27,254	$33,252	$5,998
2040	0	0	0	$136,344	$165,121	$26,668	$32,296	$5,628
TOTAL	17	8	9			$657,786	$736,723	$78,937

***Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Class 4 and 8 ICE vehicle replacements are expected to result in savings of approximately $529,000 **(Table 43)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 43: Modeled WSP Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles

	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		
YEAR	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	BEV Savings – Eligible Only
2023	$0.70	$0.22	$0	$0	$0	$0	$0
2024	$0.70	$0.22	$0	$0	$0	$0	$0
2025	$0.70	$0.22	$116,752	$70,359	$99,239	$59,805	$39,434
2026	$0.71	$0.22	$0	$0	$0	$0	$0
2027	$0.72	$0.22	$0	$0	$0	$0	$0
2028	$0.74	$0.22	$122,608	$71,722	$245,215	$143,445	$101,771
2029	$0.75	$0.22	$0	$0	$0	$0	$0
2030	$0.77	$0.22	$126,068	$72,643	$126,068	$72,643	$53,425
2031	$0.78	$0.22	$127,869	$73,106	$127,869	$73,106	$54,763
2032	$0.80	$0.22	$263,428	$256,064	$31,931	$31,038	$893
2033	$0.82	$0.22	$398,369	$331,099	$1,243,395	$1,033,429	$209,965
2034	$0.83	$0.22	$270,355	$258,056	$32,770	$31,279	$1,491
2035	$0.85	$0.23	$273,788	$259,056	$16,593	$15,700	$893
2036	$0.87	$0.23	$414,001	$335,520	$37,636	$30,502	$7,135
2037	$0.89	$0.23	$419,117	$337,006	$55,036	$44,253	$10,782
2038	$0.91	$0.23	$424,161	$338,498	$64,267	$51,288	$12,979
2039	$0.93	$0.23	$429,113	$339,995	$82,355	$65,252	$17,104
2040	$0.95	$0.23	$433,950	$341,499	$84,877	$66,795	$18,083
TOTAL					$2,247,252	$1,718,535	$528,717

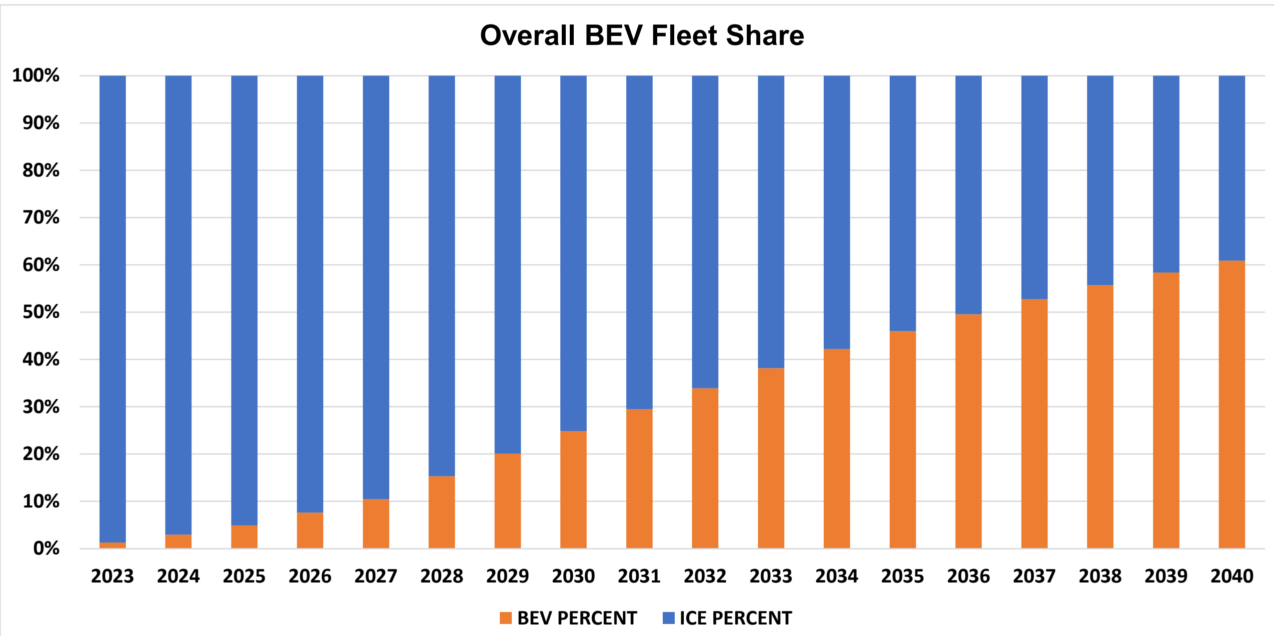
**Includes vehicle recovery value at time of surplus*

2.4 Washington State Department of Transportation (WSDOT)

2.4.1 Fleet Overview

The Washington State Department of Transportation (WSDOT) presently manages a fleet of 2,918 vehicles that are potentially subject to the Executive Order. Of the existing fleet, 32 vehicles are already BEVs. WSDOT manages 1,093 vehicles in the class 4-8 range. Additionally, WSDOT manages large fleets of heavy-duty trucks in the classes 2b and 3. The WSDOT forecast employs a probability-based retirement forecast based off the average fleet age. Due to the predominance of trucks in classes 3 and 4 in the WSDOT fleet, these vehicle classes are modeled as BEV unavailable for the first 5-years, same as the class 2a truck forecast. Overall, the fleet is forecasted to achieve 61% electrification by 2040 **(Figure 21)**.

Figure 21: Modeled WSDOT Combined BEV Fleet Share



WSDOT faces substantial challenges to reaching BEV goals due to the lack of BEV alternatives for medium and heavy-duty trucks. Additionally, WSDOT operates an older fleet of class 1 and 2a vehicles than DES or WSP, resulting in longer duty cycles and fewer opportunities to electrify the existing fleet. While WSDOT does use age and mileage criteria to determine replacement eligibility, the model employs the average vehicle age to estimate *actual* replacement year since due to fiscal constraints and COVID-19 purchase moratoria, WSDOT has not been able to replace vehicles in accordance with their internal age and mileage policies. Furthermore, providing publicly accessible charging infrastructure, necessary for many grant funding criteria, faces significant hurdles since these are typically secure facilities to protect department assets. Based on the modeled conditions, WSDOT is set to achieve 70% electrification in class 1 and 2a by 2035, 79% electrification for classes 2b and 3 by 2040, and 22% electrification for classes 4-8 **(Table 44)**.

Table 44: Modeled WSDOT Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

Year	Class 1-2a			Class 2b-3			Class 4-8			All Classes		
	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %
2023	38	1118	3%	0	676	0%	0	1116	0%	38	2,910	1%
2024	80	1076	7%	7	669	1%	0	1116	0%	87	2,861	3%
2025	127	1029	11%	14	662	2%	3	1113	0%	144	2,804	5%
2026	196	960	17%	22	654	3%	7	1109	1%	224	2,724	8%
2027	269	887	23%	29	647	4%	11	1105	1%	309	2,639	10%
2028	345	811	30%	77	599	11%	29	1087	3%	451	2,497	15%
2029	421	735	36%	125	551	18%	48	1068	4%	593	2,355	20%
2030	494	662	43%	171	505	25%	67	1049	6%	732	2,216	25%
2031	564	592	49%	217	459	32%	87	1029	8%	868	2,080	29%
2032	632	524	55%	261	415	39%	107	1009	10%	999	1,949	34%
2033	696	460	60%	302	374	45%	127	989	11%	1,125	1,823	38%
2034	756	400	65%	342	334	51%	147	969	13%	1,245	1,703	42%
2035	812	344	70%	379	297	56%	166	950	15%	1,356	1,592	46%
2036	863	293	75%	414	262	61%	184	932	16%	1,460	1,488	50%
2037	909	247	79%	447	229	66%	201	915	18%	1,556	1,392	53%
2038	949	207	82%	477	199	71%	216	900	19%	1,642	1,306	56%
2039	985	171	85%	506	170	75%	230	886	21%	1,721	1,227	58%
2040	1,018	138	88%	533	143	79%	244	872	22%	1,795	1,153	61%

2.4.2 Classes 1-2a

Class 1 and 2a vehicles are forecasted to fall 30% short of their 2035 100% BEV target **(Figure 22)**. The shortfall is due to long forecasted operational lifespans for vehicles and forecasted BEV availability and adoption constraints through 2027 **(Table 45)**. Based on the observed inability of currently available BEV sedans to replace ICE sedans, if future BEV sedan offerings do not significantly improve, WSDOT anticipates replacing ICE sedans with BEV SUVs or higher range alternatives. If this occurs, greater outlays for vehicle replacement will be needed to support fleet electrification goals.

Figure 22: Modeled WSDOT Class 1-2a Vehicle Turnover and BEV Share

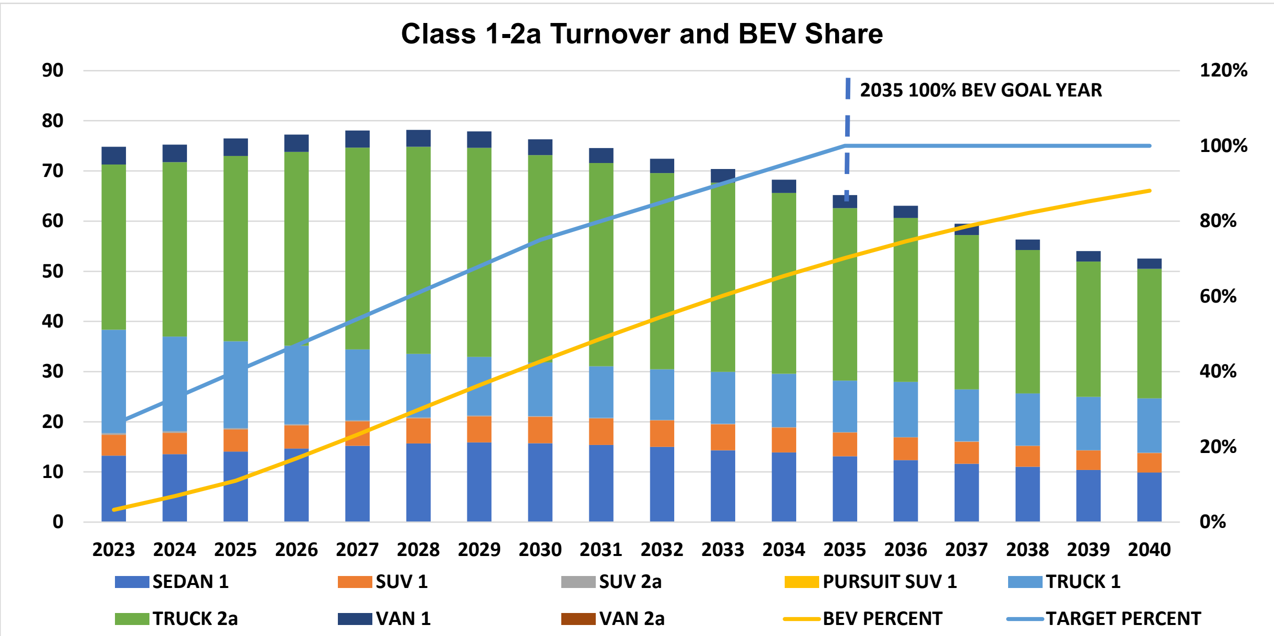


Table 45: WSDOT Class 1-2a Vehicle Fleet Summary Information

Classification	Sedan 1	SUV 1	SUV 2a	Truck 1	Truck 2a	Van 1
Average Annual Miles	5,695	7,595	7,152	4,635	9,262	7,213
Average Age	9	8.3	15	11.2	8.8	11
Count	226	83	1	202	598	46

The long forecasted operational lifespan of vehicles is a major barrier to increasing BEV fleet share. The longer service lives correlate with lighter average usage compared to DES and WSP fleets. If the average fleet age remains the same in the future, ICE vehicles will not become available for BEV replacement fast enough to achieve fleet share goals. However, given the high share of sedans, the lowest cost BEV alternative the purchase price difference is small compared to the more SUV 1 heavy fleets of DES and WSP, with a 2023 purchase price difference of roughly $7,000 **(Table 46)**.

Table 46: Modeled WSDOT Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	75	37	38	$34,089	$41,599	$1,287,073	$1,570,626	$283,553
2024	75	33	42	$34,858	$40,882	$1,466,993	$1,720,516	$253,523
2025	76	29	47	$35,623	$40,162	$1,685,084	$1,899,783	$214,699
2026	77	8	70	$34,256	$37,004	$2,381,936	$2,573,028	$191,092
2027	78	4	74	$35,185	$36,583	$2,609,155	$2,712,867	$103,712
2028	78	0	78	$36,094	$36,097	$2,821,957	$2,822,222	$265
2029	78	0	78	$36,935	$35,850	$2,876,215	$2,791,682	-$84,533
2030	76	0	76	$37,781	$36,302	$2,882,927	$2,770,091	-$112,836
2031	75	0	75	$38,544	$36,665	$2,874,288	$2,734,167	-$140,121
2032	72	0	72	$39,252	$36,965	$2,842,741	$2,677,112	-$165,629
2033	70	0	70	$39,938	$37,235	$2,810,851	$2,620,607	-$190,244
2034	68	0	68	$40,603	$37,476	$2,770,849	$2,557,491	-$213,358
2035	65	0	65	$41,409	$37,838	$2,699,462	$2,466,670	-$232,792
2036	63	0	63	$42,026	$38,018	$2,649,999	$2,397,260	-$252,739
2037	59	0	59	$42,845	$38,371	$2,548,534	$2,282,422	-$266,112
2038	56	0	56	$43,504	$38,572	$2,451,330	$2,173,426	-$277,904
2039	54	0	54	$44,222	$38,816	$2,389,081	$2,097,047	-$292,034
2040	53	0	53	$44,954	$39,064	$2,361,873	$2,052,438	-$309,435
TOTAL	1,250	111	1,139			$44,410,347	$42,919,454	-$1,490,893

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

The procurement of BEVs in place of ICE vehicles is forecasted to generate savings of approximately $1.5 Million through the forecast period and dramatic lifetime ownership cost savings. For the first forecast year, the least competitive year for BEV adoption from a purchase cost standpoint, BEV vehicles are expected to save $19,000 over their service lives **(Table 47)**.

Table 47: Modeled WSDOT Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.28	$0.11	$65,985	$46,769	$2,491,344	$1,765,794	$725,550
2024	$0.29	$0.11	$68,001	$46,836	$2,861,830	$1,971,086	$890,744
2025	$0.29	$0.11	$70,090	$46,826	$3,315,490	$2,215,005	$1,100,485
2026	$0.30	$0.11	$72,263	$46,747	$5,024,707	$3,250,517	$1,774,190
2027	$0.30	$0.11	$74,092	$46,623	$5,494,319	$3,457,355	$2,036,965
2028	$0.30	$0.11	$75,806	$46,414	$5,926,784	$3,628,845	$2,297,940
2029	$0.31	$0.11	$77,327	$46,353	$6,021,596	$3,609,607	$2,411,989
2030	$0.31	$0.11	$78,875	$46,892	$6,018,690	$3,578,137	$2,440,554
2031	$0.31	$0.12	$80,172	$47,303	$5,978,512	$3,527,453	$2,451,059
2032	$0.32	$0.12	$81,323	$47,617	$5,889,711	$3,448,614	$2,441,097
2033	$0.32	$0.12	$82,428	$47,896	$5,801,314	$3,370,926	$2,430,388
2034	$0.32	$0.12	$83,447	$48,116	$5,694,648	$3,283,544	$2,411,105
2035	$0.33	$0.12	$84,803	$48,515	$5,528,320	$3,162,718	$2,365,602
2036	$0.33	$0.12	$85,702	$48,660	$5,404,098	$3,068,357	$2,335,741
2037	$0.34	$0.12	$87,140	$49,065	$5,183,329	$2,918,523	$2,264,806
2038	$0.35	$0.12	$88,121	$49,224	$4,965,317	$2,773,611	$2,191,706
2039	$0.35	$0.12	$89,132	$49,425	$4,815,363	$2,670,191	$2,145,173
2040	$0.36	$0.12	$90,135	$49,627	$4,735,715	$2,607,429	$2,128,286
TOTAL					$91,151,088	$54,307,709	$36,843,380

**Includes vehicle recovery value at time of surplus*

Replacing ICE vehicles with BEV vehicles is forecasted to generate savings of approximately $36.8 Million over the forecast period. However, a significant number of older ICE vehicles are forecasted to remain in the vehicle fleet due to longer duty cycles, curtailing greater BEV adoption and potential savings. <u>The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.</u>

2.4.3 Classes 2b-3

Class 2b and 3 vehicles are forecasted to achieve 79% electrification by 2040 **(Figure 23)**. The shortfall is caused due to long operational lifespans and the lack of BEV availability for truck models in classes 2b and 3. However, when BEV options become available, massive cost savings are possible due to the very high usage profiles of Truck 2b and class 3 vehicles in the WSDOT fleet **(Table 48).**

Figure 23: Modeled WSDOT Class 2b-3 Vehicle Turnover and BEV Share

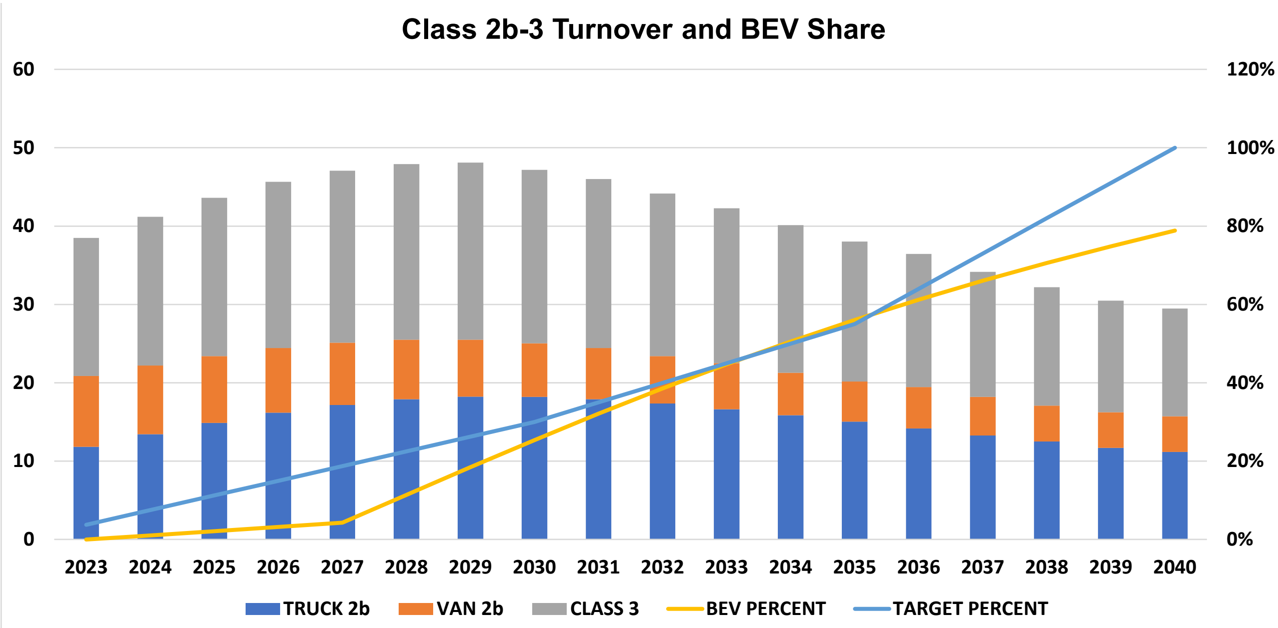


Table 48: WSDOT Class 2b-3 Vehicle Fleet Summary Information

Classification	Truck 2b	Van 2b	Class 3
Annual Miles Forecast	15,120	8,320	14,614
Average Age	8	11.9	8.9
Count	255	98	316

Due to the lack of availability in the modeled classes through 2028, procuring BEVs later in the forecast period is expected to generate $763,000 in savings over the forecast period **(Table 49)**. The long lifespan of these vehicles paired with their usage levels result in major lifetime savings of $39,000 per vehicle starting in 2024 **(Table 50)**.

Table 49: Modeled WSDOT Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	39	39	0	$0	$0	$0	$0	$0
2024	41	34	7	$32,553	$47,946	$228,609	$336,708	$108,100
2025	44	36	7	$33,206	$45,547	$240,616	$330,043	$89,427
2026	46	38	7	$33,871	$43,147	$251,411	$320,263	$68,853
2027	47	40	8	$34,550	$40,748	$260,976	$307,792	$46,816
2028	48	0	48	$38,918	$42,142	$1,864,796	$2,019,277	$154,480
2029	48	0	48	$39,729	$40,680	$1,910,658	$1,956,371	$45,713
2030	47	0	47	$40,548	$39,932	$1,912,669	$1,883,636	-$29,034
2031	46	0	46	$41,371	$39,946	$1,903,868	$1,838,267	-$65,601
2032	44	0	44	$42,224	$40,362	$1,864,812	$1,782,567	-$82,245
2033	42	0	42	$43,056	$40,745	$1,820,662	$1,722,921	-$97,742
2034	40	0	40	$43,939	$41,165	$1,762,425	$1,651,157	-$111,268
2035	38	0	38	$44,821	$41,572	$1,704,873	$1,581,275	-$123,598
2036	36	0	36	$45,673	$41,937	$1,664,166	$1,528,035	-$136,132
2037	34	0	34	$46,590	$42,352	$1,591,876	$1,447,052	-$144,824
2038	32	0	32	$47,538	$42,782	$1,530,227	$1,377,132	-$153,095
2039	30	0	30	$48,452	$43,168	$1,476,585	$1,315,539	-$161,046
2040	29	0	29	$49,401	$43,573	$1,456,065	$1,284,286	-$171,778
TOTAL	733	187	546			$23,445,296	$22,682,321	-$762,975

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Table 50: Modeled WSDOT Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.29	$0.12	$104,833	$69,674	$0	$0	$0
2024	$0.30	$0.12	$107,521	$68,729	$755,084	$482,662	$272,422
2025	$0.30	$0.12	$110,315	$67,691	$799,371	$490,504	$308,867
2026	$0.31	$0.12	$113,444	$66,627	$842,048	$494,546	$347,502
2027	$0.31	$0.12	$115,579	$65,635	$873,036	$495,778	$377,258
2028	$0.32	$0.12	$117,568	$64,639	$5,633,398	$3,097,278	$2,536,120
2029	$0.32	$0.12	$119,558	$63,626	$5,749,783	$3,059,882	$2,689,902
2030	$0.32	$0.12	$121,612	$63,234	$5,736,559	$2,982,802	$2,753,757
2031	$0.33	$0.12	$123,546	$63,475	$5,685,484	$2,921,048	$2,764,436
2032	$0.33	$0.12	$125,702	$64,094	$5,551,602	$2,830,714	$2,720,888
2033	$0.34	$0.12	$127,567	$64,600	$5,394,246	$2,731,626	$2,662,621
2034	$0.34	$0.12	$129,879	$65,235	$5,209,521	$2,616,611	$2,592,910
2035	$0.35	$0.12	$131,968	$65,809	$5,019,724	$2,503,205	$2,516,519
2036	$0.35	$0.13	$133,670	$66,221	$4,870,447	$2,412,869	$2,457,578
2037	$0.36	$0.13	$135,905	$66,813	$4,643,531	$2,282,835	$2,360,695
2038	$0.36	$0.13	$138,332	$67,429	$4,452,854	$2,170,522	$2,282,332
2039	$0.37	$0.13	$140,113	$67,842	$4,269,960	$2,067,498	$2,202,462
2040	$0.38	$0.13	$141,926	$68,276	$4,183,144	$2,012,369	$2,170,774
TOTAL					$69,669,792	$35,652,749	$34,017,043

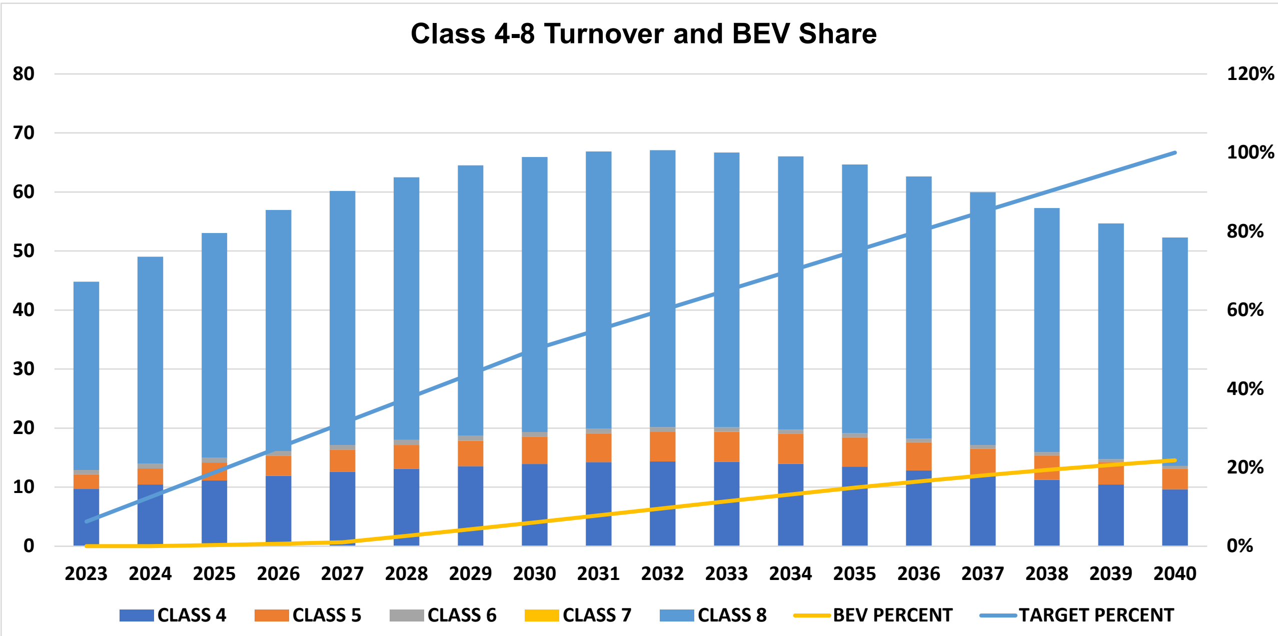
**Includes vehicle recovery value at time of surplus*

The high miles traveled by truck 2b and class 3 classifications makes them particularly valuable to convert from ICE to BEV. Once these classes enter full availability in 2028, the forecasted per vehicle lifetime savings for BEV class 2b and 3 vehicles jumps to roughly $53,000 or 54% the estimated lifetime costs of operating an ICE vehicle. Replacing ICE vehicles with BEVs, when possible, will create major savings. Based on the modeled availability, BEV adoption would result in almost a halving of total lifetime costs compared to ICE. A savings of over $34 Million. <u>The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.</u>

2.4.4 Classes 4-8

Class 4-8 vehicles are forecasted to achieve 22% electrification driven almost entirely by class 4 and 5 electrification **(Figure 21)**.

Figure 24: Modeled WSDOT Class 4-8 Vehicle Turnover and BEV Share



While WSDOT's class 4-8 fleet is younger than the other analyzed fleets, the low annual average miles traveled results in Class 6 vehicles being ineligible in the near-term for BEV replacement on SEEP cost grounds while class 8 vehicles are exempt for the duration of the forecast **(Table 51).**

Table 51: WSDOT Classes 4-8 Vehicle Fleet Summary Information

Classification	Class 4	Class 5	Class 6	Class 7*	Class 8
Annual Average Miles	12,169	7,334	5,643	-	645
Average Age	9.9	8.9	11.6	-	9.8
Count	234	80	13	-	789

**Isolating Class 7 vehicles was not possible based on provided information, these vehicles are included in Class 8*

Class 4 and 5 BEV eligible vehicles remain more expensive at the point of purchase throughout the forecast period, resulting in greater increased expenditures over $2.3 Million over the forecast period **(Table 52)**.

Table 52: Modeled WSDOT Class 4-8 Vehicle Purchase Cost Forecast

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Costs Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	45	45	0	$0	$0	$0	$0	$0
2024	49	49	0	$0	$0	$0	$0	$0
2025	53	50	3	$95,955	$119,148	$311,666	$386,999	$75,333
2026	57	53	4	$96,958	$118,966	$364,679	$447,456	$82,777
2027	60	56	4	$97,240	$118,900	$419,634	$513,107	$93,472
2028	62	45	18	$68,570	$76,259	$1,233,333	$1,371,620	$138,286
2029	65	46	19	$68,903	$76,784	$1,288,618	$1,436,002	$147,385
2030	66	47	19	$69,308	$77,411	$1,339,441	$1,496,037	$156,596
2031	67	47	20	$69,632	$77,919	$1,386,953	$1,552,008	$165,055
2032	67	47	20	$69,961	$78,432	$1,410,947	$1,581,782	$170,835
2033	67	47	20	$70,314	$78,976	$1,415,443	$1,589,824	$174,381
2034	66	46	20	$70,648	$79,494	$1,394,649	$1,569,265	$174,615
2035	65	46	19	$70,947	$79,960	$1,356,369	$1,528,691	$172,322
2036	63	44	18	$71,226	$80,400	$1,297,815	$1,464,982	$167,167
2037	60	43	17	$71,496	$80,828	$1,224,266	$1,384,067	$159,801
2038	57	41	16	$71,751	$81,236	$1,143,487	$1,294,654	$151,167
2039	55	40	15	$71,983	$81,615	$1,061,239	$1,203,245	$142,006
2040	52	39	14	$72,204	$81,980	$980,191	$1,112,912	$132,721
TOTAL	1,075	829	246			$17,628,731	$19,932,650	$2,303,919

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Class 4 BEV vehicles accrue significant savings over ICE vehicles due to their lower per mile operating costs and very high annual miles traveled. BEV savings over the forecast period are expected to exceed $30 Million **(Table 53)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 53: Modeled WSDOT Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.70	$0.22	$0	$0	$0	$0	$0
2024	$0.70	$0.22	$0	$0	$0	$0	$0
2025	$0.70	$0.22	$180,253	$128,313	$585,472	$416,768	$168,704
2026	$0.71	$0.22	$183,529	$128,377	$690,289	$482,852	$207,437
2027	$0.72	$0.22	$186,149	$128,529	$803,319	$554,662	$248,657
2028	$0.74	$0.22	$217,994	$104,311	$3,920,930	$1,876,181	$2,044,748
2029	$0.75	$0.22	$221,228	$104,915	$4,137,396	$1,962,123	$2,175,273
2030	$0.77	$0.22	$224,308	$105,567	$4,334,935	$2,040,173	$2,294,761
2031	$0.78	$0.22	$227,366	$106,139	$4,528,717	$2,114,094	$2,414,622
2032	$0.80	$0.22	$230,280	$106,701	$4,644,172	$2,151,890	$2,492,282
2033	$0.82	$0.22	$232,997	$107,267	$4,690,330	$2,159,329	$2,531,001
2034	$0.83	$0.22	$235,469	$107,791	$4,648,314	$2,127,875	$2,520,438
2035	$0.85	$0.23	$237,640	$108,251	$4,543,225	$2,069,554	$2,473,671
2036	$0.87	$0.23	$239,413	$108,650	$4,362,379	$1,979,733	$2,382,646
2037	$0.89	$0.23	$240,700	$108,989	$4,121,623	$1,866,272	$2,255,351
2038	$0.91	$0.23	$241,427	$109,251	$3,847,605	$1,741,132	$2,106,473
2039	$0.93	$0.23	$241,521	$109,423	$3,560,724	$1,613,213	$1,947,510
2040	$0.95	$0.23	$240,899	$109,503	$3,270,281	$1,486,540	$1,783,741
TOTAL					$56,689,709	$26,642,392	$30,047,317

**Includes vehicle recovery value at time of surplus*

2.5 Department of Corrections (DOC)

2.5.1 Fleet Overview

The Washington State Department of Corrections (DOC) presently manages 990 agency-owned vehicles subject to the Executive Order, of which 15 are already BEVs. DOC operates the oldest vehicles on average compared to the other four modeled fleets, resulting in very long duty cycles and few opportunities to replace ICE vehicles with BEVs. While DOC does lease permanently assigned vehicles from DES per RCW 43.19.600, given the large number of DOC's current agency-owned and managed vehicles that are outside of DES, these vehicles are broken into their own section. Overall, DOC's agency-owned vehicle fleet is forecasted to achieve 60% electrification by 2040 **(Figure 25).** Class 1 and 2a vehicles are expected to achieve 42% electrification by 2035 with class 2b and 3 attaining 60% by 2040 and classes 4-8 reaching 57% by 2040 **(Table 54)**.

DOC management has identified specific obstacles facing their agency fleet electrification transition including but not limited to the fact that electric vehicle infrastructure funding, specifically grants, often require public access. However, DOC facilities must restrict access to facilities due to safety and security concerns. Vehicles entering DOC facilities are subject to search, must have official business with DOC and are restricted from having contraband of any kind including legal/illegal narcotics, drugs, and weapons of any kind. Additionally, prisoner transfers between some facilities fall outside of the current range of BEVs and charging midtrip is not permitted on safety grounds, rendering transfer vehicles as currently exempt under SEEP "emergency vehicle or safety" criteria. However, this current exemption will likely decrease in relevance as BEV's range improves. Finally, DOC has placed orders for Ford F-150 Lightnings and ETransits and is pursuing electrification of eligible vehicles. But this has been slowed due to availability constraints.

Figure 25: Modeled DOC Agency-Owned Combined BEV Fleet Share

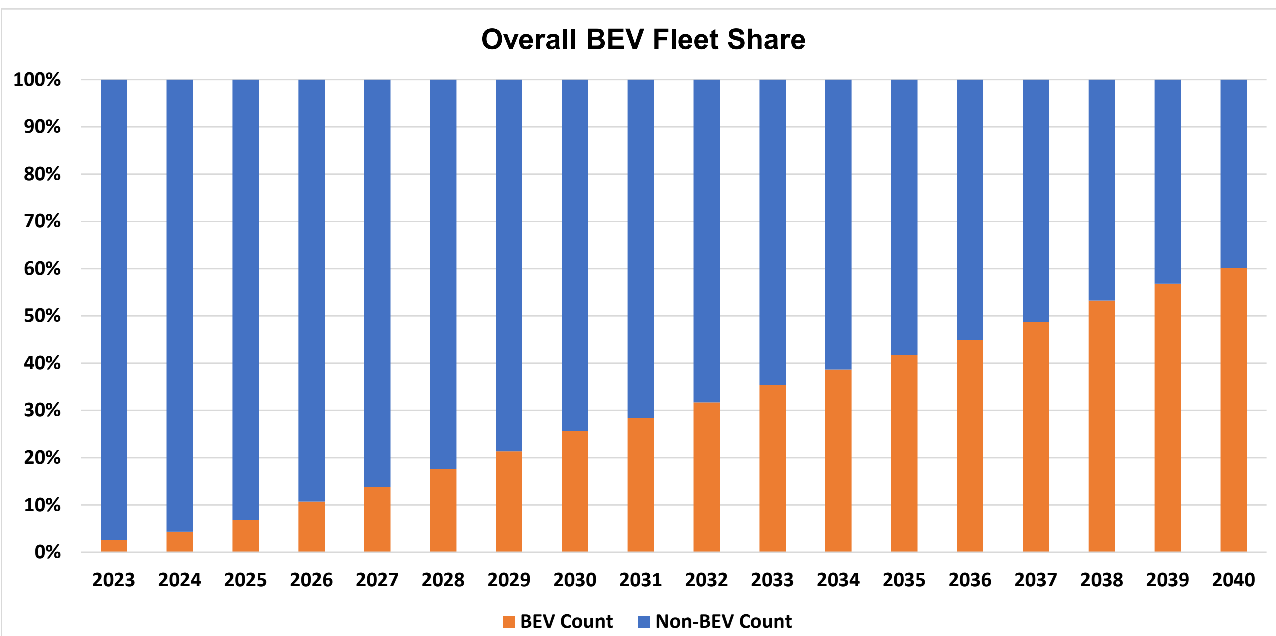


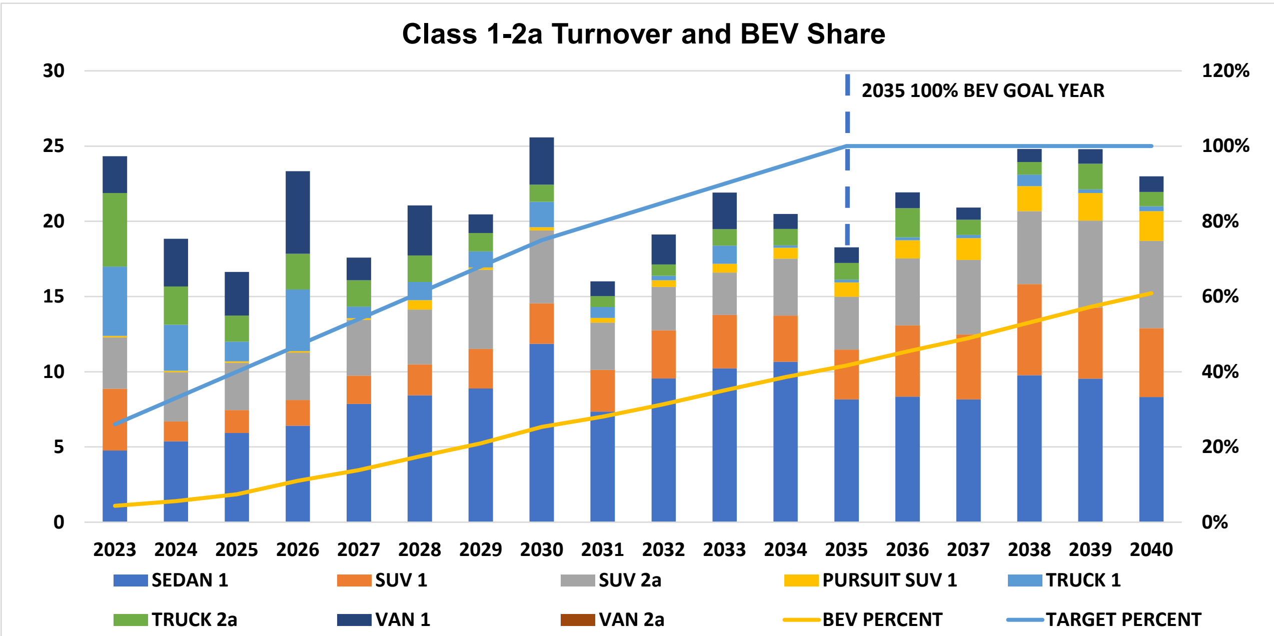
Table 54: Modeled DOC Agency-Owned Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

Year	Classes 1-2a			Classes 2b-3			Classes 4-8			All Classes		
	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %
2023	25	557	4%	0	299	0%	0	109	0%	25	965	3%
2024	33	549	6%	11	288	4%	0	109	0%	43	947	4%
2025	43	539	7%	22	277	7%	3	106	2%	68	922	7%
2026	64	518	11%	34	265	11%	8	101	7%	106	884	11%
2027	81	501	14%	45	254	15%	11	98	11%	137	853	14%
2028	102	480	17%	58	241	19%	14	95	13%	174	816	18%
2029	122	460	21%	71	228	24%	18	91	17%	211	779	21%
2030	148	434	25%	84	215	28%	22	87	20%	254	736	26%
2031	163	419	28%	92	207	31%	25	84	23%	281	709	28%
2032	182	400	31%	101	198	34%	30	79	28%	314	676	32%
2033	204	378	35%	112	187	37%	34	75	31%	350	640	35%
2034	225	357	39%	120	179	40%	38	71	35%	383	607	39%
2035	243	339	42%	129	170	43%	42	67	39%	413	577	42%
2036	264	318	45%	136	163	46%	45	64	41%	445	545	45%
2037	285	297	49%	145	154	48%	53	56	48%	482	508	49%
2038	309	273	53%	162	137	54%	56	53	51%	527	463	53%
2039	333	249	57%	171	128	57%	59	50	54%	563	427	57%
2040	354	228	61%	180	119	60%	62	47	57%	596	394	60%

2.5.2 Classes 1-2a

Class 1 and 2a DOC agency-owned vehicles are forecasted to achieve 42% electrification by 2035 due to very long duty cycles, limiting opportunities for BEV replacement **(Figure 26)**.

Figure 26: Modeled DOC Agency-Owned Class 1-2a Vehicle Turnover and BEV Share



The long duty cycles of vehicles in the DOC agency-owned vehicle fleet, excluding pursuit roles, results in limited opportunities for BEV replacements **(Table 55)**. Of the 582 agency-owned vehicles in classes 1 and 2, only 21 are replaced on average through 2040 or *3.6%* of the fleet, meaning it would take approximately 28 years for the entire fleet to turnover.

Table 55: DOC Agency-Owned Class 1-2a Vehicle Fleet Summary Information

Classification	Sedan 1	SUV 1	SUV 2a	Truck 1	Truck 2a	Van 1	Pursuit SUV 1
Average Annual Miles	8,632	6,453	6,933	1,867	3,093	4,265	9,766
Average Age	13.0	8.9	10.6	22.0	16.8	17.0	4.8
Count	200	109	124	24	39	45	41

The high share of sedans and increase in replacements in the last 5 years of the survey, results in significant savings from BEV procurement in lieu of ICE through 2040. It is forecasted BEV purchases will result in savings of over $483,000 through 2040 **(Table 56)**. These savings are paired with substantial lifetime operations savings.

Table 56: Modeled DOC Agency-Owned Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	24	14	10	$30,484	$40,473	$314,403	$417,436	$103,033
2024	19	11	7	$30,373	$36,843	$224,604	$272,446	$47,843
2025	17	6	10	$31,794	$37,100	$333,406	$389,048	$55,642
2026	23	2	21	$33,121	$36,238	$695,444	$760,900	$65,456
2027	18	1	17	$33,100	$35,101	$552,992	$586,422	$33,430
2028	21	0	21	$34,253	$34,618	$721,209	$728,898	$7,689
2029	20	0	20	$34,045	$33,423	$696,741	$684,000	-$12,741
2030	26	0	26	$34,630	$33,368	$885,946	$853,671	-$32,275
2031	16	0	16	$34,685	$33,092	$555,109	$529,614	-$25,495
2032	19	0	19	$35,531	$33,539	$679,377	$641,285	-$38,092
2033	22	0	22	$36,123	$33,752	$791,596	$739,645	-$51,952
2034	20	0	20	$36,942	$34,197	$757,103	$700,837	-$56,266
2035	18	0	18	$38,091	$34,913	$695,674	$637,639	-$58,035
2036	22	0	22	$39,233	$35,616	$860,152	$780,857	-$79,295
2037	21	0	21	$39,839	$35,802	$833,249	$748,807	-$84,442
2038	25	0	25	$39,689	$35,288	$984,772	$875,581	-$109,191
2039	25	0	25	$41,796	$36,819	$1,036,082	$912,726	-$123,356
2040	23	0	23	$42,627	$37,171	$980,030	$854,606	-$125,424
TOTAL	379	35	344			$12,597,889	$12,114,419	-$483,470

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Replacing ICE vehicles with BEVs is forecasted to result in total savings of almost $17.2 Million by 2040 for vehicle classes 1 and 2a **(Table 57)**. The exceedingly long forecasted operational lifespans leads to major forecasted lifetime savings from the first year of the forecast, 2023, exceeding $27,000 over the vehicle's lifespan. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 57: Modeled DOC Agency-Owned Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles

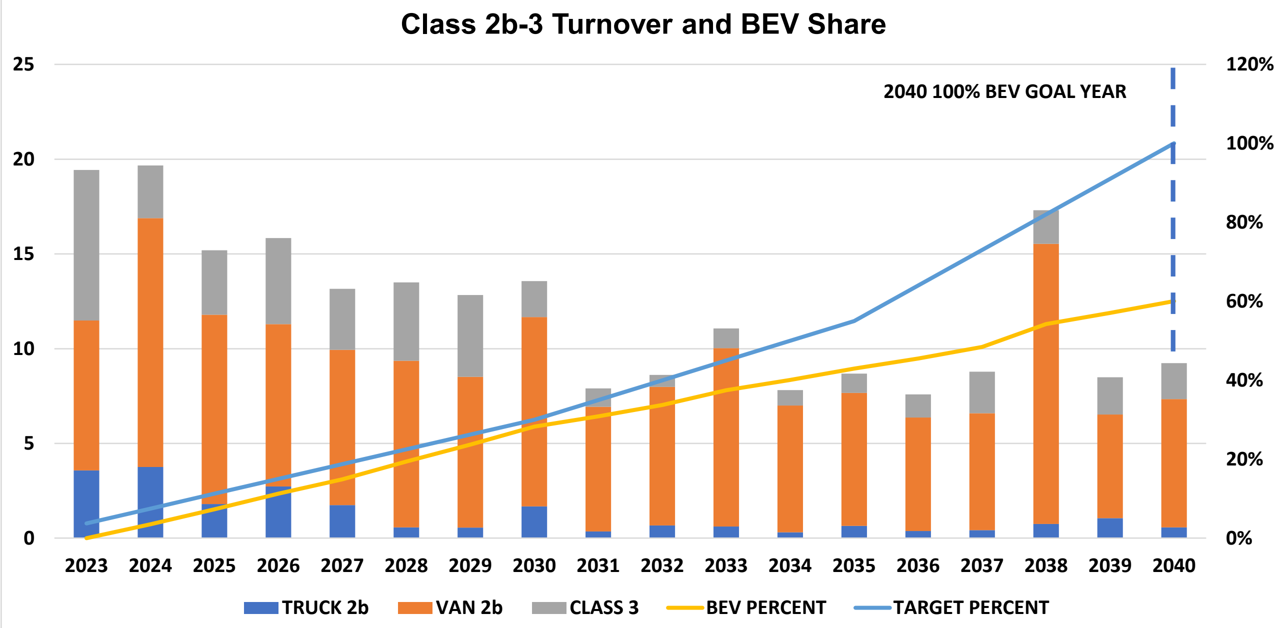
Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.28	$0.11	$80,295	$52,838	$828,148	$544,964	$283,184
2024	$0.28	$0.11	$86,054	$53,044	$636,351	$392,247	$244,104
2025	$0.28	$0.11	$93,912	$54,798	$984,798	$574,634	$410,164
2026	$0.29	$0.11	$87,153	$51,163	$1,829,976	$1,074,290	$755,685
2027	$0.29	$0.11	$102,252	$54,688	$1,708,295	$913,665	$794,630
2028	$0.29	$0.11	$100,132	$53,377	$2,108,306	$1,123,873	$984,434
2029	$0.30	$0.11	$106,675	$53,849	$2,183,116	$1,102,025	$1,081,091
2030	$0.30	$0.11	$106,209	$53,279	$2,717,170	$1,363,053	$1,354,117
2031	$0.30	$0.11	$108,224	$53,700	$1,732,065	$859,446	$872,620
2032	$0.31	$0.11	$109,491	$54,220	$2,093,527	$1,036,713	$1,056,814
2033	$0.31	$0.11	$106,068	$53,231	$2,324,376	$1,166,519	$1,157,857
2034	$0.32	$0.11	$111,678	$55,196	$2,288,757	$1,131,190	$1,157,568
2035	$0.32	$0.11	$109,475	$55,120	$1,999,395	$1,006,681	$992,714
2036	$0.33	$0.11	$107,677	$55,003	$2,360,757	$1,205,917	$1,154,840
2037	$0.33	$0.11	$108,941	$55,630	$2,278,518	$1,163,516	$1,115,002
2038	$0.34	$0.11	$106,952	$54,609	$2,653,737	$1,354,995	$1,298,743
2039	$0.34	$0.11	$107,649	$55,844	$2,668,555	$1,384,322	$1,284,233
2040	$0.35	$0.12	$107,061	$56,021	$2,461,447	$1,287,976	$1,173,471
TOTAL					$35,857,293	$18,686,026	$17,171,267

**Includes vehicle recovery value at time of surplus*

2.5.3 Classes 2b-3

Class 2b and 3 DOC agency-owned vehicles are expected to reach 60% electrification by 2040 **(Figure 24)**. The relative overperformance is driven by the very high share of vans for which BEV alternatives are already market available, albeit in limited quantities. In contrast, the WSDOT fleet of class 2b and 3 vehicles are predominately trucks, for which no BEV alternatives are readily available but possible to come -in the near future.

Figure 27: Modeled DOC Agency-Owned Class 2b-3 Vehicle Turnover and BEV Share



The high average age of the fleet results in few opportunities for ICE replacement with BEVs due to the very long expected service lives of the vehicles **(Table 58)**.

Table 58: DOC Agency-Owned Class 2b-3 Vehicle Fleet Summary Information

Classification	Truck 2b	Van 2b	Class 3
Annual Miles Forecast	5,648	5,152	3,781
Average Age	18.5	14.5	16.6
Count	28	202	69

The high upfront cost results in an increase in acquisition purchase expenditures of roughly $170,000 through 2040 **(Table 59)**. However, while the long service life decreases BEV replacement opportunities it enhances the potential per vehicle lifetime savings, generating over $19,000 in savings over the vehicle's life in 2023 increasing to over $41,000 in 2040 **(Table 60)**.

Table 59: Modeled DOC Agency-Owned Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	19	19	0	$0	$0	$0	$0	$0
2024	20	9	11	$32,553	$47,946	$341,830	$503,467	$161,637
2025	15	4	11	$34,403	$46,140	$391,634	$525,247	$133,614
2026	16	4	12	$35,537	$44,371	$419,251	$523,476	$104,225
2027	13	2	11	$35,935	$42,084	$389,859	$456,567	$66,708
2028	13	0	13	$36,924	$40,278	$498,261	$543,522	$45,261
2029	13	0	13	$37,824	$38,505	$485,242	$493,978	$8,736
2030	14	0	14	$37,855	$36,912	$513,373	$500,587	-$12,786
2031	8	0	8	$38,222	$36,776	$302,027	$290,601	-$11,426
2032	9	0	9	$38,851	$36,987	$334,649	$318,592	-$16,057
2033	11	0	11	$39,657	$37,386	$438,794	$413,661	-$25,133
2034	8	0	8	$40,453	$37,760	$316,227	$295,171	-$21,056
2035	9	0	9	$41,472	$38,328	$360,308	$332,996	-$27,312
2036	8	0	8	$42,460	$38,868	$322,308	$295,043	-$27,265
2037	9	0	9	$43,833	$39,762	$385,063	$349,298	-$35,765
2038	17	0	17	$43,792	$39,265	$757,867	$679,509	-$78,357
2039	8	0	8	$45,833	$40,740	$389,174	$345,928	-$43,246
2040	9	0	9	$46,306	$40,738	$427,982	$376,522	-$51,461
TOTAL	219	39	180			$7,073,847	$7,244,165	$170,318

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Replacing ICE vehicles with BEVs is estimated to generate savings of $6.9 Million over the lifetime of vehicles purchased between 2024 and 2040. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 60: Modeled DOC Agency-Owned Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles

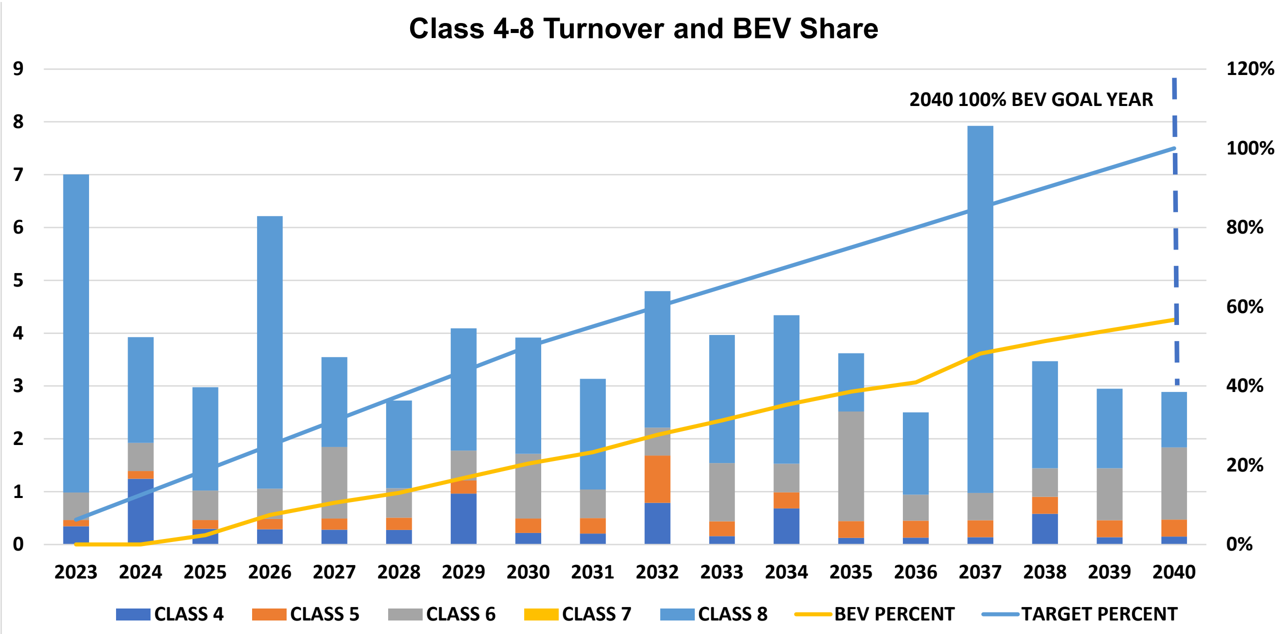
Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.29	$0.12	$81,969	$62,178	$0	$0	$0
2024	$0.30	$0.12	$86,396	$61,727	$907,215	$648,173	$259,041
2025	$0.30	$0.12	$86,575	$59,564	$985,559	$678,063	$307,496
2026	$0.31	$0.12	$88,328	$57,807	$1,042,064	$681,984	$360,081
2027	$0.31	$0.12	$89,808	$56,082	$974,315	$608,433	$365,882
2028	$0.32	$0.12	$89,593	$54,038	$1,208,993	$729,204	$479,789
2029	$0.32	$0.12	$90,608	$52,392	$1,162,395	$672,124	$490,271
2030	$0.32	$0.12	$95,106	$52,188	$1,289,785	$707,752	$582,032
2031	$0.33	$0.12	$95,115	$51,980	$751,597	$410,747	$340,851
2032	$0.33	$0.12	$96,470	$52,418	$830,958	$451,510	$379,448
2033	$0.34	$0.12	$96,390	$52,565	$1,066,522	$581,617	$484,904
2034	$0.34	$0.12	$96,426	$52,728	$753,776	$412,178	$341,598
2035	$0.35	$0.12	$96,766	$53,128	$840,702	$461,574	$379,129
2036	$0.35	$0.13	$96,125	$53,222	$729,674	$404,004	$325,670
2037	$0.36	$0.13	$95,207	$53,450	$836,373	$469,547	$366,826
2038	$0.36	$0.13	$96,582	$53,505	$1,671,434	$925,950	$745,484
2039	$0.37	$0.13	$95,906	$54,156	$814,343	$459,844	$354,499
2040	$0.38	$0.13	$95,300	$53,939	$880,801	$498,528	$382,273
TOTAL					$16,746,507	$9,801,234	$6,945,274

**Includes vehicle recovery value at time of surplus*

2.5.4 Classes 4-8

Class 4-8 DOC agency-owned vehicles are expected to reach 57% electrification by 2040 **(Figure 28)** due to the limited miles traveled by class 5 and 6 vehicles **(Table 61)** making them ineligible for BEV replacement on cost grounds during the forecast period.

Figure 28: Modeled DOC Agency-Owned Class 4-8 Vehicle Turnover and BEV Share



Despite very long forecasted lifespans, which improve the cost competitiveness of electrification through greater miles traveled, it is not sufficient to make up for the very low annual miles traveled **(Table 61)**.

Table 61: DOC Agency-Owned Classes 4-8 Vehicle Fleet Summary Information

Classification	Class 4	Class 5	Class 6	Class 7	Class 8
Annual Average Miles	6,219	3,968	1,255		7,313
Average Age	20.4	13.3	14.9		25.3
Count	11	12	28		58

Over the forecast period, a total of 74 vehicles are expected to be procured, of which 62 are BEV eligible **(Table 62).** Amongst those eligible vehicles, the cost of BEV over ICE procurement is expected to increase costs by approximately $2.9 Million at the time of purchase.

Table 62: Modeled DOC Agency-Owned Class 4-8 Vehicle Purchase Cost Forecast

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Costs Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	7	7	0	$0	$0	$0	$0	$0
2024	4	4	0	$0	$0	$0	$0	$0
2025	3	0	3	$156,453	$210,600	$395,767	$532,740	$136,972
2026	6	1	6	$174,108	$235,180	$973,911	$1,315,531	$341,621
2027	4	0	3	$149,454	$196,617	$503,811	$662,799	$158,988
2028	3	0	3	$157,349	$206,858	$428,995	$563,975	$134,980
2029	4	0	4	$147,439	$190,990	$603,237	$781,421	$178,183
2030	4	0	4	$160,806	$208,965	$629,644	$818,213	$188,569
2031	3	0	3	$168,382	$218,325	$527,882	$684,456	$156,574
2032	5	0	5	$150,330	$191,457	$721,214	$918,527	$197,313
2033	4	0	4	$170,255	$218,021	$675,110	$864,516	$189,406
2034	4	0	4	$165,965	$210,705	$720,331	$914,518	$194,187
2035	4	0	4	$150,435	$188,248	$544,602	$681,490	$136,889
2036	2	0	2	$172,927	$217,534	$432,257	$543,758	$111,501
2037	8	0	8	$200,151	$252,562	$1,585,841	$2,001,112	$415,271
2038	3	0	3	$165,544	$205,197	$574,129	$711,651	$137,522
2039	3	0	3	$170,112	$210,043	$501,619	$619,367	$117,747
2040	3	0	3	$159,447	$195,066	$460,494	$563,365	$102,871
TOTAL	74	12	62			$10,278,845	$13,177,438	$2,898,593

***Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Converting class 4 and 8 ICE vehicles to BEVs generates major savings throughout the forecast period. Overall, BEV adoption is forecasted to generate over $8 Million in savings **(Table 63)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 63: Modeled DOC Agency-Owned Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.70	$0.22	$0	$0	$0	$0	$0
2024	$0.70	$0.22	$0	$0	$0	$0	$0
2025	$0.70	$0.22	$665,497	$524,356	$1,683,458	$1,326,424	$357,035
2026	$0.71	$0.22	$666,244	$524,841	$3,726,784	$2,935,813	$790,971
2027	$0.72	$0.22	$655,077	$530,699	$2,208,273	$1,788,994	$419,279
2028	$0.74	$0.22	$666,153	$524,669	$1,816,191	$1,430,449	$385,741
2029	$0.75	$0.22	$680,582	$514,552	$2,784,554	$2,105,254	$679,300
2030	$0.77	$0.22	$653,040	$530,078	$2,557,008	$2,075,544	$481,464
2031	$0.78	$0.22	$660,191	$524,246	$2,069,719	$1,643,528	$426,191
2032	$0.80	$0.22	$671,316	$514,384	$3,220,671	$2,467,784	$752,887
2033	$0.82	$0.22	$645,431	$528,054	$2,559,316	$2,093,884	$465,432
2034	$0.83	$0.22	$661,240	$511,348	$2,869,958	$2,219,387	$650,571
2035	$0.85	$0.23	$633,350	$528,607	$2,292,834	$1,913,647	$379,187
2036	$0.87	$0.23	$639,413	$518,419	$1,598,309	$1,295,864	$302,444
2037	$0.89	$0.23	$633,591	$516,250	$5,020,096	$4,090,373	$929,723
2038	$0.91	$0.23	$635,311	$503,571	$2,203,347	$1,746,453	$456,893
2039	$0.93	$0.23	$616,049	$515,776	$1,816,586	$1,520,904	$295,682
2040	$0.95	$0.23	$607,444	$514,818	$1,754,339	$1,486,829	$267,510
TOTAL					$40,181,441	$32,141,131	$8,040,309

**Includes vehicle recovery value at time of surplus*

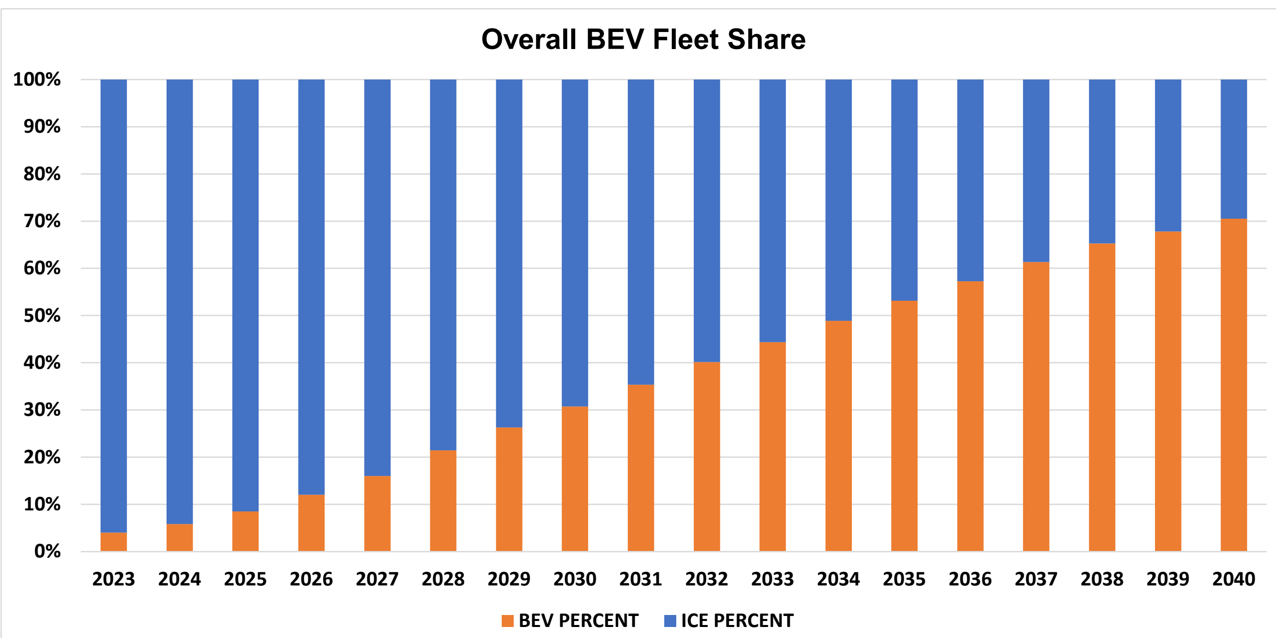
2.6 Department of Social and Health Services (DSHS)

2.6.1 Fleet Overview

While DSHS does lease permanently assigned vehicles from DES per RCW 43.19.600, given the large number of DSHS's current agency-owned and managed vehicles that are outside of DES these vehicles are broken into their own section. The Department of Social and Health Services (DSHS) operates the smallest of the five modeled fleets with 586 agency-owned vehicles subject to the Executive Order, of which 21 are BEVs. The DSHS agency-owned fleet is unlikely to meet electrification goals due to the long-expected service life of its agency-owned vehicles. The DSHS agency-owned fleet is forecasted to achieve 71% electrification by 2040 **(Figure 29).**

DSHS is subject to similar constraints as DOC due to the restricted access of their facilities and patient transfer needs. The lack of public access on safety and security grounds limits grant eligibility and opportunity to recover charger costs via sharing facilities with the public. Furthermore, there are availability concerns around vehicles that can meet the design and range needs of patient transfer vehicles since stopping to charge would pose a safety risk and would be exempt under SEEP's "emergency vehicle or safety" criteria. However, this current exemption will likely decrease in relevance as BEV's range improves. Finally, DSHS is the sole fleet that sometimes purchases surplus vehicles from other agencies to decrease costs – resulting in very long duty cycles in some roles.

Figure 29: Modeled DSHS Agency-Owned Combined BEV Fleet Share



Class 1 and 2a vehicles are forecasted to achieve 54% by 2035 with class 2b and 3 reaching 75% by 2040, and class 4-8 fleet reaching 54% by 2040 **(Table 64)**. The DSHS agency-owned vehicle fleet benefits from a lower share of trucks compared to vans, increasing the number of ICE BEV replacement eligible vehicles in the class 2b-3 fleet.

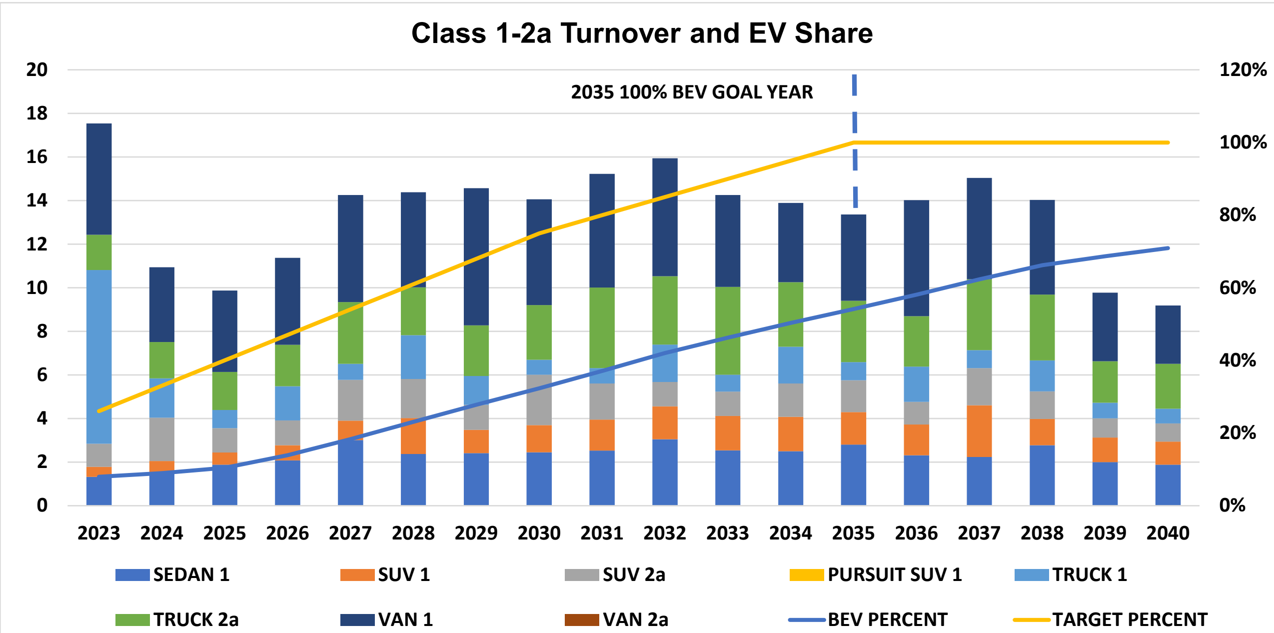
Table 64: Modeled DSHS Agency-Owned Vehicle Count and Fleet BEV % by Class – Goal Parity Year Highlighted

	Classes 1-2a			Classes 2b-3			Classes 4-8			All Classes		
Year	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %	BEV Count	ICE Count	BEV %
2023	24	273	8%	0	225	0%	0	64	0%	24	562	4%
2024	27	270	9%	8	217	3%	0	64	0%	34	552	6%
2025	31	266	10%	17	208	8%	1	63	2%	50	536	8%
2026	41	256	14%	27	198	12%	3	61	4%	70	516	12%
2027	54	243	18%	35	190	16%	4	60	6%	94	492	16%
2028	68	229	23%	52	173	23%	6	58	9%	126	460	21%
2029	83	214	28%	64	161	29%	7	57	11%	154	432	26%
2030	96	201	32%	75	150	33%	9	55	15%	180	406	31%
2031	110	187	37%	85	140	38%	12	52	18%	207	379	35%
2032	125	172	42%	94	131	42%	17	47	26%	235	351	40%
2033	137	160	46%	104	121	46%	18	46	29%	260	326	44%
2034	149	148	50%	116	109	52%	21	43	33%	286	300	49%
2035	161	136	54%	127	98	56%	24	40	37%	311	275	53%
2036	173	124	58%	138	87	61%	25	39	40%	336	250	57%
2037	185	112	62%	147	78	65%	27	37	43%	359	227	61%
2038	197	100	66%	155	70	69%	31	33	48%	382	204	65%
2039	204	93	69%	160	65	71%	34	30	52%	397	189	68%
2040	211	86	71%	168	57	75%	35	29	54%	413	173	71%

2.6.2 Classes 1-2a

The class 1-2a DSHS agency-owned vehicle fleet is expected to achieve 54% electrification due to a high number of older vehicles forecasted for retirement early in the early and medium term with BEV availability constraints **(Figure 27)**.

Figure 30: Modeled DSHS Agency-Owned Class 1-2a Vehicle Turnover and BEV Share



Low average annual miles traveled results in longer vehicle operational lifespans. The large share of very old vehicles identified for replacement in paired with low BEV availability depresses long-term electrification rates due to the very long forecasted duty cycles of DSHS's Agency-Owned Class 1 – 2a vehicle fleet **(Table 65)**.

Table 65: DSHS Agency-Owned Class 1-2a Vehicle Fleet Summary Information

Classification	Sedan 1	SUV 1	SUV 2a	Truck 1	Truck 2a	Van 1
Average Annual Miles	4,497	4,582	6,765	3,784	2,691	6,702
Average Age	6.9	4.9	11.4	22.2	8	10.4
Count	57	33	29	24	60	94

Over the forecast period, purchasing BEVs instead of ICE vehicles is expected to generate savings of nearly $394,000 by 2040 **(Table 66)**. However, these savings are far smaller than those accrued through the estimated lifetime operational cost difference between BEVs and ICE vehicles. Vehicles procured in 2023 are forecasted to cost approximately $18,000 less over their service lifespan than an ICE vehicle.

Table 66: Modeled DSHS Agency-Owned Class 1-2a Vehicle Purchase Cost Forecast – Class 1 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	18	15	3	$32,032	$40,071	$81,491	$101,945	$20,454
2024	11	8	3	$32,347	$38,918	$96,008	$115,510	$19,502
2025	10	5	5	$33,614	$38,849	$151,516	$175,112	$23,596
2026	11	1	10	$35,053	$38,111	$358,897	$390,210	$31,314
2027	14	1	14	$36,653	$38,491	$496,594	$521,488	$24,893
2028	14	0	14	$35,864	$36,233	$515,985	$521,300	$5,316
2029	15	0	15	$38,058	$37,232	$554,494	$542,466	-$12,029
2030	14	0	14	$38,960	$37,576	$547,919	$528,451	-$19,468
2031	15	0	15	$39,972	$38,171	$608,641	$581,213	-$27,428
2032	16	0	16	$39,460	$37,274	$629,170	$594,310	-$34,859
2033	14	0	14	$41,118	$38,490	$586,402	$548,925	-$37,476
2034	14	0	14	$40,588	$37,602	$563,900	$522,413	-$41,487
2035	13	0	13	$42,075	$38,585	$562,464	$515,818	-$46,646
2036	14	0	14	$42,849	$38,867	$600,673	$544,857	-$55,816
2037	15	0	15	$44,061	$39,607	$662,908	$595,888	-$67,019
2038	14	0	14	$44,566	$39,650	$625,518	$556,522	-$68,996
2039	10	0	10	$45,411	$39,989	$443,683	$390,706	-$52,977
2040	9	0	9	$46,322	$40,398	$425,518	$371,096	-$54,422
TOTAL	242	30	212			$8,511,781	$8,118,231	-$393,550

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Replacing ICE vehicles with BEVs in classes 1 and 2a are expected to generate a gross savings of $6.2 Million for the DSHS agency-owned vehicle fleet over their operational lifespans **(Table 67)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

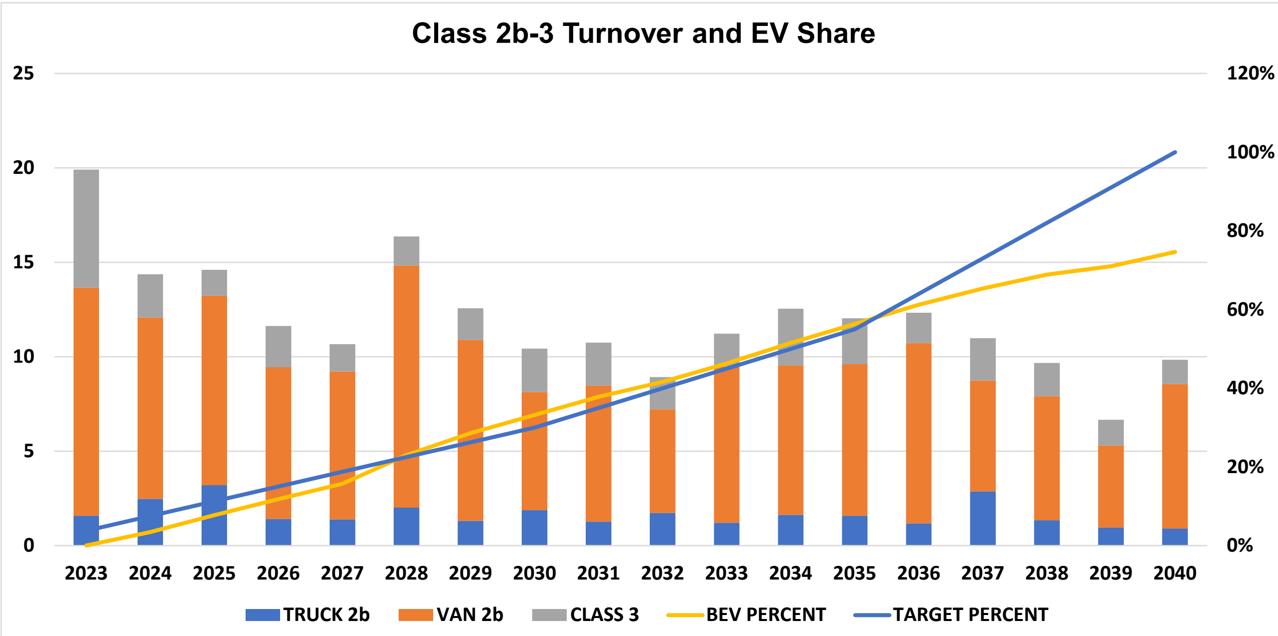
Table 67: Modeled DSHS Agency-Owned Class 1-2a Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.28	$0.11	$62,120	$43,836	$158,038	$111,521	$46,517
2024	$0.28	$0.11	$69,545	$48,229	$206,412	$143,145	$63,267
2025	$0.28	$0.11	$70,953	$48,204	$319,822	$217,279	$102,543
2026	$0.29	$0.11	$70,602	$46,714	$722,868	$478,291	$244,577
2027	$0.29	$0.11	$73,262	$47,329	$992,576	$641,226	$351,350
2028	$0.29	$0.11	$72,290	$45,157	$1,040,065	$649,698	$390,367
2029	$0.30	$0.11	$75,943	$46,451	$1,106,479	$676,781	$429,699
2030	$0.30	$0.11	$77,933	$46,996	$1,096,004	$660,934	$435,071
2031	$0.30	$0.11	$76,618	$46,809	$1,166,618	$712,741	$453,877
2032	$0.31	$0.11	$75,264	$45,713	$1,200,034	$728,875	$471,159
2033	$0.31	$0.11	$75,408	$46,363	$1,075,430	$661,207	$414,223
2034	$0.32	$0.11	$75,470	$45,730	$1,048,527	$635,339	$413,189
2035	$0.32	$0.11	$77,538	$46,806	$1,036,539	$625,716	$410,823
2036	$0.33	$0.11	$78,814	$47,196	$1,104,849	$661,610	$443,239
2037	$0.33	$0.11	$79,235	$47,671	$1,192,093	$717,217	$474,876
2038	$0.34	$0.11	$78,667	$47,384	$1,104,139	$665,066	$439,074
2039	$0.34	$0.12	$79,802	$47,789	$779,705	$466,917	$312,787
2040	$0.35	$0.12	$79,517	$47,830	$730,442	$439,368	$291,074
TOTAL					$16,080,642	$9,892,930	$6,187,712

2.6.3 Classes 2b-3

DSHS agency-owned class 2b-3 vehicles are not expected to achieve their electrification targets, forecasted to reach 75% by 2040 **(Figure 31).** The 2b and 3 class agency-owned vehicles in the DSHS fleet overperform due to the high proportion of vans **(Table 68)**, which are forecasted as market available starting in 2024.

Figure 31: Modeled DSHS Agency-Owned Class 2b-3 Vehicle Turnover and BEV Share



While the high share of vans improves ICE BEV replacement eligibility, the high average age indicates long operational life expectancies, curtailing the opportunities to replace ICE vehicles with BEVs. Furthermore, the early constraints on BEV availability means these ICE vehicles will persist in the fleet for a long duration due to their slow turnover.

Table 68: DSHS Agency-Owned Class 2b-3 Vehicle Fleet Summary Information

Classification	Truck 2b	Van 2b	Class 3
Annual Miles Forecast	4,622	4,647	4,052
Average Age	13.3	14.9	12.9
Count	32	151	42

The spike of replacements early in the forecast results in an expenditure of roughly $64,000 greater on BEVs through the forecast period **(Table 69)**. Despite the high upfront costs, BEVs are forecasted to deliver a per vehicle savings over their lifespan of approximately $12,000 per vehicle in 2024 **(Table 70)**. Class 2b and 3 ICE BEV replacements are estimated to save nearly $4.8 Million dollars over their operational lifespans. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 69: Modeled DSHS Agency-Owned Class 2b-3 Vehicle Purchase Cost Forecast – Class 3 Cost Parity Year Highlighted

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Cost Difference
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	20	20	0	$0	$0	$0	$0	$0
2024	14	7	8	$32,553	$47,946	$250,171	$368,467	$118,296
2025	15	5	10	$33,774	$45,828	$327,332	$444,163	$116,831
2026	12	2	9	$34,902	$43,905	$320,999	$403,797	$82,797
2027	11	2	9	$35,311	$41,482	$311,207	$365,592	$54,385
2028	16	0	16	$36,152	$39,241	$591,734	$642,303	$50,569
2029	13	0	13	$37,011	$37,281	$465,074	$468,469	$3,395
2030	10	0	10	$38,485	$37,623	$401,562	$392,571	-$8,991
2031	11	0	11	$38,975	$37,537	$419,049	$403,584	-$15,465
2032	9	0	9	$39,941	$38,073	$356,585	$339,910	-$16,675
2033	11	0	11	$40,199	$37,922	$450,919	$425,376	-$25,544
2034	13	0	13	$41,570	$38,858	$521,699	$487,665	-$34,034
2035	12	0	12	$42,197	$39,034	$508,138	$470,051	-$38,087
2036	12	0	12	$42,469	$38,862	$523,535	$479,079	-$44,456
2037	11	0	11	$44,474	$40,322	$488,607	$442,987	-$45,620
2038	10	0	10	$44,698	$40,111	$432,542	$388,155	-$44,387
2039	7	0	7	$45,749	$40,653	$304,555	$270,631	-$33,924
2040	10	0	10	$45,956	$40,397	$452,315	$397,595	-$54,720
TOTAL	216	36	180			$7,126,025	$7,190,394	$64,370

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Table 70: Modeled DSHS Agency-Owned Class 2b-3 Lifespan Ownership Costs of BEV Eligible Vehicles

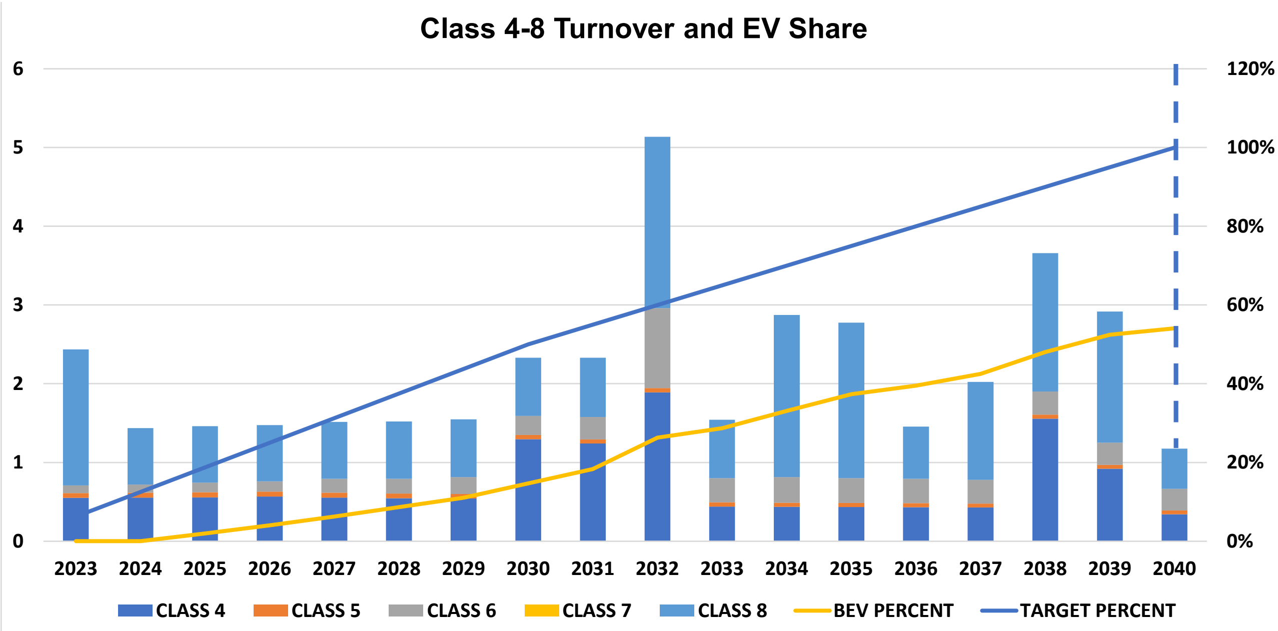
Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.29	$0.12	$0	$0	$0	$0	$0
2024	$0.30	$0.12	$67,085	$54,869	$515,550	$421,671	$93,879
2025	$0.30	$0.12	$68,586	$53,081	$664,730	$514,462	$150,269
2026	$0.31	$0.12	$69,774	$51,357	$641,717	$472,330	$169,387
2027	$0.31	$0.12	$70,947	$49,507	$625,274	$436,315	$188,959
2028	$0.32	$0.12	$72,033	$47,570	$1,179,040	$778,637	$400,403
2029	$0.32	$0.12	$73,069	$45,871	$918,182	$576,411	$341,771
2030	$0.32	$0.12	$74,421	$46,106	$776,534	$481,086	$295,448
2031	$0.33	$0.12	$74,825	$46,039	$804,496	$494,995	$309,501
2032	$0.33	$0.12	$75,670	$46,515	$675,571	$415,283	$260,288
2033	$0.34	$0.12	$76,000	$46,432	$852,491	$520,834	$331,656
2034	$0.34	$0.12	$76,651	$47,088	$961,960	$590,950	$371,010
2035	$0.35	$0.12	$77,230	$47,275	$930,004	$569,292	$360,712
2036	$0.35	$0.13	$77,674	$47,214	$957,533	$582,028	$375,505
2037	$0.36	$0.13	$78,820	$48,319	$865,934	$530,848	$335,086
2038	$0.36	$0.13	$78,980	$48,134	$764,285	$465,787	$298,498
2039	$0.37	$0.13	$79,548	$48,517	$529,560	$322,980	$206,580
2040	$0.38	$0.13	$79,853	$48,350	$785,936	$475,871	$310,065
TOTAL					$13,448,800	$8,649,781	$4,799,019

**Includes vehicle recovery value at time of surplus*

2.6.4 Classes 4-8

DSHS agency-owned Class 4-8 vehicles are not expected to achieve their electrification goals. By 2040 it is estimated 540% of the fleet will be electrified, driven by the high share of BEV eligible class 4 vehicles **(Figure 32)**.

Figure 32: Modeled DSHS Agency-Owned Class 4-8 Vehicle Turnover and BEV Share



The relatively high mileage paired with long service lives results in a high share of BEV eligible class 4, 5, and 8 vehicles. Class 6 vehicles low average mileage exempts them from BEV purchase on SEEP grounds due to the inability to recover the higher purchase cost via lower operational costs **(Table 71)**.

Table 71: Modeled DSHS Agency-Owned Classes 4-8 Vehicle Fleet Summary Information

Classification	Class 4	Class 5	Class 6	Class 7	Class 8
Annual Average Miles	4,944	8,879	2,966		6,134
Average Age	18	13.5	6.2		17.8
Count	20	2	12		30

BEV replacement vehicles are expected to cost approximately $1.3 Million more over the forecast period. **(Table 72).**

Table 72: Modeled DSHS Agency-Owned Class 4-8 Vehicle Purchase Cost Forecast

Year	Vehicles Purchased			Vehicle Price – Eligible Only		Purchase Costs – Eligible Only		BEV Eligible Costs Difference*
	Total Vehicles	ICE	BEV Eligible	ICE	BEV	ICE	BEV	
2023	2	2	0	$0	$0	$0	$0	$0
2024	1	1	0	$0	$0	$0	$0	$0
2025	1	0	1	$127,572	$166,943	$158,325	$207,186	$48,861
2026	1	0	1	$128,715	$166,803	$170,892	$221,461	$50,569
2027	2	0	1	$130,623	$168,589	$187,837	$242,431	$54,595
2028	2	0	2	$132,534	$170,354	$201,487	$258,982	$57,495
2029	2	0	2	$134,016	$171,470	$207,390	$265,350	$57,960
2030	2	0	2	$110,368	$136,447	$257,094	$317,841	$60,747
2031	2	0	2	$113,371	$140,109	$264,118	$326,408	$62,290
2032	5	0	5	$133,757	$168,151	$687,195	$863,897	$176,702
2033	2	0	2	$144,241	$181,829	$222,489	$280,467	$57,978
2034	3	0	3	$173,443	$221,000	$498,557	$635,258	$136,701
2035	3	0	3	$174,306	$220,767	$483,697	$612,626	$128,929
2036	1	0	1	$145,311	$180,296	$211,364	$262,252	$50,888
2037	2	0	2	$165,681	$206,551	$335,185	$417,868	$82,683
2038	4	0	4	$140,506	$172,106	$513,949	$629,536	$115,587
2039	3	0	3	$157,318	$193,299	$458,811	$563,748	$104,937
2040	1	0	1	$148,943	$181,451	$175,163	$213,394	$38,231
TOTAL	40	4	35			$5,033,553	$6,318,706	$1,285,153

**Forecast results in fractional vehicles, vehicle counts rounded to nearest whole vehicle, cost data includes fractional vehicle data.*

Cumulatively, over the forecast period, the electrification of class 4-8 vehicles is forecasted to generate savings of nearly $7.3 Million **(Table 73)**. The forecasted cost savings do not include the associated charging infrastructure investments necessary to enable BEV operations. This is exclusively the total cost of ownership of the vehicles.

Table 73: Modeled DSHS Agency-Owned Class 4-8 Lifespan Ownership Costs of BEV Eligible Vehicles

Year	Per Mile Cost – Eligible Only		Lifetime Vehicle Costs – Eligible Only		Lifetime Total Costs – Eligible Only		BEV Savings – Eligible Only
	ICE	BEV	ICE	BEV	ICE Fleet	BEV Fleet	
2023	$0.70	$0.22	$0	$0	$0	$0	$0
2024	$0.70	$0.22	$0	$0	$0	$0	$0
2025	$0.70	$0.22	$561,903	$326,635	$697,356	$405,374	$291,982
2026	$0.71	$0.22	$562,503	$328,401	$746,823	$436,012	$310,812
2027	$0.72	$0.22	$562,594	$333,763	$809,011	$479,951	$329,059
2028	$0.74	$0.22	$562,278	$336,217	$854,810	$511,137	$343,672
2029	$0.75	$0.22	$561,822	$339,657	$869,417	$525,616	$343,800
2030	$0.77	$0.22	$554,785	$329,498	$1,292,323	$767,538	$524,785
2031	$0.78	$0.22	$554,150	$333,138	$1,290,988	$776,102	$514,885
2032	$0.80	$0.22	$554,555	$347,474	$2,849,094	$1,785,192	$1,063,901
2033	$0.82	$0.22	$559,368	$354,869	$862,813	$547,378	$315,435
2034	$0.83	$0.22	$557,722	$357,495	$1,603,157	$1,027,608	$575,549
2035	$0.85	$0.23	$555,469	$358,468	$1,541,420	$994,745	$546,675
2036	$0.87	$0.23	$552,830	$359,417	$804,125	$522,795	$281,330
2037	$0.89	$0.23	$549,810	$360,448	$1,112,308	$729,213	$383,095
2038	$0.91	$0.23	$534,982	$339,636	$1,956,881	$1,242,333	$714,547
2039	$0.93	$0.23	$534,619	$347,917	$1,559,190	$1,014,684	$544,505
2040	$0.95	$0.23	$540,076	$367,291	$635,151	$431,949	$203,202
TOTAL					$19,484,865	$12,197,629	$7,287,235

**Includes vehicle recovery value at time of surplus*

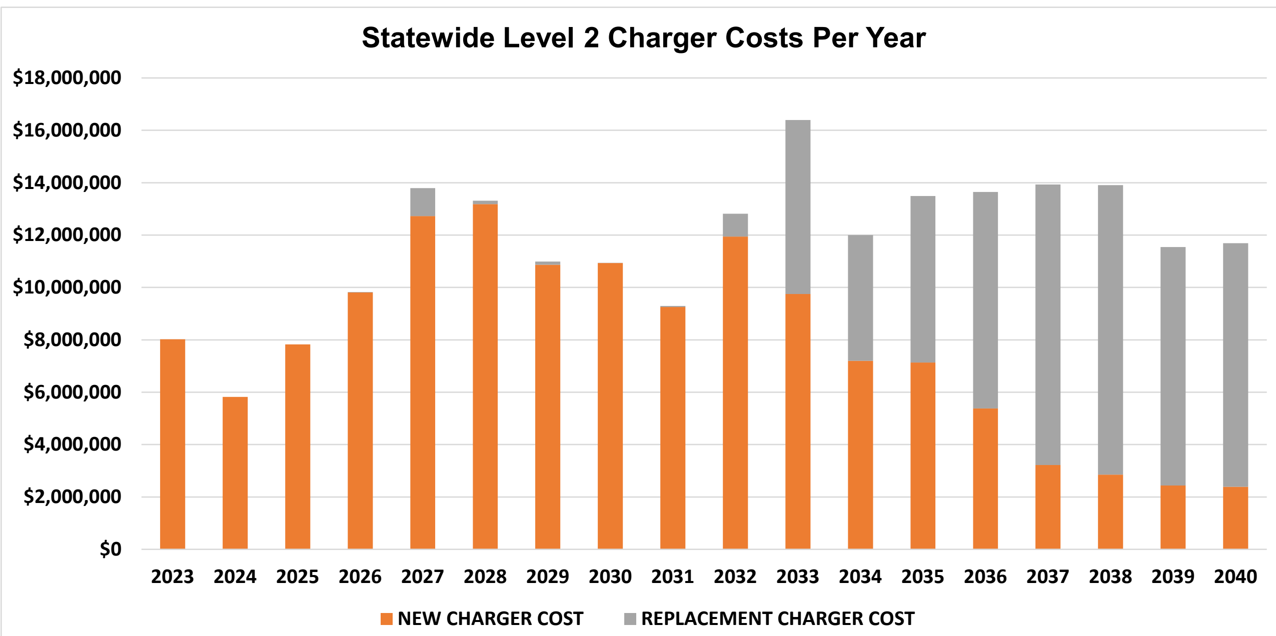
3. Charging Infrastructure

3.1 Level 2 Charging Infrastructure

3.1.1 Overview

Under the modeled scenario, the State of Washington is forecasted to need 8,425 new level 2 networked charging ports and replace approximately 5,216 charging ports by 2040 **(Table 74)**. The 5,216 ports to replace is a mixture of existing ports, estimated off of the existing BEVs in services, and future 'new' ports reaching the end of their 10-year operational lifespan during the forecast period **(Charger Cost Forecast, page 22**). Costs plateau after 2033 due to replacements ports, without associated site preparation costs, dominating level 2 charger installations **(Figure 33)**. Site preparation costs do not include real-estate costs but are solely the cost to provide the physical infrastructure necessary for a level 3 charger installation. The estimated charger needs are based on the vehicle fleets modeled in this report and does not take into consideration already available public charging infrastructure. This forecast should be considered the highest possible cost scenario to deliver the charging infrastructure necessary for BEV adoption.

Figure 33: Modeled Fleets Statewide Level 2 Charger Costs



3.1.2 Level 2 Charger Cost and Distribution

Level 2 network charger costs are forecasted to peak in 2033 with the first wave of charger retirements occurring concurrent with substantial new charger deployments. New charger installations are forecasted to peak in 2028 at 802 charger portals, costing approximately $13.3 Million. Over the forecast period level 2 charger costs are estimated to reach $213.2 Million.

Table 74: Recommended Modeled Fleets Statewide Level 2 Charger Port Count and Cost Per Year

Year	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	532	$8,017,966	0	$0	$8,017,966
2024	381	$5,823,577	0	$0	$5,823,577
2025	514	$7,921,671	0	$0	$7,921,671
2026	710	$11,348,010	1	$11,224	$11,359,234
2027	788	$12,869,562	94	$1,065,596	$13,935,158
2028	802	$13,313,567	11	$125,944	$13,439,511
2029	655	$11,052,392	10	$115,640	$11,168,032
2030	642	$11,097,926	1	$11,680	$11,109,606
2031	533	$9,415,291	3	$35,389	$9,450,680
2032	695	$12,197,651	73	$874,868	$13,072,519
2033	560	$9,936,567	532	$6,647,432	$16,583,999
2034	407	$7,405,993	381	$4,800,107	$12,206,100
2035	393	$7,245,509	513	$6,431,063	$13,676,572
2036	215	$3,938,080	709	$9,491,435	$13,429,515
2037	185	$3,434,435	788	$10,822,823	$14,257,258
2038	157	$2,966,232	803	$11,153,821	$14,120,053
2039	131	$2,514,362	655	$9,252,177	$11,766,538
2040	126	$2,458,174	641	$9,430,773	$11,888,947
TOTAL	8,425	$142,956,965	5216	$70,269,971	$213,226,936

Five counties, Thurston, King, Pierce, Spokane, and Yakima account for 65.8% of the modeled fleets recommended level two charger port installations, with Thurston alone accounting for 27% of all recommended level 2 charger installations **(Table 75)**. A county-by-county breakdown of charger need by year can be found in the **Appendix - A.5 - Modeled Fleets Overall Charging Data** . Individual fleets annual charger needs, expenditures, and top-5 counties can similarly be found in the Appendix under their respective fleets. The below table does not include WSP data because, according to their fleet manager's guidance, 90-95% of vehicles are taken home by employees at night.

Table 75: Modeled Fleets Recommended Level 2 Charging Port Needs/Installations in the Top-5 Counties

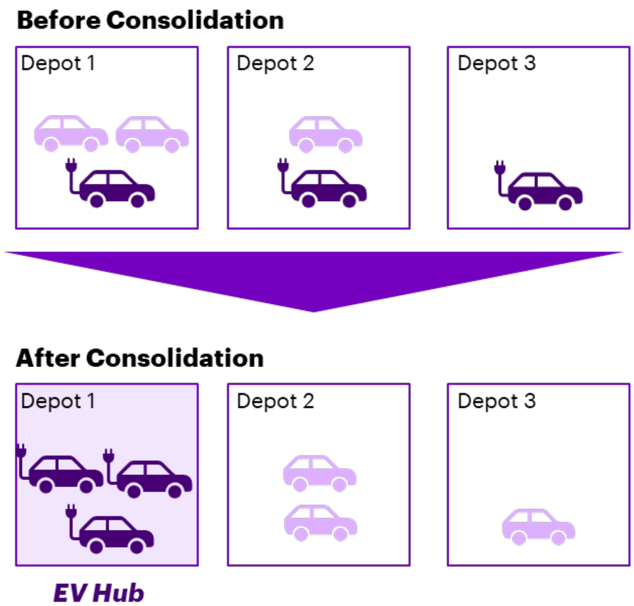
Year	Thurston	King	Pierce	Spokane	Yakima	Top-5 Total
2023	131	56	38	39	37	301
2024	84	36	27	27	24	199
2025	121	52	40	39	34	285
2026	112	48	39	38	32	268
2027	173	74	57	57	49	411
2028	133	59	48	47	39	326
2029	97	44	37	36	28	241
2030	77	35	31	30	22	194
2031	51	25	24	23	16	139
2032	130	57	52	49	38	326
2033	220	96	72	72	63	524
2034	130	58	49	48	38	323
2035	168	74	61	60	48	412
2036	156	69	60	58	45	387
2037	160	70	61	59	46	397
2038	139	63	58	55	40	355
2039	101	47	43	41	29	262
2040	84	39	38	36	24	221
TOTAL	2,266	1,004	836	814	652	5,572
PERCENT OF TOTAL	**26.8%**	**11.9%**	**9.8%**	**9.6%**	**7.7%**	**65.8%**

**Washington State Patrol is excluded due to 90-95% of their employees storing their vehicles at home*
***See Appendix A.5 - Modeled Fleets Overall Charging Data – New Level 2 Charger Needs by County for forecasted charger needs in other counties*

3.1.3 Charger Site Selection and Fleet Management

One of the primary pre-conditions, and a barrier to fleet electrification, is the overall charging infrastructure and charging capacity of the system. Given the gradual nature of fleet electrification and benefits of scale, fleet managers are recommended to prioritize grouping BEV adoption by specific locations, leveraging existing publicly available charging infrastructure, and installing the additional needed charging infrastructure by the grouped locations. Washington State could adopt a 'Depot Consolidation' model, where one location within a specific geography is selected as a 'BEV Hub.' As ICE vehicles within a geography are replaced with BEVs, electrification occurs amongst the mixed ICE/BEV fleet at a hub location first. If an ICE vehicle is retired from a non-hub location, the BEV procured would be assigned to the hub **(Figure 34)**. While the ICE presently at the hub would be re-assigned to the non-hub location. Under such a model, chargers can be installed in the most cost-efficient manner while electrification rates would track overall fleet turnover. However, adopting a hub model is case dependent and necessitates enough vehicles in a location that have roles that can be served by BEV options. It also assumes baseline available infrastructure necessary to build out charging facilities. In these circumstances, fleet managers could look at the vehicles eligible for BEV replacement usage profiles, identify range needs, and assess regional charging access to identify an appropriate vehicle for the role and an operational plan to support its electrification.

Figure 34: BEV Hub Model



A BEV Hub model carries several major advantages including, but not limited to:

- Reduces buildout costs by reducing feasibility studies, installation costs, and utility investments.
- Cuts operational risk by having more chargers at one location, thereby building capacity and reduces risk of failure by incorporating redundancy due to scale.
- Develops understanding of the capabilities required to operate BEV's at scale at a location.

Under this model, a conservate approach of 1:1 vehicle to level 2 network charger ratio could be employed in the near-term. A 1:1 ratio reduces operational risk by allowing for the aggregate charger demand needs at a specific site to be developed and provide flex capacity whereas a 'optimized' location can result in operational constraints if an optimized charging schedule is disrupted. Finally, it is more cost effective to build charging facilities at one time and grow into them as the fleet electrifies further.

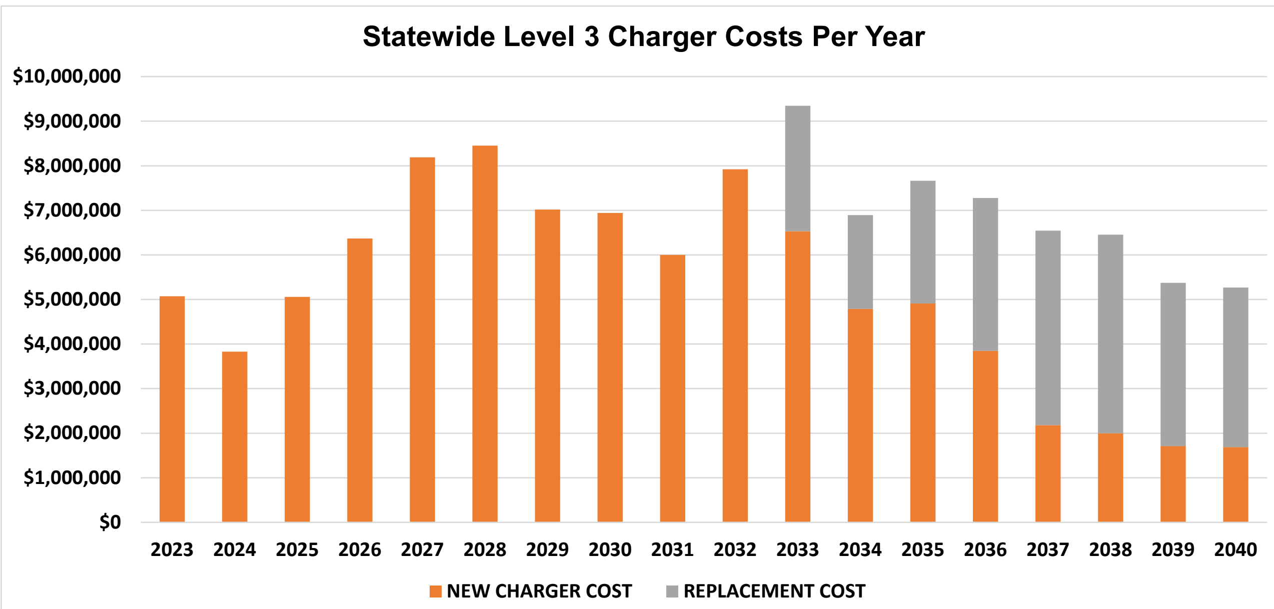
Using the modeled fleets overall charging data by county, DES and SEEP will evaluate hub locations. This will include identifying optimal, centralized hub locations within counties, giving priority to state-owned facilities where current baseline infrastructure can best accommodate new charging facilities and whose long-term usage is most predictable given foreseeable continuation of site operations. We also plan to incorporate overburdened communities in the modeling and giving additional weight to this criteria in the scoring of applications for EVSE funding. If hub charging is located at a specific agency's site, coordination and development of MOU's between agencies as necessary will be supported by SEEP and DES. Best practices for scheduling charging and effective scheduling tools for hub locations will need to be identified and shared.

3.2 Level 3 Charging Infrastructure

3.2.1 Overview

Level 3 charger costs parallel level 2 network costs through 2033 as the number of BEVs increases statewide. However, there is a decline in expenditures in the second half of the forecast period due to the cost differential between installing new level 3 units versus their replacement **(Figure 35)**. The estimated level 3 charger needs are based solely on the overall number of BEV vehicles modeled in this report and the assumed 10:1 vehicle to charger ratio across the fleet. This forecast does not reflect significant potential to generate revenue through high value level 3 charging services, or the potential to use existing public infrastructure to meet fleet charging needs. Siting level 3 chargers will also depend upon the composition of vehicles in each geography. The high energy needs of class 6-8 vehicles will likely necessitate them using a level 3 charger for overnight charging, while during the day it could serve as a 'fast charger' for class 1-4 vehicles.

Figure 35: Modeled Fleets Statewide Level 3 Charger Costs



3.2.1 Charger Cost

Level 3 chargers have extensive infrastructure investment needs to support their higher voltages, resulting in a $96,188 baseline site preparation cost versus the much lower $8,224 for a dual port bollard installation in **(Charger Cost Forecast, page 22**). The cost differential results in replacement costs overtaking new charger costs in 2037 **(Table 76)** where site preparation accounts for much lower share of overall charger costs. Prioritizing sites for level 3 charging that can remain so for multiple equipment lifecycles is therefore critical to ensure the high installation costs are amortized over a longer period.

Table 76: Modeled Fleets Recommended Statewide Level 3 Charger Count and Cost Per Year

Year	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	52	$5,074,356	0	$0	$5,074,356
2024	38	$3,827,858	0	$0	$3,827,858
2025	50	$5,119,887	0	$0	$5,119,887
2026	72	$7,385,441	0	$0	$7,385,441
2027	80	$8,285,289	0	$0	$8,285,289
2028	80	$8,541,646	0	$0	$8,541,646
2029	66	$7,141,897	0	$0	$7,141,897
2030	64	$7,054,315	0	$0	$7,054,315
2031	54	$6,107,340	0	$0	$6,107,340
2032	70	$8,096,844	0	$0	$8,096,844
2033	56	$6,655,744	52	$2,816,885	$9,472,628
2034	40	$4,935,070	38	$2,103,481	$7,038,551
2035	40	$4,987,884	50	$2,784,794	$7,772,678
2036	22	$2,846,423	72	$3,975,707	$6,822,130
2037	18	$2,326,533	80	$4,413,734	$6,740,268
2038	16	$2,074,136	80	$4,502,524	$6,576,661
2039	14	$1,766,753	66	$3,724,770	$5,491,524
2040	12	$1,735,897	64	$3,639,717	$5,375,613
TOTAL	832	$92,227,417	438	$24,321,896	$116,549,313

4. Report Findings, Recommendations, and Strategies

4.1 Fleet Electrification Findings and Recommendations

4.1.1 Classes 1-2a

Class 1-2a have the greatest probability of achieving the electrification goals set forth in the Executive Order. However, the long-expected lifespan of the vehicles in WSDOT, DSHS's agency-owned, and DOC's agency-owned vehicle fleets limit the opportunity to replace ICE vehicles with BEVs *despite their significant forecasted lifespan savings.* Given the substantial per mile cost difference in favor of BEVs, the departments could prioritize electrifying their highest use ICE vehicles first. As BEVs reach price parity, fleet managers could increase BEV procurement to take advantage of operational savings that will accrue even in low usage applications. Within the context of Washington State's current high fuel and low electricity costs environment, the miles traveled necessary to generate savings is very low. While there is currently a scarcity of BEV models in van, truck, and large SUV models, as these models become available, fleets could generate significant lifetime savings by increasing vehicle replacement in the second half of the decade.

4.1.2 Classes 2b-3

Classes 2b and 3 suffer from a lack of availability for truck configurations, significantly curtailing electrification opportunities in the near and medium term. However, electric vans are available and could be procured when possible. The major per mile cost advantage of BEVs means they will provide major savings over a vehicle's lifespan. A price advantage that will only continue to grow as acquisition purchase costs decrease. As availability increases, fleet managers could prioritize BEV adoption in high usage roles and increase fleet turnover to capture the lifetime savings associated with BEVs.

4.1.3 Classes 4-8

Classes 4-8 are the most difficult to electrify due to the high upfront costs of these vehicles and their lower usage profiles compared to classes 1-3. There are many market offerings of class 4 vans and box trucks that could provide substantial savings for fleet operators. However, the critical aspect of achieving cost performance in accordance with SEEP guidance is to increase vehicle utilization to capture the per mile savings of BEVs. Fleet managers could seek vehicle consolidation opportunities and create opportunities for BEVs to travel the miles necessary to recover their higher upfront costs.

4.2 Electric Vehicle Supply Equipment Findings and Recommendations

Assuming a high 1:1 vehicle to charger ratio, the State is forecasted to spend $213.2 Million on networked level 2 charger over the forecast period to support the state modeled vehicle fleet. This is a substantial expenditure that erodes the forecasted $374.8 Million vehicle lifetime costs savings. When paired with the modeled level 3 charger investment needs, $116.5 Million, it would *still* result in a savings of $45.1 Million. However, that is not how this report should be interpreted. The modeled charging investments are based on how charging need can be met by *either* level 2 or 3. An efficient deployment will employ a mixture of the two charging levels and take advantage of existing and future public charging resources. Given each charger modeled is networked, they each will have revenue generating capacities. While this may be very limited in the case of level 2 chargers. Depending on location, level 3 chargers could recover significant revenues by serving the public at large in addition to state fleets. Furthermore, it is critical to note that the significant operational savings predicted by BEVs are contingent upon the low charging costs accessible via state owned EVSE.

However, these challenges are surmountable and small relative to the major benefits of electrification. The baseline assumption of 1:1 vehicle to charger ratio, which guarantees full charge at the start of the workday, curtails conflicts associated with charging on the clock, rights to charge, and charging priority. Additionally, the use of networked charging infrastructure enables the dynamic management of charging infrastructure in the future as the ratio of vehicles to chargers increases, providing charger availability and vehicle charge data to support the active management of charging resources.

High upfront costs of charging infrastructure and the lead time needed to build the infrastructure to support BEV operations is a major source of risk for delaying BEV adoption. The usage of a BEV hub model mitigates this risk by maximizing the number of charger installations relative to time and fiscal investments, ensuring faster rates of charger deployment. Additionally, the hub model will reduce the demand for charge at home resources by providing geography-based charging resources to support electrification of vehicles taken home at night. However, before making any hub investments, consideration should be given to forthcoming directives concerning the reduction of occupied space. Hub facilities should be located at sites where the operations are expected to remain for a long duration of time, to maximize the return on charger investments. Therefore, state owned facilities should likely receive priority over leased facilities. Given the fleet with the most vehicles that overnight at employees' residences, and the use of their vehicles occurring on heavily trafficked corridors, the State could take advantage of forthcoming National Electric Vehicle Infrastructure funding investments in level 3 chargers on federally designated Alternative Fuel Corridors to support initial WSP electrification. The state could supplement this coverage with state investments in level 3 charging resources on non-designated corridors, as the WSP continues to electrify.

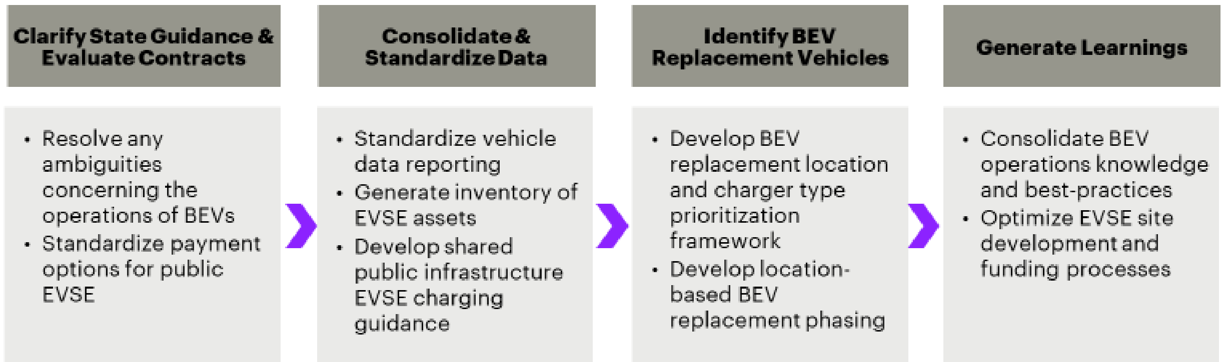
4.3 Additional recommendations and strategies to overcome electrification barriers to state vehicle fleets

4.3.1 Data Reporting and General Recommendations

Reporting vehicle usage and cost profiles across fleets would assist in generating reliable replacement forecast, estimating lifetime operating costs of vehicles, and prioritizing vehicles for replacement. The key reporting requirements should be annual mileage or hours, the vehicle's retirement criteria, and standardized reporting of vehicle make, model, year, and service role. If possible, the time-of-day usage profile should also be reported. Vehicle fuel utilization would be the best data point for calculating GHG reductions. Additional information concerning a vehicle's assigned location and the viability of installing charging infrastructure should collected, too. Critical location information includes whether the facility is leased or owned, whether the parking infrastructure is structured or surface, whether the location is in a historically disadvantaged area, or an area disproportionately burdened by air pollution, and if location has multiple parking lots or a parking garage. From the aforementioned information, the replacement ICE vehicles and provision of charging infrastructure can be pursued in the most cost-effective manner by understanding charging needs and the locations of their provision. Additionally, areas with air pollution burdens could be prioritized for BEV investments to address these existing issues or to invest in workforce development, and opportunities in disadvantaged regions. Finally, all charging infrastructure will need to consider ADA requirements as specified by the U.S. Access Board. **Figure36,** below, summarizes the general strategy to address barriers to electrification identified in **Table 77.**

DES/SEEP is developing a baseline implementation template to guide agencies through their early adoption phase. The template will incorporate metric and reporting needs as identified in the report, as well as categories deemed essential for EVSE and EV fleet planning. It will also guide agencies through the useful portions of the overall implementation strategy contained in this report. In order to gauge the depth of resources required by agencies a questionnaire was sent to all Executive and Small Cabinet agencies. It was designed to obtain initial feedback on agency overall EV readiness, preferred template tools and formatting. An outline of the template, meeting topics, and schedule will be emailed to participants and posted to the SEEP website to ensure maximum participation. The Interagency EV Coordinating Council, Current Facilities workgroup, and SEEP Governing Council will be notified of the implementation template creation and a link to the draft template. All comments from members and the template development, including responses addressing how the input was considered or used will be published to the SEEP website. Upon incorporating stakeholder input, the template design will be published on the SEEP website including contact information to obtain further feedback. These groups will be encouraged to review and provide feedback. This feedback will be incorporated, and response information will be shared. Once the template is finalized, a link will be included in the final implementation strategy report to the legislature.

Figure 36: BEV Transition Strategy



In addition to vehicle availability and electric vehicle supply equipment, there are other significant barriers facing state vehicle fleet electrification including, but not limited to:

Table 77: State Barriers to BEV adoption

Barrier	Strategy Recommendation	Owning Authority
Unclear statewide guidance and directives for charging on the clock.	• Work with Office of Financial Management (OFM) to implement statewide policy and framework and clarify how “routine” is defined in WAC 194-28-070	Office of Financial Management
Unclear statewide directives for rights to charge.	• Work with Office of Financial Management (OFM) to implement statewide policy and framework.	Office of Financial Management
Unclear statewide guidance on usage reporting requirements for EVSE installations and management.	• Work with Office of Financial Management (OFM) to implement statewide policy and framework.	Office of Financial Management
Unclear statewide guidance for hierarchy of charging priority	• Work with Office of Financial Management (OFM) to implement statewide policy and framework.	Office of Financial Management
Unclear statewide guidance relating to take home vehicle charging for state vehicle fleets and associated electricity and installation cost reimbursement to state employee	• Work with Office of Financial Management (OFM) to implement statewide policy and framework.	Office of Financial Management
Lack of central repository of current state owned and managed EVSE that can be shared amongst state agencies	• Invest in development and implementation of a central repository, or interactive map, of state-owned EVSE charging assets. • Educate state agencies on best practices for trip planning and vehicle operations.	Department of Enterprise Service, Department of Transportation, Department of Commerce
Multiple payment options for public facing EVSE, requiring state agencies to acquire/maintain multiple active membership cards (i.e., ChargePoint, Shell Recharge, Sema Connect, EVgo, etc.).	• Develop uniform standards for payment options for EVSE infrastructure and ensure state vehicle fleet cards have capability to function as chip readers for use at all EVSE network stations. • Evaluate state fuel cards contract specifications to enable payment at public charging infrastructure, modify contract as needed to ensure charger accessibility across providers.	Office of Financial Management, Department of Commerce
Installing EVSE at multi-tenant buildings or leased facilities	• Develop analysis framework and criteria for charger installations including but not limited to publicly available infrastructure, state charging resources, lease duration, and vehicle usage profile.	

Planning for higher BEV and EVSE upfront costs	• Develop strategy to leverage existing/future funding opportunities including grants, rebates, and tax credits for vehicle purchases and infrastructure development. • Review/evaluate existing vehicle fleets to identify vehicle role consolidation or “right sizing” opportunities to facilitate BEV cost recovery via greater vehicle utilization. • Explore leasing versus purchase for low utilization vehicle roles. • Work with state programs budget analysts to prepare for the upfront acquisition cost for BEVs and EVSE infrastructure. • Develop budget requests and/or decision packets for BEV adoption and EVSE development.	Office of Financial Management, Department of Enterprise Services
Lack of central repository of state fleet vehicles and usage metrics	• Professionally managed state vehicle fleets should standardize data reporting. Mileage, fuel/electricity costs, maintenance costs, and operational costs should be reported annually. Vehicle replacement policy and existing practices should be specified for each vehicle.	State agencies that manage their own state-owned vehicle fleets
Inadequate funding to replace vehicles at time of recommended retirement	• Increase funding for vehicle procurement to ensure the timely retirement of vehicles at age/mileage retirement criteria. • Assess ‘optimal’ retirement criteria for vehicle purchases based on estimated fuel, depreciation, maintenance, and operational costs.	

Appendix A:
State Level Summary Data

A.1 - Fleet Vehicle Counts by Classification

Classification	DES	WSP	WSDOT	DOC	DSHS
SEDAN 1	1420	228	227	200	57
SUV 1	1033	18	81	109	33
SUV 2a	320	9	2	124	29
TRUCK 1	66	4	204	24	24
TRUCK 2a	280	13	596	39	60
VAN 1	277	11	46	45	94
VAN 2a	0	0	0	0	0
PURSUIT SUV 1	319	1013	0	41	0
PURSUIT SUV 2a	0	156	0	0	0
PURSUIT TRUCK 2a	0	78	0	0	0
TRUCK 2b	57	21	259	28	32
VAN 2b	186	12	101	202	151
CLASS 3	49	35	316	69	42
CLASS 4	11	8	234	11	20
CLASS 5	1	0	80	12	2
CLASS 6	4	0	13	28	12
CLASS 7	3	0	0	0	0
CLASS 8	14	8	789	58	30

A.2 - Modeled Fleets Overall Class 1-2a Fleet Data

Year	ICE PURCHASE	TOTAL ICE	BEV PURCHASES	TOTAL BEV	TOTAL FLEET	BEV PERCENT	GOAL PERCENT
2023	445	6,553	532	727	7,280	10%	26%
2024	383	6,204	348	1,076	7,280	15%	33%
2025	399	5,765	444	1,515	7,280	21%	40%
2026	161	5,213	563	2,067	7,280	28%	47%
2027	38	4,594	729	2,686	7,280	37%	54%
2028	0	3,940	698	3,340	7,280	46%	61%
2029	0	3,432	577	3,848	7,280	53%	68%
2030	0	2,917	603	4,363	7,280	60%	75%
2031	0	2,490	562	4,790	7,280	66%	80%
2032	0	1,981	749	5,299	7,280	73%	85%
2033	0	1,571	944	5,709	7,280	78%	90%
2034	0	1,264	723	6,016	7,280	83%	95%
2035	0	968	775	6,312	7,280	87%	100%
2036	0	756	739	6,524	7,280	90%	100%
2037	0	658	705	6,622	7,280	91%	100%
2038	0	582	686	6,698	7,280	92%	100%
2039	0	514	597	6,766	7,280	93%	100%
2040	0	453	614	6,827	7,280	94%	100%

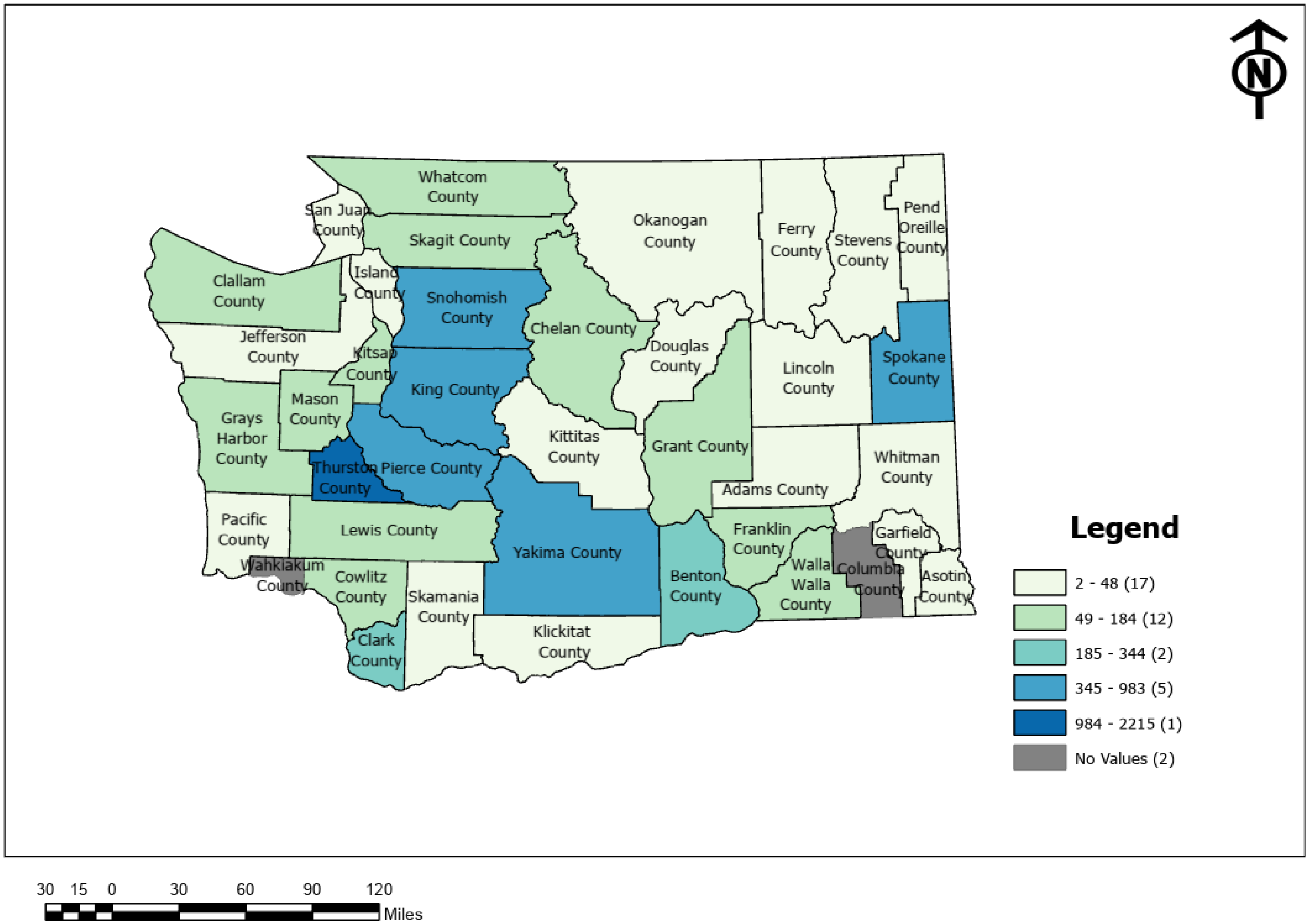
A.3 - Modeled Fleets Overall Class 2b-3 Fleet Data

Year	ICE PURCHASE	TOTAL ICE	BEV PURCHASES	TOTAL BEV	TOTAL FLEET	BEV PERCENT	GOAL PERCENT
2023	151	1,560	0	0	1,560	0%	4%
2024	66	1,528	32	32	1,560	2%	8%
2025	60	1,462	66	98	1,560	6%	11%
2026	58	1,406	57	154	1,560	10%	15%
2027	54	1,341	66	219	1,560	14%	19%
2028	0	1,228	114	332	1,560	21%	23%
2029	0	1,119	112	441	1,560	28%	26%
2030	0	1,020	103	540	1,560	35%	30%
2031	0	941	86	619	1,560	40%	35%
2032	0	836	114	724	1,560	46%	40%
2033	0	717	130	843	1,560	54%	45%
2034	0	646	89	914	1,560	59%	50%
2035	0	579	107	981	1,560	63%	55%
2036	0	517	96	1043	1,560	67%	64%
2037	0	461	98	1099	1,560	70%	73%
2038	0	406	98	1154	1,560	74%	82%
2039	0	364	86	1196	1,560	77%	91%
2040	0	319	86	1241	1,560	80%	100%

A.4 - Modeled Fleets Overall Class 4-8 Fleet Data

Year	ICE PURCHASE	TOTAL ICE	BEV PURCHASES	TOTAL BEV	TOTAL FLEET	BEV PERCENT	GOAL PERCENT
2023	62	1338	0	0	1338	0%	6%
2024	54	1338	0	0	1338	0%	13%
2025	51	1330	8	8	1338	1%	19%
2026	54	1319	12	19	1338	1%	25%
2027	57	1308	11	30	1338	2%	31%
2028	46	1281	26	57	1338	4%	38%
2029	46	1255	26	83	1338	6%	44%
2030	47	1228	28	110	1338	8%	50%
2031	47	1201	26	137	1338	10%	55%
2032	47	1166	35	172	1338	13%	60%
2033	47	1135	31	203	1338	15%	65%
2034	46	1108	28	230	1338	17%	70%
2035	46	1078	30	260	1338	19%	75%
2036	44	1053	25	285	1338	21%	80%
2037	43	1023	30	315	1338	24%	85%
2038	41	1000	24	338	1338	25%	90%
2039	40	979	21	359	1338	27%	95%
2040	39	961	19	377	1338	28%	100%

A.5 - Modeled Fleets Overall Charging Data – New Level 2 Charging Port Needs by County

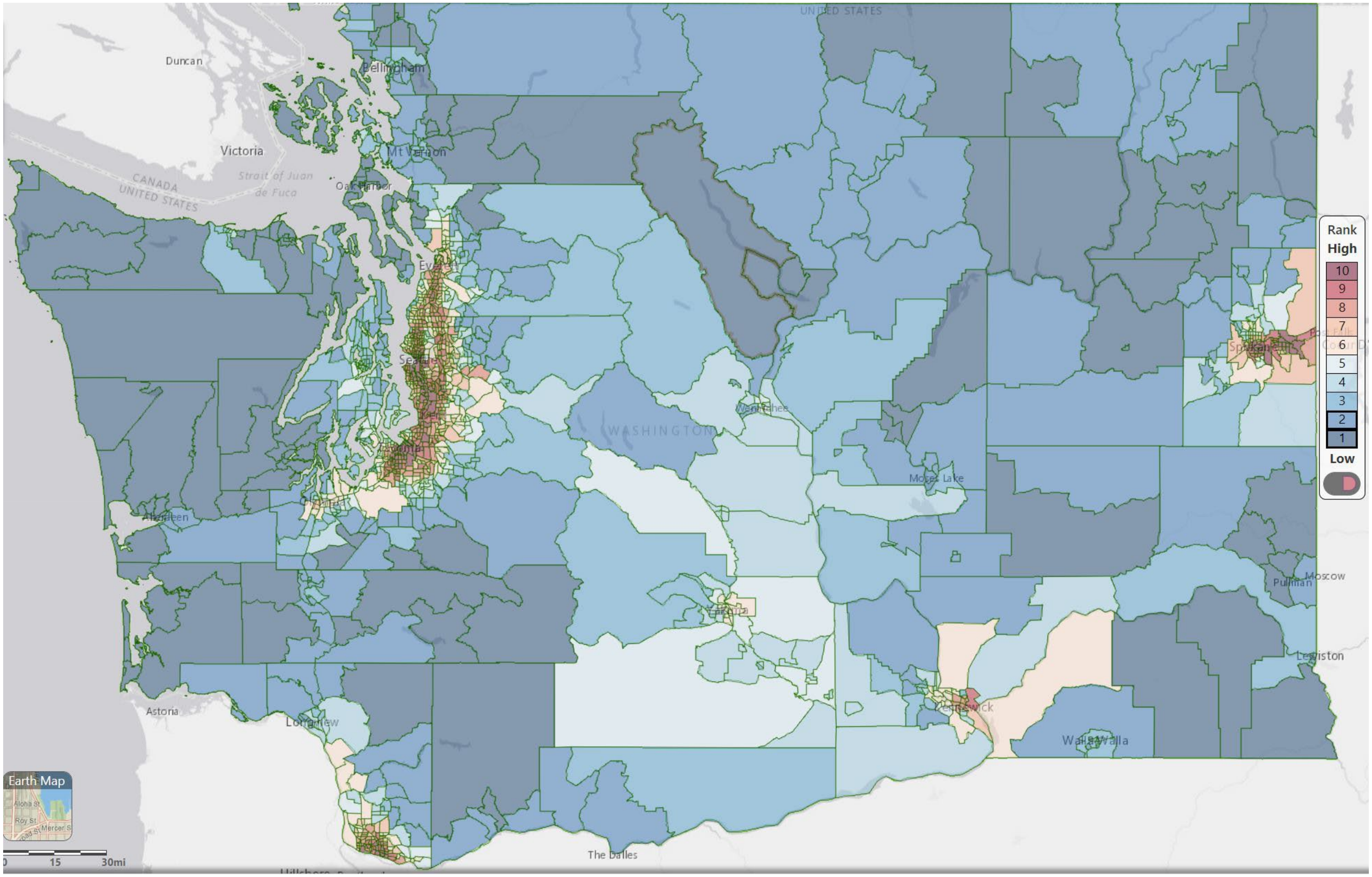


YEAR	THURSTON	KING	PIERCE	SPOKANE	YAKIMA	SNOHOMISH	CLARK	BENTON	KITSAP	SKAGIT
2023	131	56	38	39	37	26	20	14	11	8
2024	84	36	27	27	24	19	13	9	7	5
2025	121	52	40	39	34	28	18	13	10	8
2026	112	48	39	38	32	28	17	11	9	7
2027	173	74	57	57	49	40	26	18	15	11
2028	133	59	48	47	39	35	21	13	11	9
2029	97	44	37	36	28	28	15	9	8	7
2030	77	35	31	30	22	24	12	7	6	5
2031	51	25	24	23	16	18	8	5	4	4
2032	130	57	52	49	38	36	20	13	11	9
2033	220	96	72	72	63	52	34	23	19	15
2034	130	58	49	48	38	37	20	13	11	9
2035	168	74	61	60	48	45	26	17	14	11
2036	156	69	60	58	45	44	24	15	13	11
2037	160	70	61	59	46	45	25	16	13	11
2038	139	63	58	55	40	44	22	13	11	10
2039	101	47	43	41	29	35	16	9	8	7
2040	84	39	38	36	24	32	14	7	6	6
TOTAL	2,266	1,004	8,36	814	652	616	352	225	188	153
PERCENT OF TOTAL	26.8%	11.9%	9.8%	9.6%	7.7%	7%	4%	3%	2%	2%

YEAR	WHATCOM	CHELAN	GRAYS HARBOR	GRANT	COWLITZ	WALLA WALLA	LEWIS	CLALLAM	FRANKLIN
2023	9	7	8	9	9	6	7	6	5
2024	6	5	5	5	5	4	4	4	4
2025	8	7	7	8	7	5	6	5	5
2026	7	6	6	6	6	5	5	5	5
2027	11	9	8	10	9	6	7	6	6
2028	9	7	7	7	7	5	6	5	5
2029	6	6	6	6	5	4	4	4	4
2030	5	4	5	4	4	4	4	4	4
2031	3	3	4	3	3	3	3	3	3
2032	9	7	7	7	7	6	5	5	5
2033	15	12	12	13	12	10	10	9	9
2034	9	7	9	8	7	7	6	6	7
2035	11	9	10	11	10	8	8	8	7
2036	10	9	10	10	9	8	8	7	8
2037	10	9	10	10	9	8	8	7	7
2038	9	8	10	8	8	8	7	7	8
2039	7	6	8	6	6	7	5	6	6
2040	5	5	8	5	5	7	4	5	6
TOTAL	149	127	139	137	126	112	107	103	103
PERCENT OF TOTAL	2%	1%	1.4%	1.4%	1.2%	1.1%	1.1%	1.0%	1.0%

YEAR	MASON	DOUGLAS	KITTITAS	JEFFERSON	OKANOGAN	STEVENS	WHITMAN	ALL OTHER
2023	5	4	4	2	2	2	2	7
2024	4	2	2	2	1	1	1	4
2025	5	3	3	2	2	2	2	6
2026	5	3	3	2	2	2	1	5
2027	6	4	4	2	3	2	2	8
2028	5	3	3	2	2	2	2	6
2029	4	2	2	2	2	1	1	4
2030	4	2	2	2	1	1	1	4
2031	3	1	1	1	1	1	1	3
2032	5	3	3	2	2	2	2	6
2033	9	5	5	4	3	3	3	10
2034	6	3	3	3	2	2	2	6
2035	7	4	4	3	3	3	2	8
2036	7	4	4	3	3	2	2	8
2037	7	4	4	3	3	2	2	8
2038	8	3	3	3	2	2	2	7
2039	6	3	3	3	2	2	1	5
2040	6	2	2	3	2	1	1	4
TOTAL	101	57	56	43	37	34	30	109
PERCENT OF TOTAL	1.0%	0.6%	0.6%	0.4%	0.4%	0.3%	0.3%	1.1%

A.6 – Department of Health Environmental Health Disparities Map – Environmental Effects

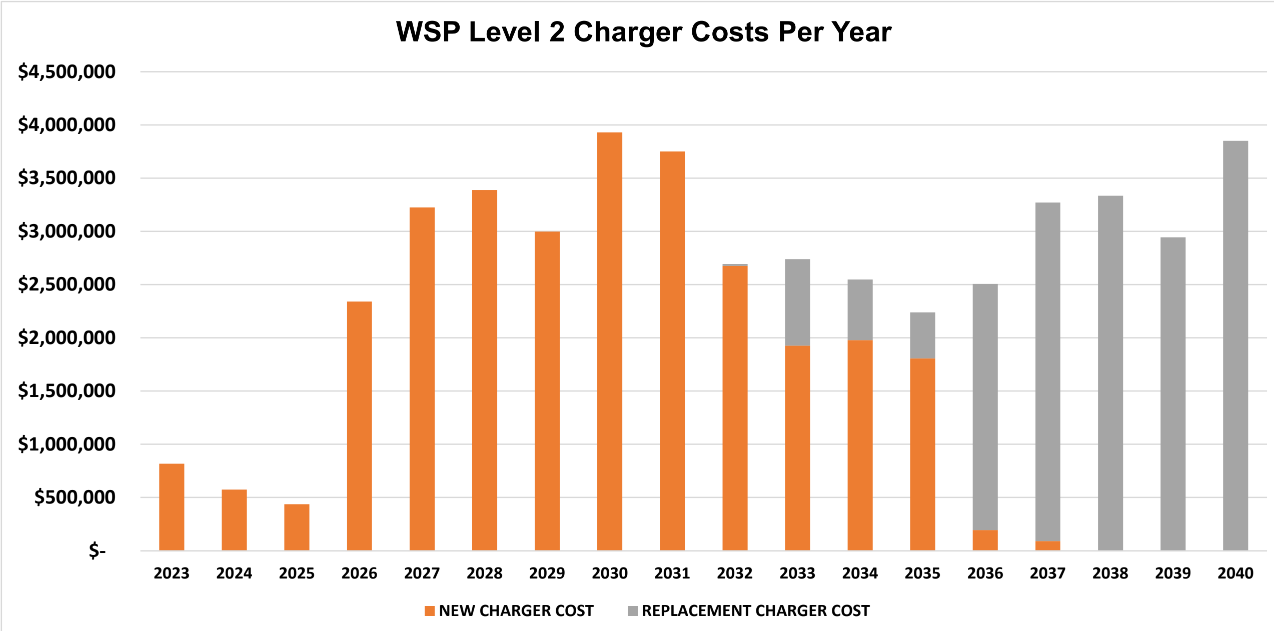


Appendix B - Fleet Summary Data

B.1 - Washington State Patrol Charging Data

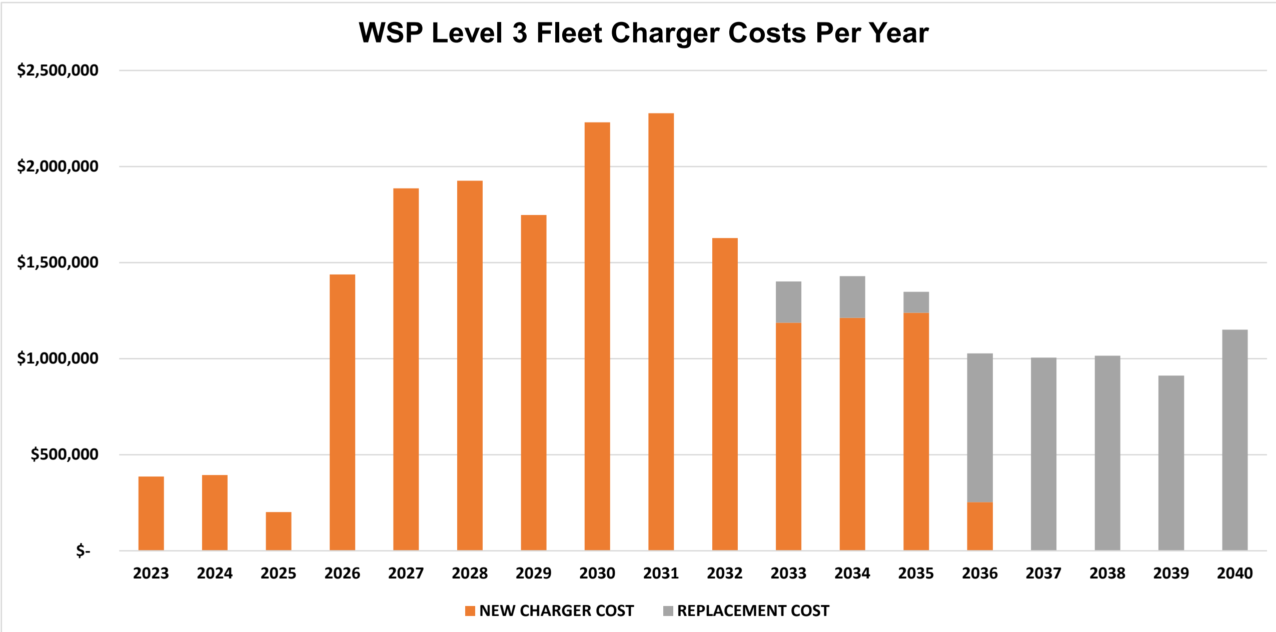
B.1.1 - WSP Forecasted Level 2 Charger Needs

Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	47	$817,000	0	$0	$817,000
2024	33	$574,206	0	$0	$574,206
2025	25	$436,752	0	$0	$436,752
2026	131	$2,340,287	0	$0	$2,340,287
2027	178	$3,224,990	0	$0	$3,224,990
2028	184	$3,389,041	0	$0	$3,389,041
2029	161	$2,998,903	0	$0	$2,998,903
2030	209	$3,930,414	0	$0	$3,930,414
2031	197	$3,751,962	0	$0	$3,751,962
2032	139	$2,678,334	1	$17,032	$2,695,366
2033	99	$1,928,845	47	$812,809	$2,741,654
2034	100	$1,981,639	33	$569,878	$2,551,516
2035	90	$1,808,751	25	$432,560	$2,241,311
2036	10	$195,757	131	$2,312,923	$2,508,680
2037	5	$93,567	178	$3,180,418	$3,273,986
2038	0	$2,436	184	$3,334,873	$3,337,309
2039	0	$2,223	161	$2,944,382	$2,946,605
2040	0	$2,082	209	$3,850,185	$3,852,267
TOTAL	1,608	$30,157,188	968	$17,455,061	$47,612,249



B.1.2 - WSP Forecasted Level 3 Charger Needs

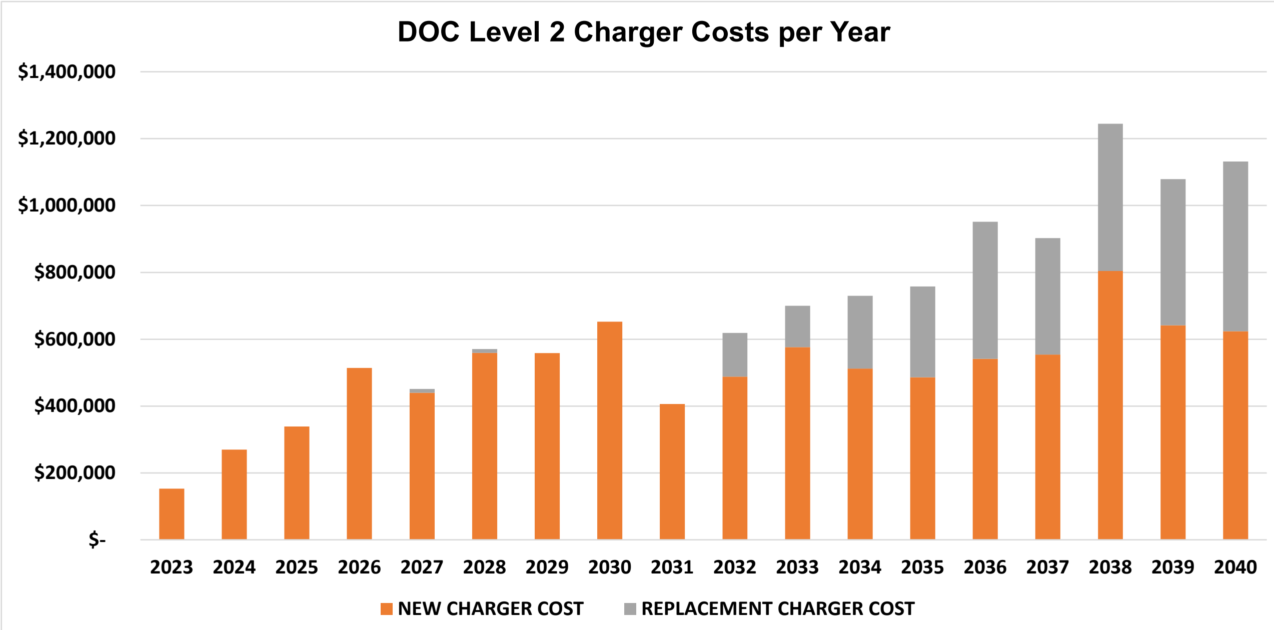
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	4	$386,718	0	$0	$386,718
2024	4	$394,567	0	$0	$394,567
2025	2	$201,309	0	$0	$201,309
2026	14	$1,438,059	0	$0	$1,438,059
2027	18	$1,887,043	0	$0	$1,887,043
2028	18	$1,926,137	0	$0	$1,926,137
2029	16	$1,747,772	0	$0	$1,747,772
2030	20	$2,230,434	0	$0	$2,230,434
2031	20	$2,277,343	0	$0	$2,277,343
2032	14	$1,627,833	0	$0	$1,627,833
2033	10	$1,187,435	4	$214,675	$1,402,110
2034	10	$1,212,779	4	$216,822	$1,429,602
2035	10	$1,238,791	2	$109,495	$1,348,286
2036	2	$253,098	14	$774,131	$1,027,229
2037	0	$0	18	$1,005,265	$1,005,265
2038	0	$0	18	$1,015,317	$1,015,317
2039	0	$0	16	$911,529	$911,529
2040	0	$0	20	$1,150,806	$1,150,806
TOTAL	162	$18,009,317	76	$4,247,235	$22,256,552


WSP Level 3 Fleet Charger Costs Per Year
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
NEW CHARGER COST
REPLACEMENT COST

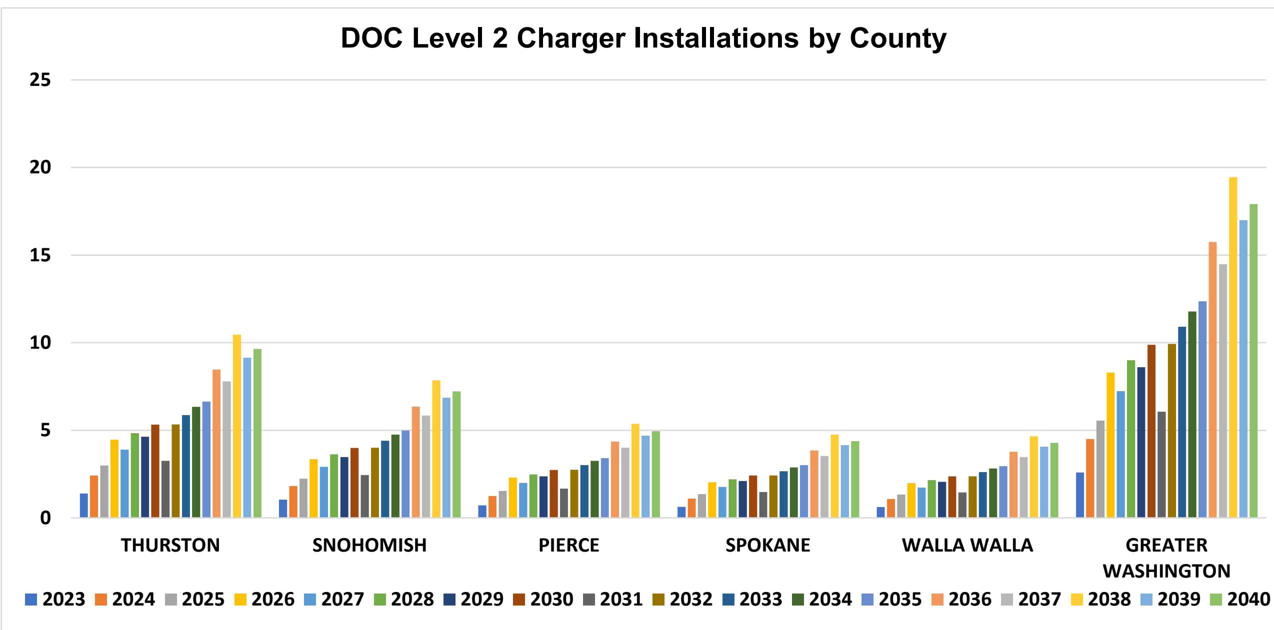
B.2 - Department of Corrections Charging Data

B.2.1 - DOC Agency-Owned Forecasted Level 2 Charger Needs

Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	10	$153,176	0	$0	$153,176
2024	18	$269,898	0	$0	$269,898
2025	24	$373,739	0	$0	$373,739
2026	38	$597,230	0	$0	$597,230
2027	31	$488,726	1	$11,336	$500,062
2028	37	$598,396	1	$11,449	$609,846
2029	37	$609,720	0	$0	$609,720
2030	43	$713,525	0	$0	$713,525
2031	27	$455,305	0	$0	$455,305
2032	33	$556,618	11	$131,058	$687,676
2033	37	$642,407	10	$124,112	$766,518
2034	33	$577,063	18	$217,499	$794,562
2035	31	$549,199	24	$299,519	$848,718
2036	32	$584,650	38	$475,950	$1,060,600
2037	38	$698,504	31	$387,268	$1,085,773
2038	45	$858,860	37	$471,441	$1,330,301
2039	36	$689,134	37	$477,555	$1,166,689
2040	34	$670,810	43	$555,547	$1,226,357
TOTAL	585	$10,086,960	253	$3,162,735	$13,249,695



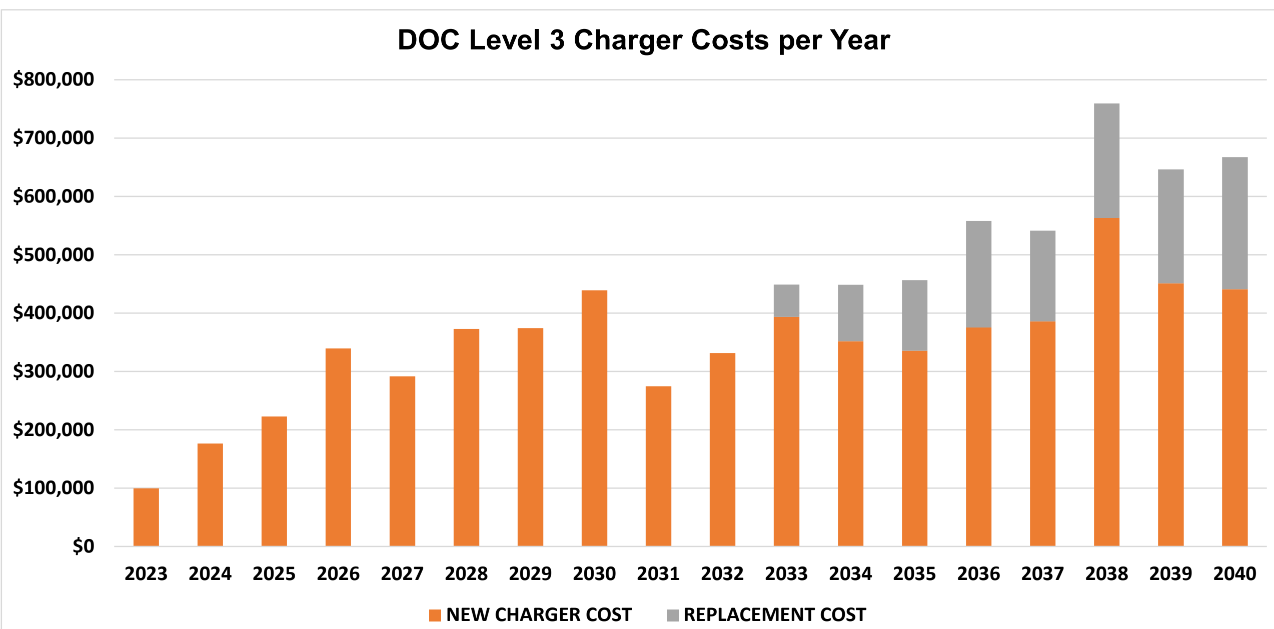
DOC Level 2 Charger Costs per Year
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$-
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040
NEW CHARGER COST
REPLACEMENT CHARGER COST



DOC Level 2 Charger Installations by County
25
20
15
10
5
0
THURSTON
SNOHOMISH
PIERCE
SPOKANE
WALLA WALLA
GREATER WASHINGTON
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

B.2.2 - DOC Agency-Owned Forecasted Level 3 Charger Needs

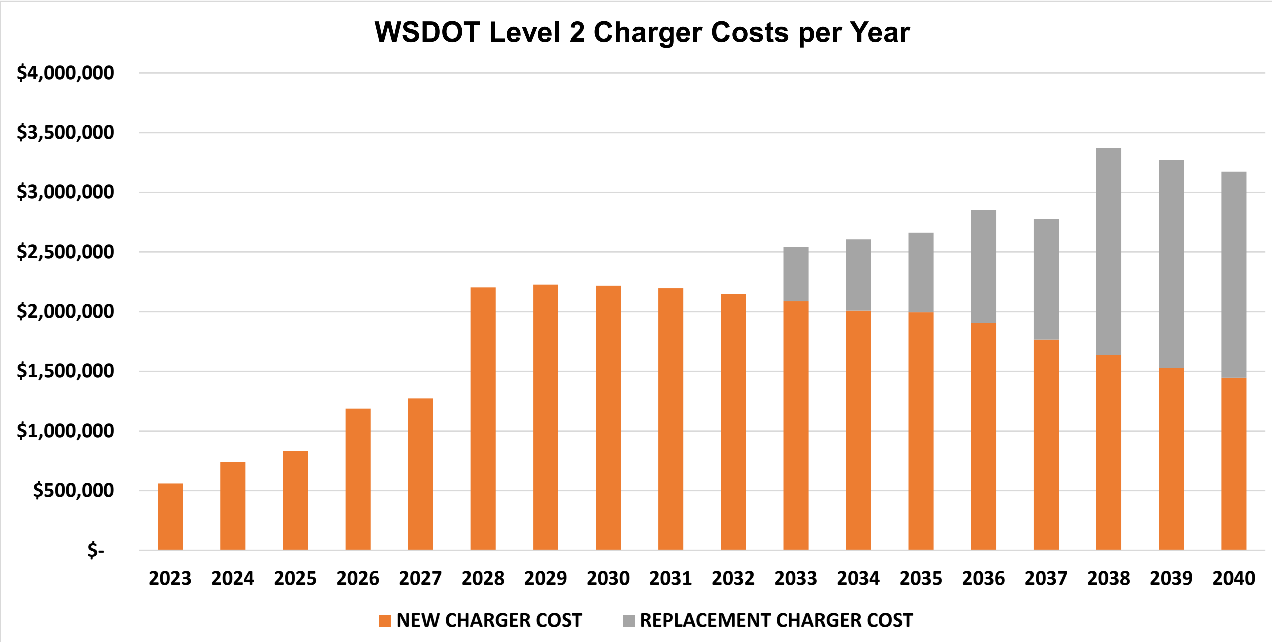
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	2	$99,713	0	$0	$99,713
2024	2	$176,524	0	$0	$176,524
2025	2	$245,596	0	$0	$245,596
2026	4	$394,323	0	$0	$394,323
2027	4	$324,222	0	$0	$324,222
2028	4	$398,880	0	$0	$398,880
2029	4	$408,383	0	$0	$408,383
2030	4	$480,217	0	$0	$480,217
2031	2	$307,914	0	$0	$307,914
2032	4	$378,259	0	$0	$378,259
2033	4	$438,686	2	$55,353	$494,039
2034	4	$395,991	2	$97,003	$492,995
2035	4	$378,718	2	$133,584	$512,302
2036	4	$405,146	4	$212,271	$617,417
2037	4	$486,428	4	$172,720	$659,148
2038	4	$601,051	4	$210,260	$811,311
2039	4	$484,659	4	$212,987	$697,646
2040	4	$474,110	4	$247,771	$721,880
TOTAL	56	$6,404,711	20	$1,094,178	$7,498,889

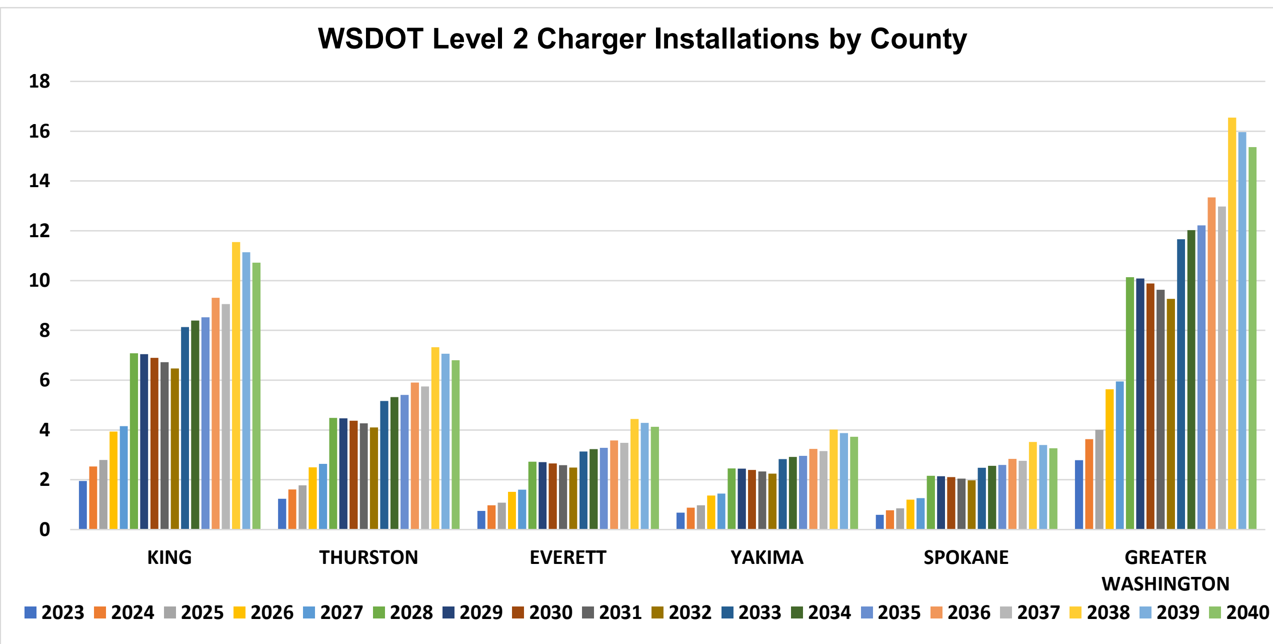


B.3 - Washington State Department of Transportation Charging Data

B.3.1 - WSDOT Forecasted Level 2 Charger Needs

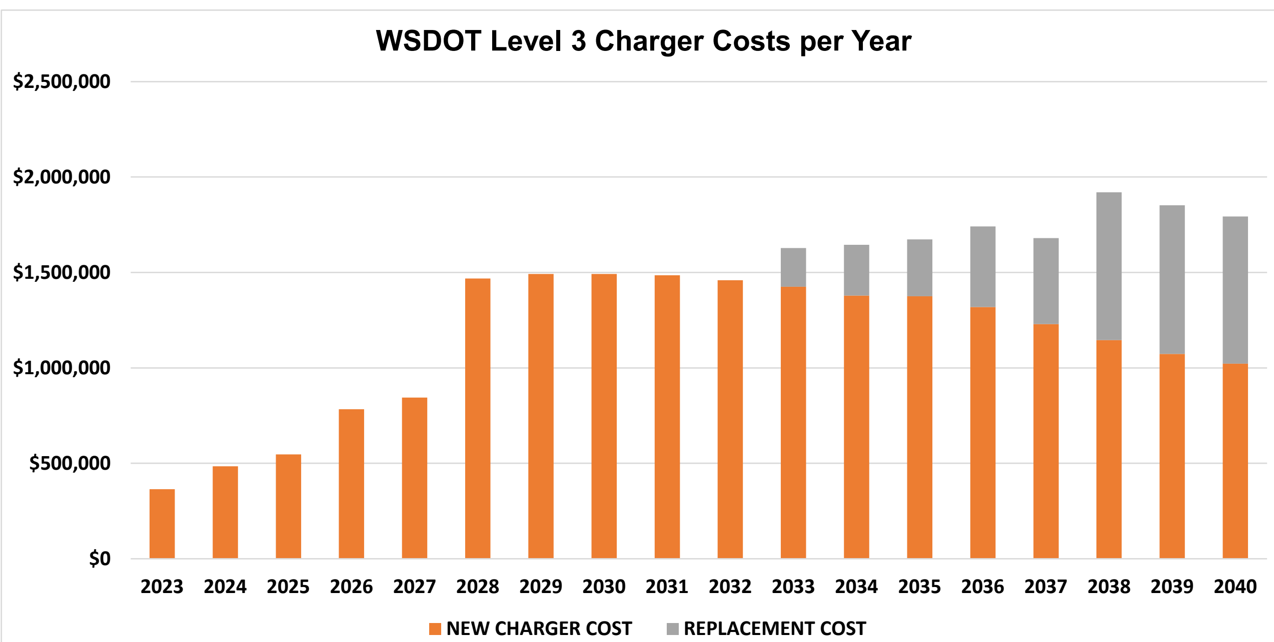
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	38	$560,734	0	$0	$560,734
2024	49	$740,642	0	$0	$740,642
2025	58	$881,154	0	$0	$881,154
2026	80	$1,245,811	0	$0	$1,245,811
2027	85	$1,340,845	0	$0	$1,340,845
2028	142	$2,281,131	0	$0	$2,281,131
2029	142	$2,310,402	0	$0	$2,310,402
2030	139	$2,306,292	0	$0	$2,306,292
2031	136	$2,289,820	0	$0	$2,289,820
2032	131	$2,245,119	0	$0	$2,245,119
2033	126	$2,187,761	38	$454,338	$2,642,098
2034	119	$2,109,007	49	$596,850	$2,705,857
2035	111	$2,001,404	58	$706,168	$2,707,572
2036	104	$1,907,255	80	$992,822	$2,900,077
2037	95	$1,766,470	85	$1,062,492	$2,828,963
2038	87	$1,635,058	142	$1,797,168	$3,432,226
2039	79	$1,520,264	142	$1,809,593	$3,329,857
2040	74	$1,436,728	139	$1,795,666	$3,232,394
TOTAL	1,795	$30,765,897	732	$9,215,097	$39,980,994


WSDOT Level 2 Charger Costs per Year
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040
NEW CHARGER COST
REPLACEMENT CHARGER COST


WSDOT Level 2 Charger Installations by County
18
16
14
12
10
8
6
4
2
0
KING
THURSTON
EVERETT
YAKIMA
SPOKANE
GREATER WASHINGTON
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

B.3.2 - WSDOT Forecasted Level 3 Charger Needs

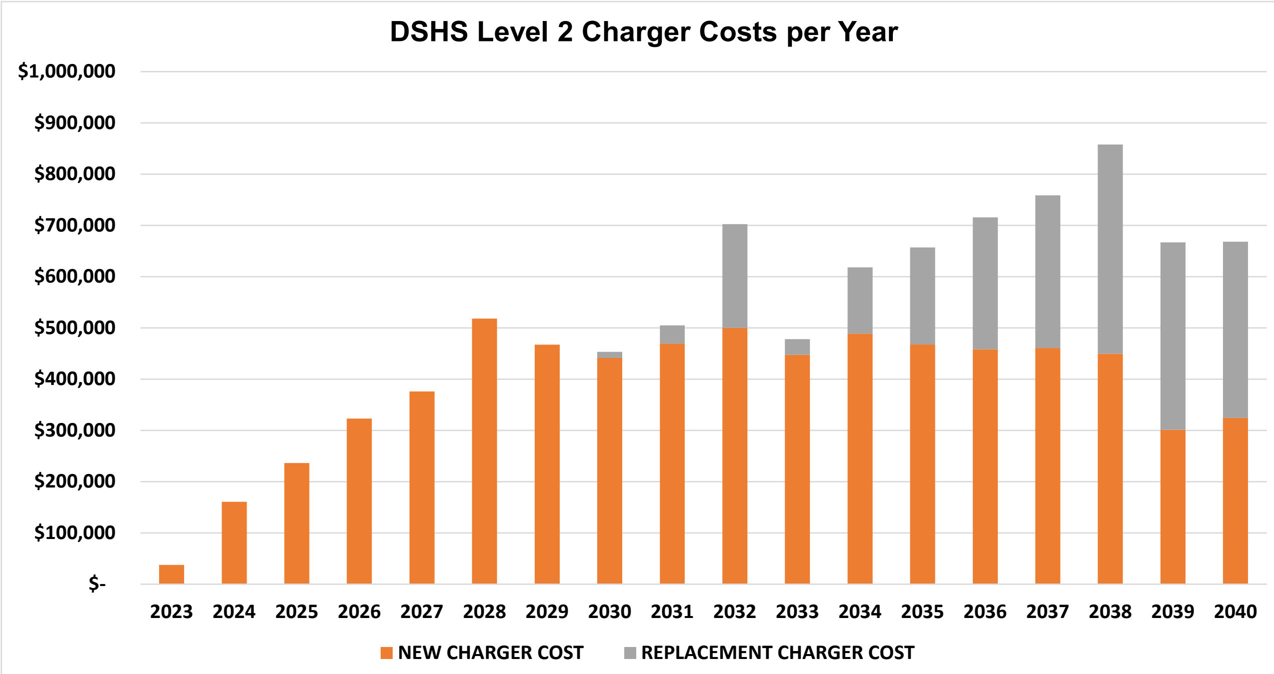
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	4	$365,023	0	$0	$365,023
2024	4	$484,408	0	$0	$484,408
2025	6	$579,035	0	$0	$579,035
2026	8	$822,551	0	$0	$822,551
2027	8	$889,522	0	$0	$889,522
2028	14	$1,520,560	0	$0	$1,520,560
2029	14	$1,547,478	0	$0	$1,547,478
2030	14	$1,552,181	0	$0	$1,552,181
2031	14	$1,548,560	0	$0	$1,548,560
2032	14	$1,525,708	0	$0	$1,525,708
2033	12	$1,493,977	4	$202,632	$1,696,609
2034	12	$1,447,239	4	$266,192	$1,713,431
2035	12	$1,380,133	6	$314,947	$1,695,080
2036	10	$1,321,674	8	$442,793	$1,764,467
2037	10	$1,230,145	8	$473,866	$1,704,011
2038	8	$1,144,253	14	$801,527	$1,945,780
2039	8	$1,069,181	14	$807,068	$1,876,249
2040	8	$1,015,439	14	$800,857	$1,816,296
TOTAL	172	$19,921,629	60	$3,309,025	$23,230,654

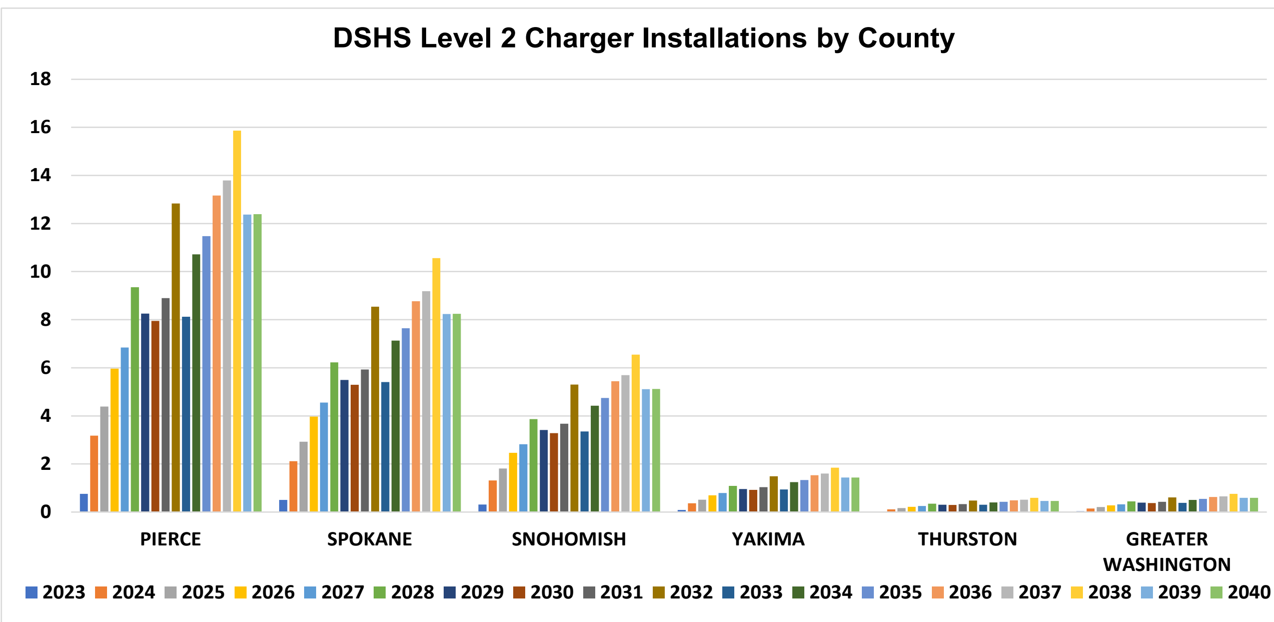


B.4 - Department of Social and Health Services Charging Data

B.4.1 - DSHS Agency-Owned Forecasted Level 2 Charger Needs

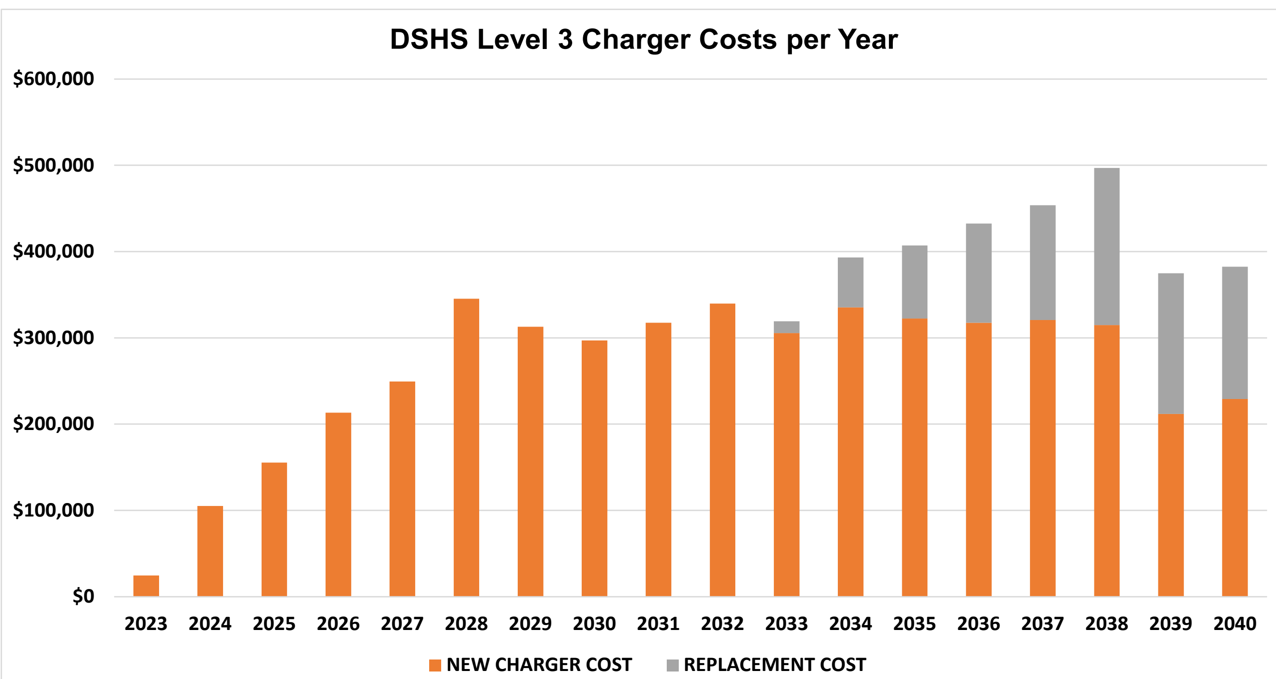
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	3	$37,783	0	$0	$37,783
2024	11	$160,669	0	$0	$160,669
2025	15	$236,505	0	$0	$236,505
2026	21	$323,025	0	$0	$323,025
2027	24	$376,098	0	$0	$376,098
2028	32	$518,129	0	$0	$518,129
2029	29	$467,227	0	$0	$467,227
2030	27	$441,470	1	$11,680	$453,150
2031	28	$469,591	3	$35,389	$504,980
2032	29	$500,075	17	$202,545	$702,620
2033	26	$447,330	3	$30,614	$477,944
2034	28	$488,788	11	$129,476	$618,264
2035	26	$467,608	15	$189,538	$657,146
2036	25	$458,212	21	$257,428	$715,640
2037	25	$460,570	24	$298,022	$758,592
2038	24	$449,743	32	$408,204	$857,946
2039	16	$301,074	29	$365,950	$667,024
2040	17	$324,224	27	$343,726	$667,951
TOTAL	403	$6,928,122	182	$2,272,572	$9,200,694


DSHS Level 2 Charger Costs per Year
$1,000,000
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$-
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040
NEW CHARGER COST
REPLACEMENT CHARGER COST


DSHS Level 2 Charger Installations by County
18
16
14
12
10
8
6
4
2
0
PIERCE
SPOKANE
SNOHOMISH
YAKIMA
THURSTON
GREATER WASHINGTON
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

B.4.2 - DSHS Agency-Owned Forecasted Level 3 Charger Needs

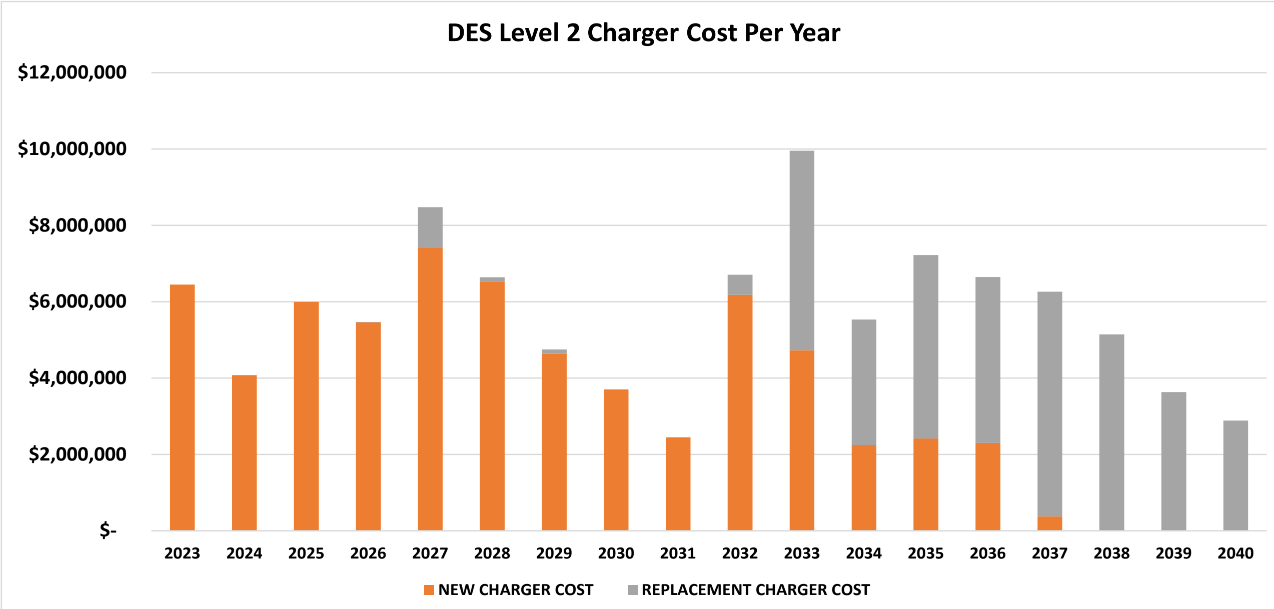
Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	0	$24,596	0	$0	$24,596
2024	2	$105,084	0	$0	$105,084
2025	2	$155,415	0	$0	$155,415
2026	2	$213,279	0	$0	$213,279
2027	2	$249,505	0	$0	$249,505
2028	4	$345,376	0	$0	$345,376
2029	2	$312,943	0	$0	$312,943
2030	2	$297,118	0	$0	$297,118
2031	2	$317,575	0	$0	$317,575
2032	2	$339,834	0	$0	$339,834
2033	2	$305,472	0	$13,654	$319,126
2034	2	$335,415	2	$57,745	$393,161
2035	2	$322,454	2	$84,533	$406,987
2036	2	$317,528	2	$114,811	$432,340
2037	2	$320,734	2	$132,916	$453,650
2038	2	$314,741	4	$182,056	$496,797
2039	2	$211,741	2	$163,212	$374,953
2040	2	$229,153	2	$153,300	$382,453
TOTAL	38	$4,488,811	14	$748,928	$5,237,739

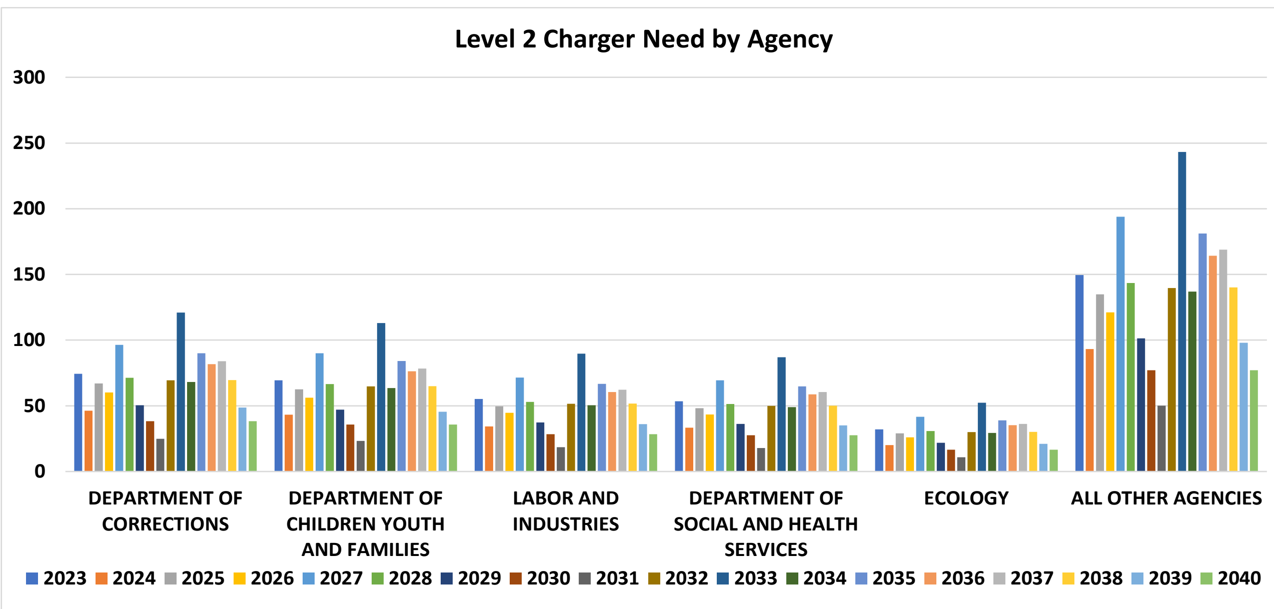


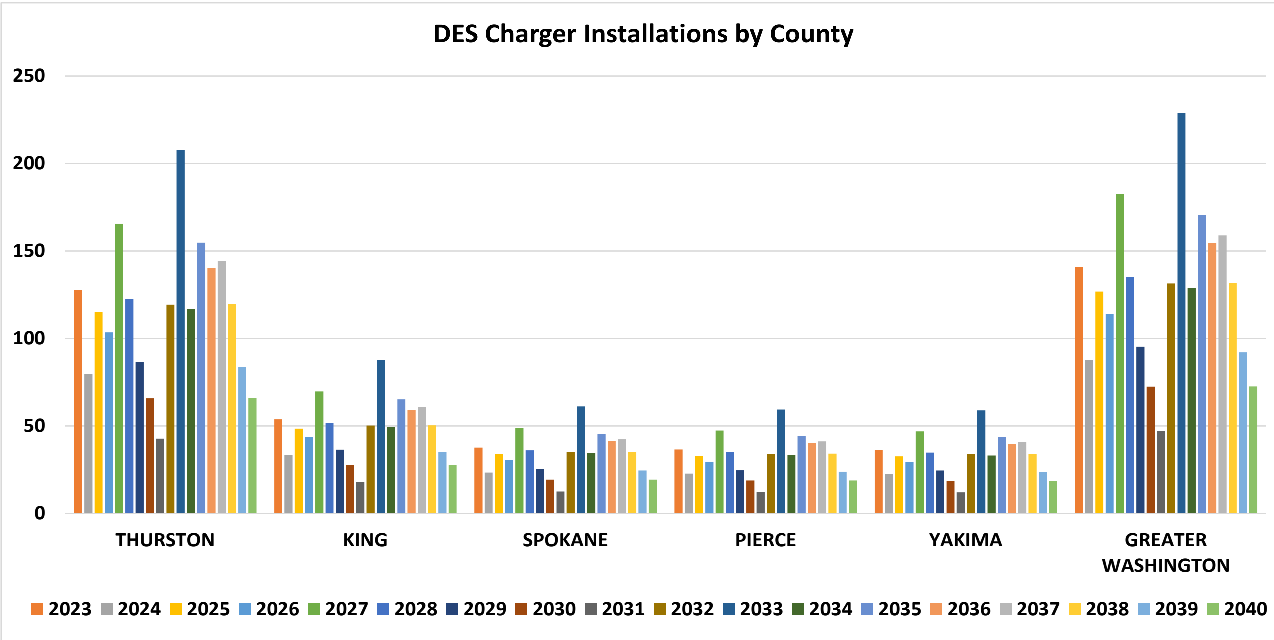
B.5 - Department of Enterprise Services Charging Data

B.5.1 - DES Cabinet Fleet Forecasted Level 2 Charger Needs

Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	434	$6,449,273	0	$0	$6,449,273
2024	270	$4,078,162	0	$0	$4,078,162
2025	391	$5,993,520	0	$0	$5,993,520
2026	440	$6,841,656	1	$11,224	$6,852,880
2027	471	$7,438,902	93	$1,054,260	$8,493,162
2028	407	$6,526,869	10	$114,495	$6,641,364
2029	286	$4,666,140	10	$115,640	$4,781,780
2030	224	$3,706,226	0	$0	$3,706,226
2031	145	$2,448,613	0	$0	$2,448,613
2032	363	$6,217,505	44	$524,233	$6,741,738
2033	272	$4,730,224	434	$5,225,560	$9,955,784
2034	127	$2,249,496	270	$3,286,405	$5,535,901
2035	135	$2,418,547	391	$4,803,278	$7,221,826
2036	43	$792,206	440	$5,452,311	$6,244,517
2037	22	$415,324	471	$5,894,622	$6,309,945
2038	1	$20,135	407	$5,142,135	$5,162,270
2039	0	$0	286	$3,654,696	$3,656,363
2040	1	$24,330	224	$2,885,648	$2,909,978
TOTAL	4,034	$65,018,798	3,081	$38,164,506	$103,183,304

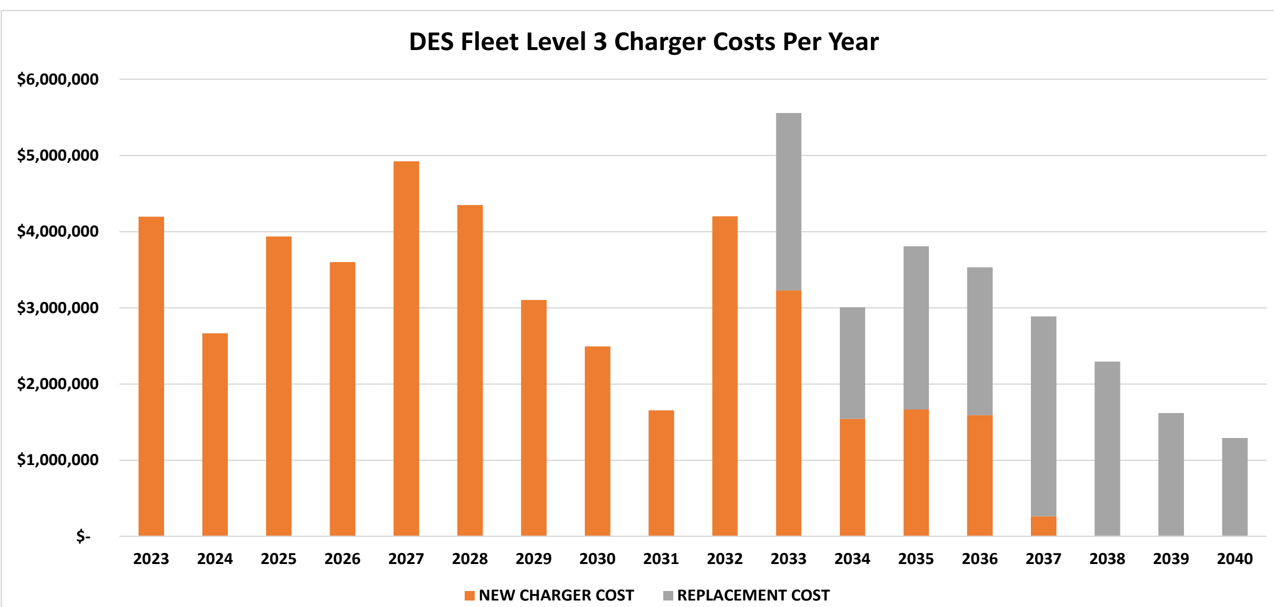

DES Level 2 Charger Cost Per Year
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$-
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040
NEW CHARGER COST
REPLACEMENT CHARGER COST


Level 2 Charger Need by Agency
300
250
200
150
100
50
0
DEPARTMENT OF CORRECTIONS
DEPARTMENT OF CHILDREN YOUTH AND FAMILIES
LABOR AND INDUSTRIES
DEPARTMENT OF SOCIAL AND HEALTH SERVICES
ECOLOGY
ALL OTHER AGENCIES
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040


DES Charger Installations by County
250
200
150
100
50
0
THURSTON
KING
SPOKANE
PIERCE
YAKIMA
GREATER WASHINGTON
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

B.5.2 - DES Cabinet Fleet Forecasted Level 3 Charger Needs

Total Cost	New Charging Port Count	New Charging Port Cost	Replacement Charging Port Count	Replacement Charging Port Cost	Total Cost
2023	44	$4,198,306	0	$0	$4,198,306
2024	28	$2,667,275	0	$0	$2,667,275
2025	40	$3,938,533	0	$0	$3,938,533
2026	44	$4,517,229	0	$0	$4,517,229
2027	48	$4,934,996	0	$0	$4,934,996
2028	40	$4,350,692	0	$0	$4,350,692
2029	28	$3,125,322	0	$0	$3,125,322
2030	22	$2,494,365	0	$0	$2,494,365
2031	14	$1,655,949	0	$0	$1,655,949
2032	36	$4,225,209	0	$0	$4,225,209
2033	28	$3,230,173	44	$2,330,571	$5,560,744
2034	12	$1,543,645	28	$1,465,718	$3,009,364
2035	14	$1,667,788	40	$2,142,235	$3,810,023
2036	4	$548,976	44	$2,431,700	$2,980,677
2037	2	$289,226	48	$2,628,968	$2,918,194
2038	0	$14,091	40	$2,293,363	$2,307,454
2039	0	$1,173	28	$1,629,974	$1,631,147
2040	0	$17,196	22	$1,286,983	$1,304,179
TOTAL	404	$43,402,948	270	$14,922,530	$58,325,479



Appendix C - Assumptions

C.1 – Baseline Assumptions

Assumption #	General Model Assumption
1	Forecast applies **only** to fleets currently in service for their respective fleets.
4	Vehicles assumed not to retire early due to crash/mechanical issues.
5	No panel or utility constraints for level 2 charger installations
6	Real-estate costs are not included in siting charging infrastructure
7	No fiscal resource constraints that delay BEV procurement
8	EVSE infrastructure can expand fast enough to meet BEV needs
9	BEV vehicles will not subject to ordering constraints when modeled availability occurs
10	EVSE system costs do not include management expense

C.2 – Modeled Scenario Assumptions

Assumptions		
Metric	**Value**	**Source**
Forecast Period	2023-2040	Scope of Work
Annual Mileage		
DES and WSP	Average of 2019 and 2022 by 2024	Fleet Managers
DOC agency-owned vehicles, DSHS agency-owned vehicles, and WSDOT	Lifetime Annual Miles	Fleet Managers
Availability - BEV Eligible, All Classes		
2023	75%	Assumption
2024	80%	Assumption
2025	85%	Assumption
2026	90%	Assumption
2027	95%	Assumption
2028	100%	Assumption
Exemption - Cost		
Lifetime Cost Threshold	10%	SEEP Guidance
Fleet Cost Exempt Threshold	>50%	Assumption
Exemption - Range		
Range	Ford, F-150 Lighting Chevrolet, Bolt	2023 Vehicle Specifications
Working Days	220	Assumption
Planning Range	80%	Fleet Manager Guidance
Class 1-3 Forecast		
ICE to BEV Price Parity	2028-2030	International Council on Clean Transportation
Post Price Parity BEV Annual Discount	1%	Assumption
Annual Price Increase	2%	Federal Reserve Bank of St. Louis
Per Mile Maintenance Cost	Class 1-3: BEV: \$0.061; ICE: \$0.101 Class 4-6: BEV: \$0.076; ICE: \$0.118 Class 7-8: BEV: \$0.098; ICE: \$0.152	Department of Energy, *Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains*, 2021.
MPG/MPGe Forecast	Variable	Energy Information Administration, AEO 2022, Table 40
Baseline Vehicle Purchase Cost	Variable	CARS/Statewide contract
Class 4-8 Forecast		
Vehicle Purchase Cost	Variable	Department of Energy, *Spatial and Temporal Analysis of the Total Cost of Ownership for Class 8 Tractors and Class 4 Parcel Delivery Trucks*, 2021.
Per Mile Maintenance Cost	Variable	
Vehicle Range	Variable	

Fuel and Electricity Cost Forecast (2022 Value & Compound Growth Rate)		
Gasoline (gallon)	$4.93 (3.5%)	Energy Information Administration, AEO 2022
Diesel (gallon)	$5.52 (1.3%)	Energy Information Administration, AEO 2022
Electricity (kWh)	$0.09 (2%)	Energy Information Administration, AEO 2022
Charger Installation Assumption		
Level 2 BEV to Charger Ratio	1:1	Assumption
Level 3 BEV to Charger Ratio	10:1	Assumption
Charger Annualized Cost Increase	1%	Assumption
Installation Annualized Cost Increase	3.07%	WSDOT Construction Cost Forecast

C.3 - Vehicle Availability Assumptions

Classification	Year	Representative Model	Source
Sedan 1	2023	Chevrolet Bolt Nissan Leaf	Contract Automobile Request System
SUV 1	2023	Mustang Mach-e Volkswagen ID.4	Contract Automobile Request System
SUV 1 Pursuit	2026*	Chevrolet Blazer	https://media.chevrolet.com/media/us/en/chevrolet/home.detail.html/content/Pages/news/us/en/2022/aug/0816-blazerevppv.html
Truck 1	2026	Ford Ranger	https://cars.usnews.com/cars-trucks/features/ford-ranger-lightning
Van 1	2026	Chrysler Pacifica	https://topelectricsuv.com/news/chrysler/chrysler-pacifica-ev/
SUV 2a	2025	Ford Explorer Chevrolet Equinox	https://topelectricsuv.com/news/ford/ford-explorer-electric-ev/ https://www.chevrolet.com/electric/equinox-ev
Pursuit SUV 2a	2026	Chevrolet Tahoe	Assumption
Truck 2a	2023	Ford F-150 Lightning	Contract Automobile Request System
Pursuit Truck 2a	2026*	Ford F-150 Lightning	https://media.ford.com/content/fordmedia/fna/us/en/news/2022/07/28/2023-ford-f-150-lightning-pro-ssv.html
Truck 2b	2028	Ford F-250	Assumption
Van 2b	2024*	Ford E-Transit Ram ProMaster	Contract Automobile Request System https://www.caranddriver.com/news/a43063537/2023-ram-promaster-ev-confirmed/
Class 3	2025	Rivian, EDV 500/700 BrightDrop, Zevo 600	https://topelectricsuv.com/news/rivian/rivian-amazon-edv-700-electric-van/ https://www.gobrightdrop.com/products/brightdrop-zevo?utm_source=google&utm_medium=paid&utm_term=zevo&utm_campaign=brand_awareness
Class 4	2025*	Rivian, EDV 900 BYD 6F Isuzu NPR	Contract Automobile Request System https://www.greencarreports.com/news/1138310_rivian-edv-specs
Class 5	2025*		
Class 6	2025*		
Class 7	2025	Kenworth T680E	https://www.kenworth.com/trucks/t680e/
Class 8	2025		

*Model availability assumed later than official launch due to known availability constraints or exclusive partnership agreements