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PORT OF SEATTLE

SUSTAINABLE FLEET PLAN

2021

Contents

AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation Tool
AV	Aviation
B20	20% biodiesel blend
CNG	Compressed natural gas
CO_2e	Carbon dioxide equivalent
COR	Corporate fleet
CPO	Central Procurement Office
EDD	Economic Development Division
EV	Electric vehicle
EX	Executive Policy
F&B	Finance and Budget Department
FMOT	Fleet Management Oversight Team
GHG	Greenhouse gas
GPU	Ground power unit
GSE	Ground support equipment
GVWR	Gross Vehicle Weight Rating
ICT	Information and Communications Technology
LCFS	Low carbon fuel standard
MAR	Maritime fleet
MAR/COR	Maritime and Corporate Fleets
MM	Marine Maintenance
NWPCAS	Northwest Ports Clean Air Strategy
Ops	Operations
PC	Pre-conditioned
PCS	Port Construction Services
Port	The Port of Seattle
RD	Renewable diesel
RNG	Renewable natural gas
SEA	Seattle-Tacoma International Airport
SFP	Sustainable Fleet Plan
SUV	Sport Utility Vehicle
TCO	Total cost of ownership

EXECUTIVE SUMMARY

Executive Summary

The Port of Seattle (Port) is a leader in moving people and cargo across the country and around the world:

- Sea-Tac Airport (SEA) is a top-ten U.S. airport, serving 51.8 million passengers and more than 450,000 metric tons of air cargo in 2019[1]
- Over one million passengers embarked on a cruise journey through Seattle before COVID-19[2]
- A total of 13 percent of the U.S. commercial fishing harvest is caught by vessels that move through the Port's commercial marinas.[3]

The Port is also committed to being the greenest and most energy efficient port in North America. This commitment is reflected in the Port's Century Agenda strategic objectives and significant investments in environmental programs. In 2017, the Port Commission adopted greenhouse gas (GHG) reduction targets to reduce emissions from port-owned or controlled sources (Scope 1 and 2) by fifty percent by 2030 and to be carbon neutral or carbon negative by 2050.

All of these important businesses across the Port rely on fleet vehicles and equipment to transport employees, passengers, and supplies, maintain properties and assets, and generally keep operations running smoothly. Fuel use from Port-owned fleet vehicles and equipment accounts for nearly one quarter of all port-owned or controlled emissions. The Port is actively working to reduce these emissions and leads multiple successful programs including:

- Dispensed 20 percent biodiesel blend (B20) at Marine Maintenance fueling sites since 2008 and in 2019, began fueling all marine vehicles with renewable diesel. Aviation Maintenance also began fueling all diesel vehicles with renewable diesel (RD) in 2018.
- Signed a contract in 2020 for renewable natural gas (RNG) that dramatically reduced emissions from what was previously the largest source of fleet GHG emissions: SEA's fleet of 44 buses.
- Installed electric vehicle (EV) charging stations in the SEA Airport main terminal garage, Fishermen's Terminal, and Shilshole Bay Marina. In addition, two Level 3 (fast-charging) stations are now available in the SEA Cell Phone Lot and additional Level 2 chargers will be installed at Marine Maintenance by 2022.

At the same time, opportunities remain to reduce emissions from the Port's large and diverse vehicle fleet. ***The purpose of the Port's Sustainable Fleet Plan (SFP) is to evaluate and recommend strategies that will continue to reduce GHG emissions from the Port's vehicle fleet in order to meet Port goals while maintaining operational effectiveness***.

Port of Seattle Century Agenda GHG Reduction Targets

- Reduce GHG from port-owned and controlled sources (Scope 1 and 2) 50% by 2030 relative to a 2005 baseline
- Be carbon neutral or carbon negative by 2050

[1] Port of Seattle. (n.d.) SEA Airport Statistics. Retrieved 14 May 2021 from https://www.portseattle.org/page/airport-statistics/
[2] Port of Seattle. (2019). Cruise Fact Sheet. Retrieved 14 May 2021 from https://www.portseattle.org/sites/default/files/2019-05/POS_2019-03_Cruise-FactSheet.pdf.
[3] Port of Seattle. (2019, March). Economic Impact of Commercial Fishing. Retrieved 14 May 2021 from https://www.portseattle.org/sites/default/files/2019-05/190412_commercial_fishing_chapter_3_economic_impact.pdf

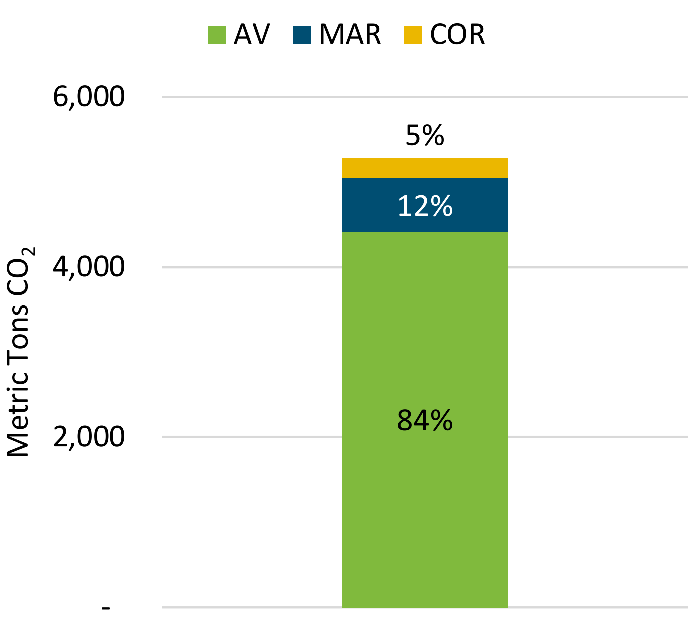
Port Fleets

The Port has over 1,500 vehicle and equipment assets assigned to and supporting different divisions, each with different functions and vehicle needs. Fleet management is organized as follows:

- **Aviation (AV) Fleet** includes vehicles and equipment that support the Aviation Division and operations at SEA such as trucks, buses, and sedans, as well as vehicles for security, emergency response, and the Port's Police force.
- **Maritime (MAR) Fleet** includes vehicles and equipment that serve the Maritime Division and Economic Development Division (EDD), such as trucks, SUVs, sedans, and heavy-duty lift equipment needed by Marine Maintenance, Cruise, and Fishing Operation.
- **The Corporate (COR) fleet** includes vehicles and equipment that support services that cross the Port's operating divisions (AV, EDD, and Maritime). This category includes vehicles used by Port Construction Services (PCS), Engineering, Information and Communications Technology (ICT), External Relations, and Executive Services.

While critical to operations, fleet assets require fuel, and the use of fossil fuels in the Port's fleet contributes to GHG emissions. Fleet fuel use accounts for 22 percent of total Port-wide Scope 1 and 2 GHG emissions. GHG emissions from the AV, MAR, and COR fleets are shown in Figure 1. The AV fleet accounts for 84 percent of emissions and the smaller MAR and COR fleets account for 12 and 5 percent, respectively.[4]

Figure 1. Port of Seattle GHG Emissions from Fleet Fuel Use, 2019



This document is divided in two chapters: an Aviation chapter, which covers AV fleet vehicles; and, a Maritime chapter, which covers MAR/COR fleet vehicles, as the AV fleet vehicles are managed by the Aviation fleet manager and the MAR and COR fleets are both managed by the Marine Maintenance fleet manager. While divided in this plan, in practice there are linka ges and areas of overlap across the fleets. For example, vehicles used by some departments such as the Port's Engineering and PCS departments, regularly move between SEA and maritime facilities and may fuel at multiple locations. Similarly, fleet managers routinely manage vehicle needs across facility boundaries and address the strategic needs of the Port overall.

[4] The percent contribution of GHG emission for each fleet category are rounded to the nearest whole number, so do not add up exactly to 100%.

For the purposes of this plan, fleet vehicles are assumed to be managed by the department that purchases the vehicles, rather than where the vehicle operates or fuels. For example, PCS vehicles that fuel at SEA are considered part of the MAR/COR fleet, and their fuel use is assigned to MAR/COR.[5]

Key Strategies

The SFP analyzes the impact of several green fleet strategies including:

- Right-sizing vehicles and fleets
- Standardizing vehicle models for specific uses
- Purchasing more efficient vehicles and electric vehicles
- Using drop-in renewable fuels
- Investing in data collection equipment called telematics and,
- Improving driver education to incorporate sustainable driving practices.

Each chapter presents analysis and corresponding recommendations to achieve the Port's 2030 Century Agenda GHG targets in each of the fleet divisions.

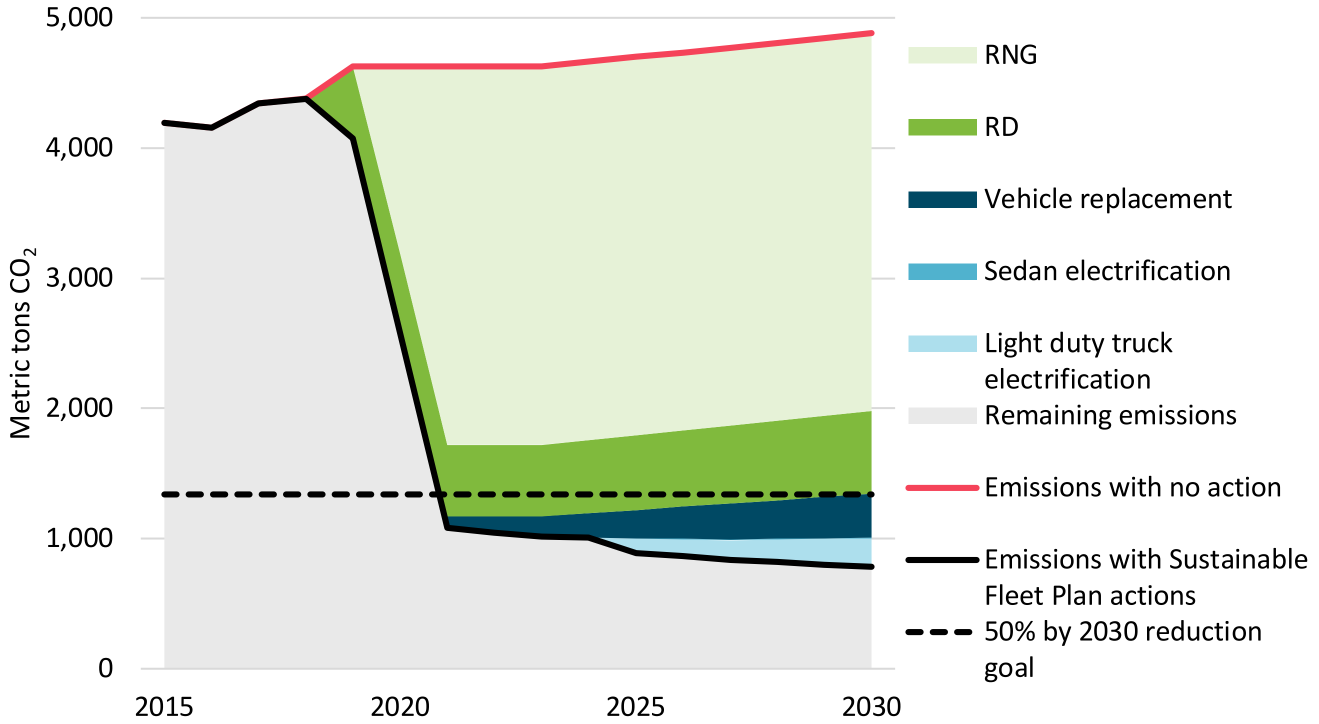
Aviation Fleet

The Aviation chapter analyzes several green fleet strategies including right-sizing vehicles, standardizing vehicles, and purchasing more efficient vehicles. All three of these strategies will produce significant carbon reductions while saving money for the organization. In addition, the Aviation chapter analyzes the impact of replacing most of the gasoline-powered trucks, sedans, and SUVs with EVs, replacing natural gas with RNG in the SEA bus fleet, and replacing conventional diesel with RD. The Aviation chapter also evaluates the potential benefit of using telematics to better understand vehicle use, and driver training to ensure efficient use of the vehicles.

AV Fleet Findings: The analysis shows that by implementing all these recommended strategies, the AV Fleet could reduce its emissions by approximately 4,000 metric tons of CO_2e by 2030. As shown in Figure 2 below, the largest contributors toward the goal include using RNG in the bus fleet, replacing fossil diesel with RD, and replacing existing vehicles with either more efficient vehicles or EV in that order.

[5] The division of fleet vehicles and associated fuel use differs from how mobile fossil fuel use from fleet vehicles is accounted for in the Port's annual Aviation and Maritime GHG Emissions Inventories. The emission inventory methodology divides fleet fuel use between Aviation and Maritime by where the fuel was dispensed rather than which vehicle used the fuel. This means that comparing mobile fossil fuel use totals with the GHG inventories and fossil fuel use total sin the SFP will not line up exactly when split between Aviation and Maritime; however, total port-wide mobile fossil fuel use from fleet is the same.

Figure 2. 2030 GHG emission reduction potential of Aviation SFP strategies

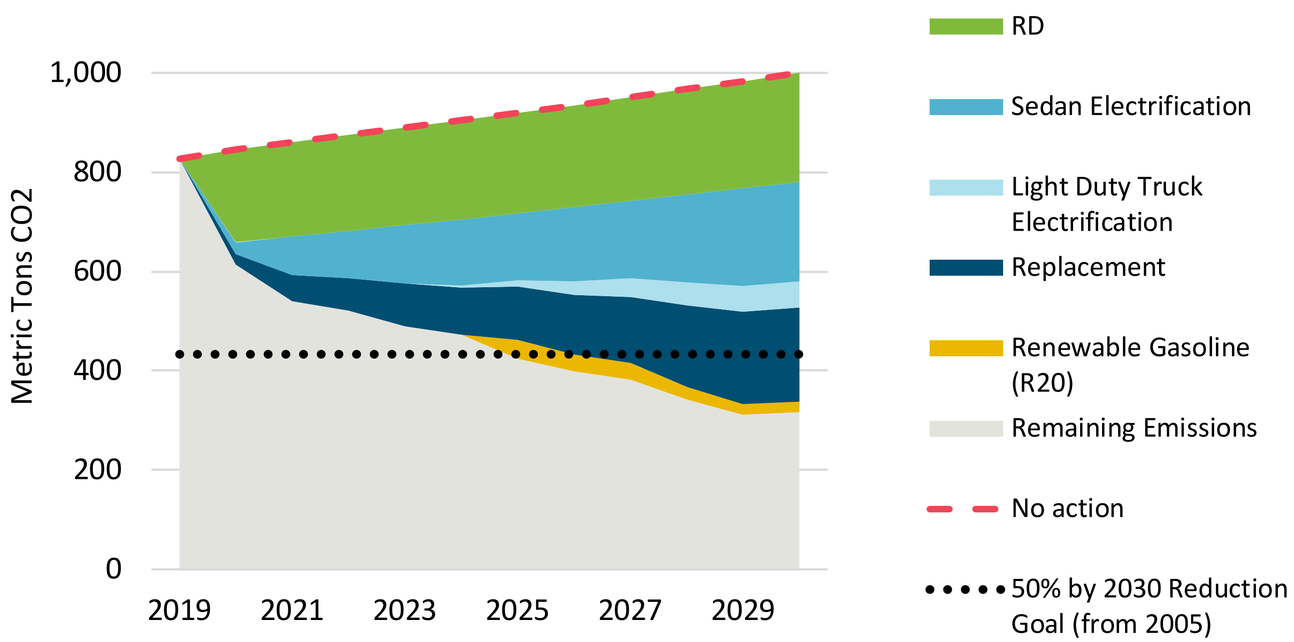


Maritime and Corporate Fleets

The Maritime chapter of the SFP also analyzes and applies the same list of green fleet strategies (right-sizing vehicles, replacing fossil-fueled vehicles with EVs, and replacing fossil diesel fuel with RD) to the nearly 600 vehicle, equipment, and watercraft assets across the MAR/COR fleet categories.

MAR/COR Fleet Findings: Similar to the AV fleet, the green fleet strategies analyzed for the MAR/COR fleet show an opportunity to reduce emissions by over 600 metric tons of CO_2e by 2030, surpassing the Century Agenda 50 percent GHG reduction target, with the bulk of those reductions achieved by replacing fossil diesel with RD and converting sedans to EVs, as shown in Figure 3 below:

Figure 3. 2030 GHG emission reduction potential of Maritime SFP strategies



Summary of Sustainable Fleet Recommendations

Analysis of the AV and MAR/COR fleets surfaced common challenges and opportunities to reduce GHG emissions from the Port's fleet vehicles and equipment. Both plans recommend the following steps to ensure that the full emission reduction opportunities defined above are realized, and that the Port continues to operate a sustainable and efficient fleet:

Develop an EV readiness plan to expand EV charging across Port Properties.

Converting to EVs is a key sustainable fleet strategy in both the Aviation and Maritime chapters, and fleet managers must have access to adequate charging infrastructure before committing to new EVs. However, locating and installing EV charging stations can take multiple years. In some instances, fleet procurement and vehicle location assignments can change within that time. For example, a Port business unit requesting an EV could get assigned to a new location in the time it takes to locate and install charging for that vehicle.

To achieve electrification of the Port's fleets, an EV readiness plan is needed to guide location, infrastructure, and timing of installing EV charging infrastructure at both SEA and across maritime and EDD properties. These plans will evaluate charging needs and prioritize locations for EV charging based on fleet needs, installation cost, and infrastructure availability. They will also help prepare for the future deployment of EV trucks and vans that are not yet commercially available.

Prioritize investment in fleet management technology and telematics.

Lack of data is one of the biggest barriers to implementing the strategies described in this plan. In some cases, the Port is not able to collect data that could inform fleet management, such as accurate numbers for vehicle mileage. In other cases, like vehicle fuel use, while data is collected for both fleets, it's difficult to access, analyze, and visualize. Investment in fleet management technology and telematics across the Port's fleet vehicles should be a priority in the near-term. Improving access to and accuracy of this information can help identify under-used vehicles, more efficiently track the efficacy of the SFP strategies, and target additional investments for the highest return in cost savings and emission reduction.

Benefits of the SFP Strategies Beyond Emission Reduction

- Reduced exposure to particulate matter and noise for employees and neighboring communities
- Lower maintenance costs with on-time replacement and EVs
- Reduced risk of major component failures
- Minimized purchases and rental expenses with pooling and equipment sharing
- Demonstrate zero-emission technology in Port fleets
- Increased operational efficiency
- Increased safety
- Improved customer morale
- Data-driven decision-making

Continue to use low-carbon fuels.

The Port should continue use of low-carbon fuels, such as RD, and evaluate the feasibility of new low-carbon fuels as they come to market. The AV and MAR/COR fleet managers have already begun purchasing RD in place of conventional diesel for fueling islands at maintenance shops, and SEA uses RNG to power the Airport's bus fleet. While renewable fuels have historically been more expensive than their conventional counterparts,[6] recent passage of a Clean Fuels Program in Washington (HB 1091) is expected to reduce the relative incremental costs associated with low carbon fuels. The Port will also need to continue to purchase renewable electricity for SEA to maximize the carbon reduction benefits of EVs.

Support the fleet managers' efforts to right-size, modernize, and electrify the fleet.

Implementing the sustainable fleet strategies will require continued investment in fleet manager efforts to achieve on-time replacement of fleet vehicles and equipment and modernize the fleet. AV and MAR/COR fleets have many older, less efficient vehicles that are operating beyond their useful life. Port leadership should support funding requests to replace aging, inefficient vehicles as budget allows and prioritize fleet modernization.

Additionally, Port leadership should support and encourage the purchase of EVs for fleet needs and optimize those purchases by pooling all or most vehicles. This would help avoid purchasing and

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[6] In 2018 and 2019, RD averaged $2.62 more per gallon than conventional diesel ($5.18 per gallon for RD versus $2.56 per gallon for conventional diesel).

maintaining unnecessary vehicles. Leadership support is also needed to promote fleet managers’ efforts to retire and pool existing vehicles and equipment where possible.

Align internal policies and purchasing procedures with sustainable fleet goals.

The Port’s Fleet Management Oversight Team (FMOT) should work with the Port’s Central Procurement Office (CPO) and Finance and Budget (F&B) department to simplify the vehicle purchase process and better incorporate fleet management needs into the budgeting process and timelines. In addition, Executive Policy (EX)-17 may need to be updated to reflect the strategies and priorities defined in this Plan.

The following two chapters provides detailed analysis and recommendations for how each division can reduce fleet emissions 50 percent by 2050.

CHAPTER 1

Aviation Sustainable Fleet Plan

Developed by Aviation Maintenance and Aviation Environmental

Chapter 1: Aviation Sustainable Fleet Plan

Developed by Aviation Maintenance and Aviation Environmental

Purpose and Objectives

The purpose and objectives of this plan are to evaluate and recommend strategies that the Port can use to reduce GHG emissions from its vehicle fleet as part of its overall efforts to meet its Century Agenda goals. In addition, the plan must ensure that Port departments who depend on fleet vehicles can successfully perform their functions and safely maintain operations at SEA.

To meet these objectives, AV Environmental staff conduct the following tasks:

1. Evaluate the fleet function, composition, usage rates, fuel use, and GHG emissions
2. Evaluate and recommend strategies that could reduce fleet-related emissions without compromising department functions or safety
3. Evaluate current vehicle purchase procedures and recommend changes to ensure the most efficient and sustainable vehicle is available to vehicle users
4. Summarize final recommendations and next steps to implement the plan.

This plan is intended to support the AV fleet manager in making the AV fleet as sustainable as possible. In preparing this plan, AV Environmental staff partnered with the AV fleet manager to do the following:

1. Gather data about AV fleet fuel usage using fueling transaction data
2. Through the data collection process, identify areas where data is incomplete or could otherwise be improved
3. Use the fleet fuel use data to identify opportunities to reduce emissions and save cost, such as:
    a. Vehicles that consume large amounts of fuel that could be replaced with a hybrid or electric model or could be retrofitted with anti-idling technology
    b. Vehicles that use little fuel and may be candidates for vehicle pooling
    c. Older vehicles that use significant fuel and should be prioritize for replacement

Each of these steps and strategies will be discussed in more detail below.

Task 1: Evaluate Fleet Function, Composition, Utilization, and GHG Emissions

The AV fleet serves numerous operational needs ranging from keeping snow off the runways during winter storms to hauling construction materials to landscaping green spaces throughout the airport property. Vehicle needs vary by department and function. Some examples include:

- **Police**: Emergency response and patrol vehicles including
    - Sedans for detective vehicles
    - SUVs for patrol vehicles and canine operations
    - Trucks and trailers for specialized emergency response, like bomb disposal
- **AV Maintenance**: Special purpose equipment specific to airport operations, such as:
    - Snow equipment that must be reliable in all weather conditions, able to be stored for long periods and deployable quickly when needed, including large snowplows and

- Sweeper trucks for runways and other paved areas, like the parking garage
    - Passenger ramps for aircraft hardstand operations
    - Vans and scooters carry craftspeople and tools to job sites at all Port facilities to ensure that maintenance and repair work can be completed as necessary
- **Airport Operations:** Buses that move large numbers of passengers and staff between the airport terminal, the rental car facility, and the north employee parking lot; these buses face constant wear and must be durable.
- **Multiple departments:** Most departments at the Port use vehicles in some fashion:
    - Cars and vans allow staff to perform site inspections, collect samples, conduct field work, and move between jobs sites
    - Some trucks and SUVs serve as mobile offices for staff

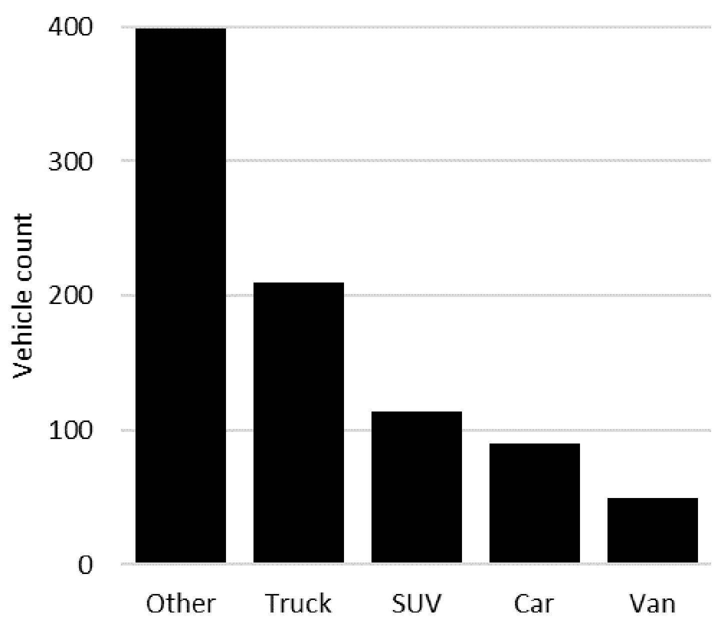
Fleet Composition

There are about 860 pieces of equipment of various types in the AV fleet, as shown in Figure 4.[7]

Only about half of the AV fleet are common “on-road” vehicles, like passenger cars and pickup trucks. These vehicles tend to be used for general-purpose transportation and have more regular replacement cycles than most off-road equipment. They include about 90 cars and nearly 120 SUVs.

Trucks are another major component of the Port’s on-road fleet. Most are light trucks, which include pickup trucks like the Ford F-150. The AV fleet also contains medium and heavy trucks, from Ford F-350s to large dump trucks. Many of those large trucks meet specific operational needs, like vacuum trucks and sweeper trucks.

Figure 4. AV Fleet Composition



[7] The fleet data in this document is current as of 2019. However, the AV fleet is dynamic and exact vehicle counts may now be different than those presented here due to vehicle purchases and removal.

The remainder of the AV fleet includes a range of non-road equipment. The largest component, by far, are about 110 low-speed utility vehicles or scooters. The AV fleet also includes forklifts, trailers, towable generators, and maintenance lifts, and aircraft passenger ramps for aircraft hardstand operations.

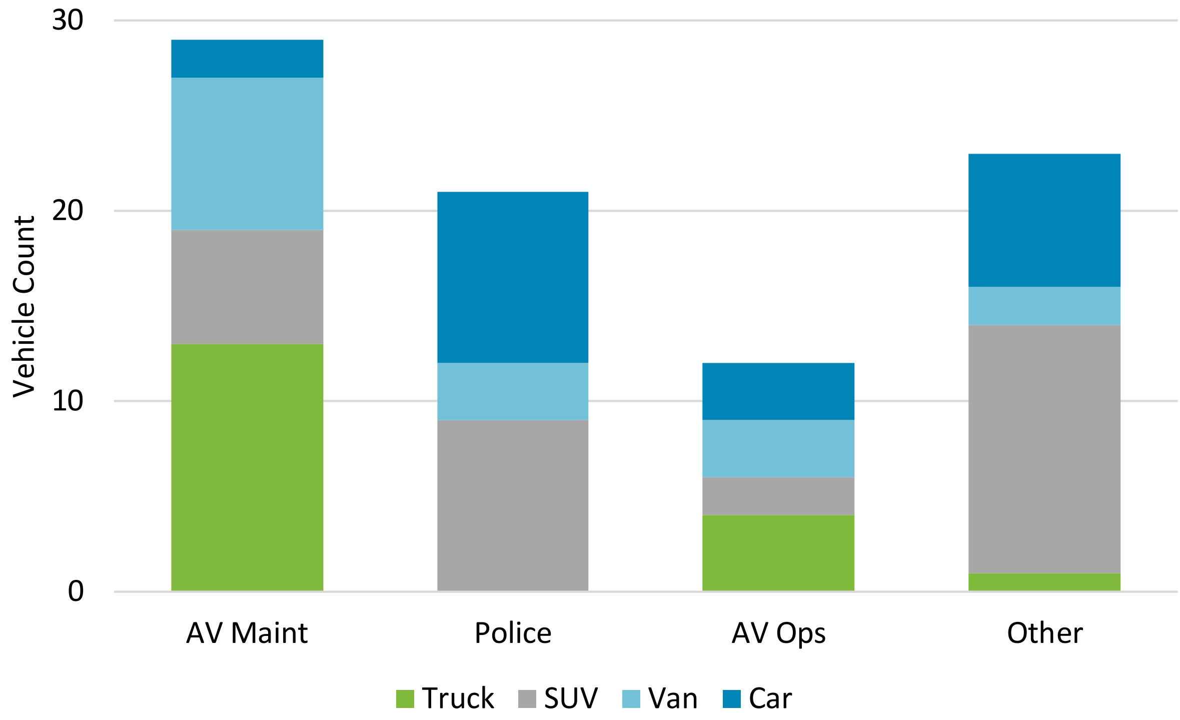
Vehicle Utilization

Vehicle utilization rates show how often a vehicle is in use. Some fleet vehicles are constantly in use while others rarely so. Low utilization vehicles often meet specific operational needs (e.g., a snowplow) that could not easily be met through a common vehicle (e.g., a sedan). However, fleet utilization rates can help identify low-use vehicles that do not serve a specialized purpose or unique need. These vehicles can be removed from the fleet with little or no impact on operations as pool vehicles can easily support those functions.

Port vehicles with specialized operational needs are more likely to use diesel rather than gasoline. Given this, we further assess the low-use vehicles based on those that use gasoline rather than diesel as shown in Figure 5 below. Based on gasoline use data[8], there were almost 90 low-use vehicles in the Port's fleet as of 2019, as shown in Figure 5.

[8] Washington state recommends that fleet vehicles be utilized at least 3,000 miles per year or on 80% of workdays. The per-day usage metric is to account for vehicles, like maintenance vans, that may not drive very far, but function like "rolling toolboxes." These vehicles are utilized nearly every day to move tools and tradespeople, but the overall distance they cover may be small. Fuel consumption data is currently more readily available than vehicle mileage data for the AV fleet. Here, we use a proxy of 100 gallons of fuel consumption per year, which roughly approximates 250 miles driven per month. We exclude gasoline hybrids that can achieve higher use with relatively less gasoline consumption. Unfortunately, using fuel data does not provide insight into which vehicles met the 80% use threshold, only on the overall amount of use.

Figure 5. Non-hybrid gasoline vehicles with less than 100 gallons of fuel consumption in 2019



Greenhouse Gas Emissions

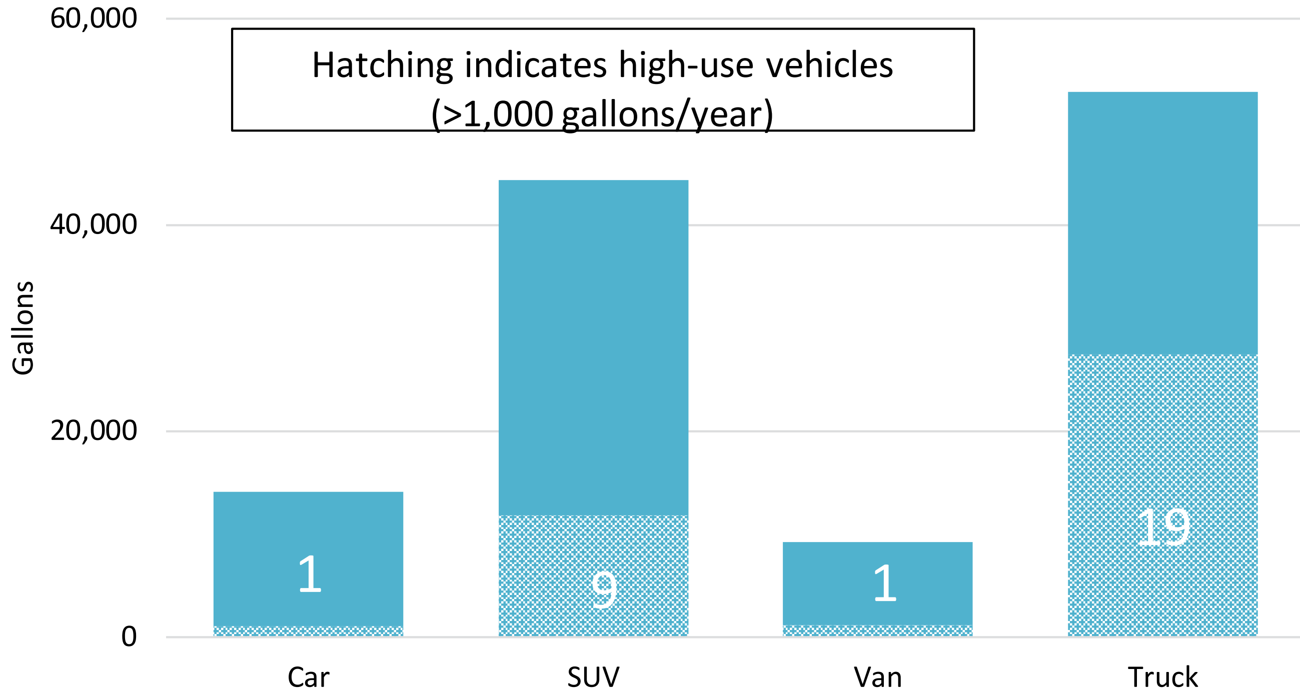
Fuel Use

To determine overall GHGs associated with the fleet, we evaluate both gasoline and diesel use for AV fleet vehicles. Evaluating fuel use data also helps identify which vehicles might be good candidate for sustainability strategies. For example, diesel can be replaced with a readily available drop in fuels such as renewable diesel or biodiesel, whereas there is no current drop-in replacement fuel for gasoline, and these vehicles must reduce emissions through increased efficiency or electrification.

Gasoline

The AV fleet consumed over 120,000 gallons of gasoline in 2019. As shown in Figure 6, trucks and SUVs comprised the majority of the AV fleet gasoline consumption (53,000 and 44,000 gallons, respectively, representing 80 percent of gasoline consumed).

Figure 6. AV fleet gasoline usage by vehicle type 2019



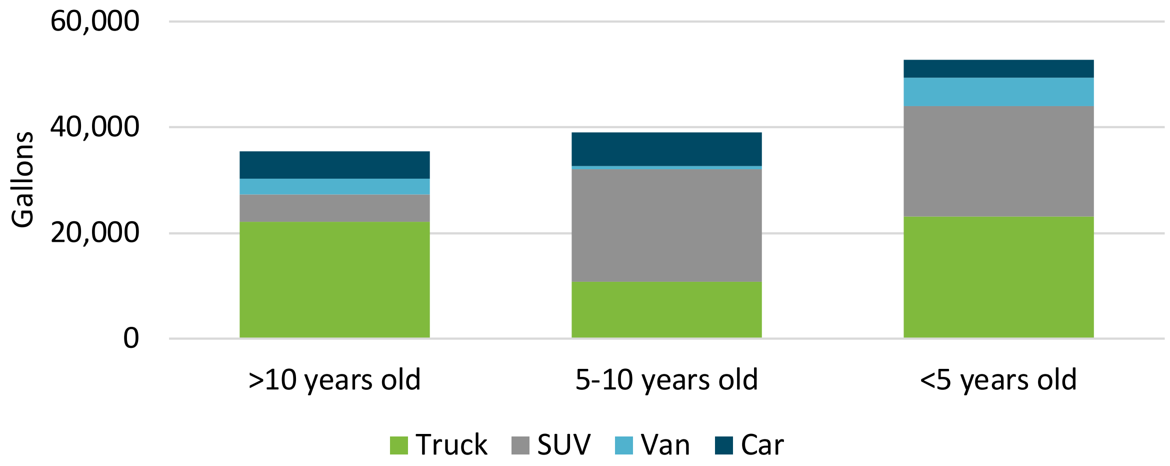
Vehicles that consume relatively large quantities of gasoline are highlighted in the crosshatch sections of the bar chart in Figure 6. These 30 vehicles represent one third of the AV fleet gasoline consumption. This skewed distribution of fuel consumption is even more extreme when looking just at the trucks in the AV Maintenance (AVM) fleet: 15 percent of the trucks account for half of the fuel consumption.

There is also variation in fuel use by department. Police show large fuel use from SUVs and cars. These vehicles could be good candidates for electrification, gasoline hybrid vehicles, or anti-idling technology. Some police vehicles need to be "pursuit-rated" and must meet higher performance standards than typical customer vehicles. The options for pursuit-rated EVs are currently limited, but hybrid models are available.

AV Operations (Ops) Department has large fuel use from four trucks. These trucks are used by airport duty managers and are typically in operation for 16 hours per day or more. These vehicles may be good candidates for replacement with EVs or hybrid vehicles. However, it will be essential to coordinate any right-sizing with the users of the vehicles to ensure the unique needs of the airport duty managers can be met with an alternative vehicle.

Older, less efficient vehicles generally consumer more fuel than newer vehicles. Analyzing the age distribution of vehicles in the fleet can be helpful for identifying opportunities to replace those older vehicles. The replacement cycle for fleet vehicles varies by vehicle use but generally falls between 5 to 10 years, especially for gasoline-fueled vehicles that are less likely to be specialty equipment. Figure 7 shows gasoline consumption by vehicle age as well as vehicle type. Vehicles under five years old are relatively new, those between 5 and 10 years old should likely be replaced soon, and those older than 10 years are due for replacement. As shown in Figure 7, there is a large amount of fuel consumed by older trucks. Replacing these trucks with more modern, efficient vehicles or right-sizing to a smaller vehicle, if possible, could reduce fuel consumption.

Figure 7. AV fleet gasoline usage by vehicle type and age in 2019

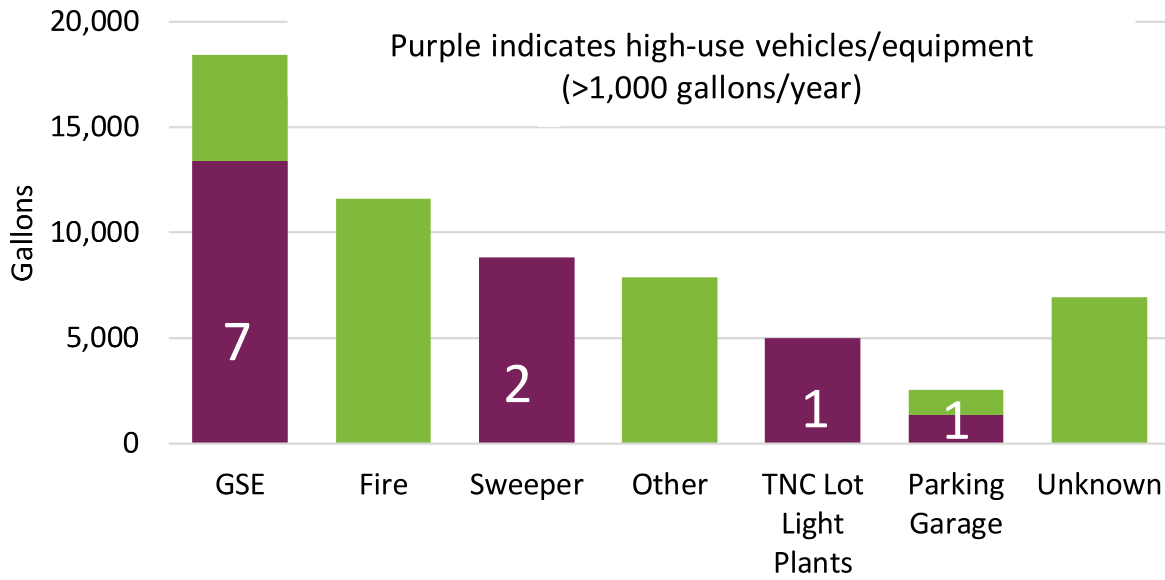


Diesel

The AV fleet consumed 48,000 gallons of diesel in 2019, as shown in Figure 8 (note that the vertical scale of Figure 8 differs from Figure 7) with ground support equipment (GSE) as the major diesel consumer. The AV fire department is also a major diesel consumer, but largely manages and maintains their vehicle fleet separately from the rest of the AV fleet, and there is limited data on how fuel dispensed to fire department vehicles is consumed.

There are two sweeper trucks within AVM that consume 20 percent of all diesel dispensed to the AV fleet. These sweeper trucks are required by the Federal Aviation Administration to continually sweep the airfield to minimize foreign object debris.

Figure 8. AV fleet diesel usage by vehicle type in 2019.



AV Ops consumes diesel in four ground power unit (GPU) generators and three pre-conditioned (PC) air units that support aircraft hardstands. These seven pieces of equipment account for 30 percent of diesel dispensed. The other major diesel fuel consumers in AV Ops are light plants for lighting the TNC/taxi holding lot (approximately 5,000 gallons) and 1,400 gallons for a paint stripper that operates in the parking garage.

Diesel use is not analyzed by equipment age, as was done in the previous section for gasoline use, because diesel equipment is more likely to be specialty-use with less regular replacement cycles than gasoline equipment.

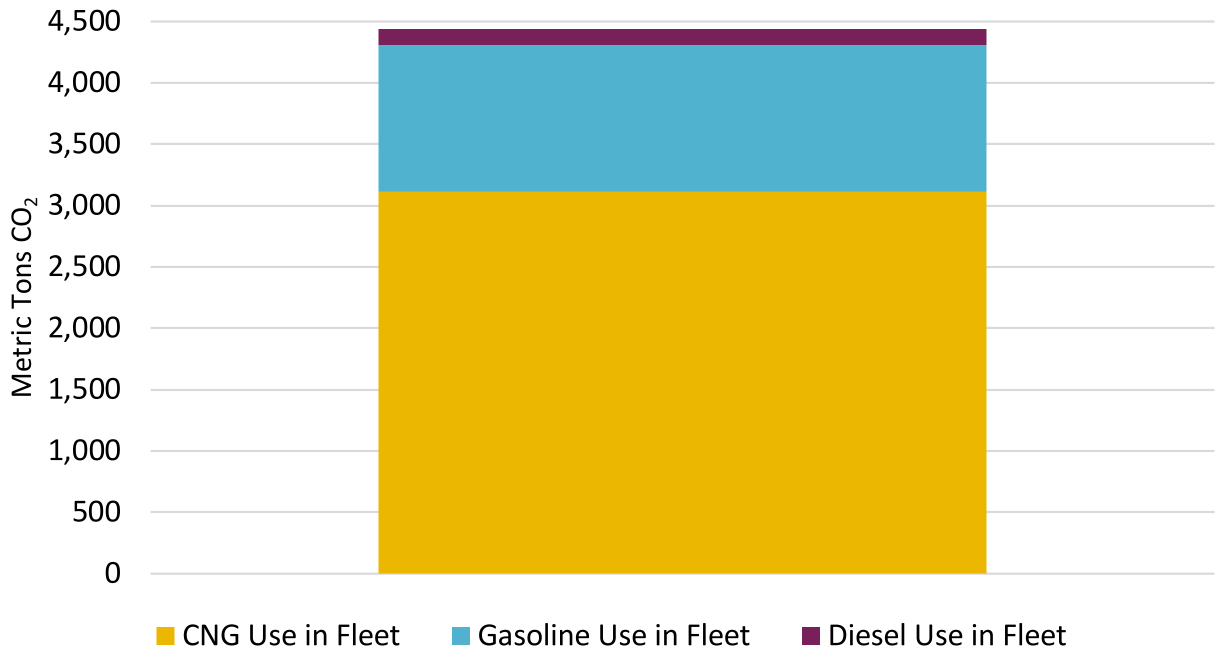
Current Emissions

Approximately 20 percent or 4,390 metric tons of the Airport's scope 1 GHG emissions are from its vehicle fleet. Figure 9 shows how different fuel sources contribute to these AV fleet emissions in 2018.

The largest contributor to AV fleet emissions is the CNG used in buses, which generated 68 percent of emissions in 2018. The second largest contributor of emissions is gasoline vehicles, which were responsible for 27 percent of AV fleet emissions.

Diesel vehicle emissions were small, only 5 percent of AV fleet emissions. However, the Port began using RD in place of conventional diesel halfway through 2018. As a result, emissions from diesel combustion are anticipated to be lower in 2019.

Figure 9. AV fleet greenhouse gas emissions, 2018



Task 2: Evaluate and Recommend Fleet Strategies

The Port's fleet managers have already begun to implement strategies to reduce greenhouse gas emissions and maintenance costs associated with the AV fleet. Many of these strategies are complementary and can be implemented simultaneously.

Vehicle Replacement Strategies

Vehicle replacement is one of the most important tools for improving the AV fleet. Replacing outdated equipment can save money on operating costs while also reducing greenhouse gases and air pollutant emissions. Replacement is the prime opportunity to implement many of the other strategies described in this section. These opportunities do not come often: replacement schedules can vary from 7 years for a high-use sedan, 12 years for a light-duty pickup, to 20 years or longer for vehicles that are larger, lower-use, or special-purpose.

- **Right-sizing vehicles** by matching vehicle purchases to a specific purpose saves money and lowers greenhouse gas emissions. Right-sizing is important both when adding new vehicles to the fleet and when replacing existing fleet vehicles. For example, replacing a larger vehicle such as a pickup truck with a smaller vehicle such as a sedan or SUV that also meets the same operational need can reduce cost in the initial vehicle purchase and over the life of the vehicle by lowering fuel consumption.
- **Standardizing vehicles.** Limiting the makes and models of vehicles in the fleet also saves cost by streamlining maintenance. The AV fleet stocks parts for vehicles in the fleet to enable quick turnaround on common repairs. Fewer vehicle makes in the fleet means that fleet managers need to stockpile fewer types of parts. It also enables mechanics to build more expertise with specific vehicle makes and models.

- **Purchase more efficient vehicles**. Newer, more efficient vehicles cost less to maintain and emit fewer air pollutants, including GHGs, compared to older vehicles. The AV fleet includes some vehicles from the mid-1990s and older. Fleet managers balance ongoing maintenance costs with the purchase price of new vehicles when deciding which vehicles to replace. When possible, fleet managers prioritize replacing the oldest vehicles in the Port's fleet. Replacing these outdated vehicles with more efficient newer versions can save cost while improving the overall fuel economy and reliability of the fleet. The lower air pollution emissions from modern vehicles can have a health benefit for Port staff who often work in or near fleet vehicles.

Vehicle Fuel Strategies

- **EVs.** Replacing light-duty gasoline vehicles with EVs is currently the most effective way to reduce emissions from this sector of the fleet. This is especially true at SEA, where the electricity is very low-carbon. All new sedans and SUVs added to the AV fleet are currently EV or gasoline-hybrid vehicles if possible. Lack of available EV charging infrastructure currently limits the ability to operate more EV passenger vehicles. Fleet managers also purchase electric versions of small equipment, like lifts and scooters, that can typically charge using existing infrastructure.
- **Renewable fuels** provide a drop-in replacement for liquid and gaseous fuels that reduce carbon emissions with few to no operational changes. This is particularly important for vehicles that cannot currently be electrified, like heavy trucks and some types of non-road equipment. Renewable fuels are an important component of the Port's ongoing effort to reduce greenhouse gas emissions. Beginning in mid-2018, all diesel dispensed onsite to the AV fleet was renewable diesel (RD). This RD displaced about 500 metric tons of carbon emissions in 2019 that would have occurred if the AV fleet consumed conventional diesel. Port staff are also recently secured a contract to fuel the AV bus fleet with RNG, which would displace approximately 70% of the AV fleet's greenhouse gas emissions.

Operational Strategies

- **Right-sizing the fleet** by ensuring that Port departments have the right vehicle available at the right time to meet operational needs. A fleet that doesn't have enough key equipment during peak times could jeopardize operations or require the Port to rent or borrow equipment, causing delays. However, a smaller fleet can save money as every piece of equipment in the fleet adds cost from the initial purchase and ongoing maintenance. Vehicles that are under-utilized can be removed from the fleet if another vehicle is readily available and serve the same function. For example, departments that only use vehicles occasionally may prefer to use pooled vehicles that are shared among departments rather than maintain their own vehicle. However, low utilization does not ensure that a vehicle is a good candidate for pooling. Some low-use equipment, like emergency response vehicles specialized equipment, meet specific needs and are not good candidates for pooling.
- **Anti-idling technology** can reduce fuel use for idling while maintaining essential vehicle functions, like electronics and temperature control for police canines. Idling can be a major source of fuel use, particularly when a vehicle serves as a mobile office. Purchasing hybrid and EVs is an easy way to reduce idling. Hybrid and EVs reduce or eliminate fuel consumption while idling by switching to electric batteries to maintain essential functions. There are also after-market solutions that can be installed on non-hybrid vehicles that limit idling. These can be

particularly useful for vehicles for which a hybrid or EV option is not currently available or for vehicles that will not be replaced soon.

- **Telematics** is a combination of hardware installed in vehicles and data management software that collects data about vehicle location and utilization. Telematics data can be used to identify vehicle pooling opportunities, for example if multiple vehicles are routinely dispatched to the same location. It can also be used to identify vehicle idling and help optimize the deployment of anti-idling technology. Telematics can be used to quickly locate equipment, like portable lights, that is commonly used at multiple sites and may not be returned to the AV maintenance shop at the end of the work day. In 2019, The AV fleet conducted a small-scale pilot program in which telematics was installed on 18 vehicles. However, that program has been put on hold pending future funding availability.

Procedural Strategies

- **Improving fleet and fueling data** would allow for more informed fleet management decisions. Lack of data is a known issue, and recommendations for improving data availability are discussed later in this plan.
- **Driver training.** Driver behavior can contribute to vehicle fuel economy, lowering fuel use and emissions by up to 25 percent.[9] The Port currently requires all employees who use fleet vehicles to complete online fleet vehicle safety orientation. Information on maximizing driving efficiency could be added. If the AV fleet expanded use of telematics, that data could help quantify which individuals or teams in the AV fleet drive most efficiently.

Task 3: Overview of Vehicle Procurement Procedures Review

The following section describes how AV fleet vehicles are purchased, as well as some of the benefits and challenges of the current approach. In addition to the information below, the Port's fleet management policy (EX-17), last revised in June of 2013, describes roles and responsibilities for fleet acquisition and other aspects of fleet management.

Roles and Responsibilities

The AV fleet manager is responsible for purchasing new and replacement vehicles for the AV fleet. The AV fleet manager meets regularly, ideally at least once per year, with representatives from departments that pay for and operate fleet vehicles. The fleet manager works with the individual departments to plan for any new fleet vehicles and department representatives describe any anticipated hiring that could require new vehicles. This annual or semi-annual communication is key because the fleet manager is usually not able to fulfill vehicle requests on short notice.

These meetings are also where the fleet manager can discuss vehicle replacement with customers. Unlike requests for new vehicles, which are initiated by customers, fleet managers drive the replacement process. They develop vehicle replacement plans that balance many factors to determine which vehicles will be replaced in what year.

[9] "Fuel-efficient driving techniques" Natural Resources Canada. Last updated October 1, 2019, accessed April 9, 2020. https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/personal-vehicles/fuel-efficient-driving-techniques/21038

Purchase Process

Once the fleet manager and the departments agree on what vehicles should be procured, the fleet manager includes the vehicle purchase in the proposed annual budget for the following year. All vehicle purchase requests should go through the Port's annual budgeting cycle. If a vehicle purchase request is not included in the upcoming budget, it may be a year or more before being fulfilled.

The process for fleet purchases depends on the cost of the equipment. Most vehicle requests fall between $20,000 and $300,000 per vehicle and are handled through the Port's small capital budget process. Requests for equipment that costs more than $300,000 per vehicle are handled through the Port's large capital budget process. Items that cost less than $20,000, like scooters, can be expensed. Fleet managers maintain a budget for replacing small equipment like this (approximately $60,000 to $90,000 per year for scooter replacement).

The fleet manager procures most of the vehicles that are the focus of this plan via the small capital budget process, so that will be the focus for the remainder of this section. The small capital procurement process starts with fleet managers preparing a justification form for each vehicle that they plan to request in the coming year. These forms are then reviewed by the Senior Manager and Director of the AVM department. Next, the fleet manager requests approval for the purchases from the Aviation Investment Committee. If approved, the new vehicle requests are incorporated into the budget approvals that are sent to the Port Commission.

Once annual vehicle purchase requests are approved, fleet managers check in with the requesting department to see if staffing or operational needs have changed since the initial vehicle request. If not, fleet managers finalize the vehicle order and work with car dealers to purchase vehicles.[10] The process typically takes about six months from the initial request to the final vehicle delivery.

When new vehicles are received, those being replaced are removed from the fleet. The Port typically sells these vehicles at auction. However, some specialized equipment, like de-icer trucks, can be sold directly to other airports.

Current Challenges

While the current process provides oversight and reduces risk to the organization, some aspects of the process create barriers to an effective and sustainable vehicle fleet. These include:

- **Approving vehicle requests prior to approving staffing requests.** This creates uncertainty when departments are requesting vehicles for new hires. It also requires fleet managers to verify that hiring requests have been approved before proceeding with vehicle purchases.
- **Adding vehicles to the Port's fleet without the fleet managers' approval**. Departments can expense small equipment without consulting the fleet manager (for equipment that costs less than $20,000 per piece of equipment). Vehicle purchases can also bypass the fleet manager if those purchases are budgeted as part of a larger capital project (e.g. the International Arrivals Facility project). Purchasing vehicles without involving the fleet manager leads to less uniformity

[10] The Port pays cash for vehicle purchases and then bills individual departments for the annual depreciation value of those vehicles. This prevents large spikes in departmental budgets. Light-duty equipment like sedans, pickup trucks, vans, and SUVs are typically depreciated over fifteen years, with exceptions for high-use vehicles used by police, AV operations, and AV security. Heavy-duty and specialized equipment typically has longer depreciation cycles of 20 years or more.

in the Port's equipment. It can also create surprises when the fleet manager is not told about equipment purchases until that equipment needs maintenance.

- **Lack of consistency among vehicles serving similar functions.** Establishing more uniformity across the fleet simplifies maintenance and makes it easier to reassign vehicles among departments as necessary. Some departments can be resistant to using or purchasing a vehicle recommended by the fleet manager because they prefer a similar model with minor differences (e.g., nicer seats or in-vehicle electronics). Having a standard set of vehicle models and in-vehicle options for all AV fleet purchases would make it easier to move vehicles within the fleet. Being able to move vehicles between departments when necessary allows fleet managers to more effectively perform maintenance and meet the operational needs of the AV fleet.
- **Budget silos reduce flexibility.** Because each department includes the vehicles they use in their budgets, departments often feel a strong sense of ownership over the vehicles they regularly use. This can be beneficial, since users treating fleet assets with care can lead to lower maintenance costs. However, this sense of financial ownership can also be a barrier to reassigning vehicles among departments as necessary. All the resources to procure and maintain vehicles ultimately come from the Port's overall budget. Promoting more flexibility around fleet assets would give fleet managers more support to reassign vehicles as necessary.
- **Vehicle purchase costs are charged back to departments, but maintenance costs are not.** This can create a perverse incentive for a department to hang on to fleet assets with high maintenance costs, since the department pays for the replacement but not the ongoing maintenance. To avoid this situation, the Port could consider mechanisms to bill back some portion of maintenance costs to individual departments.

Implementing Fleet Strategies: Benefits and Costs

Emissions reductions

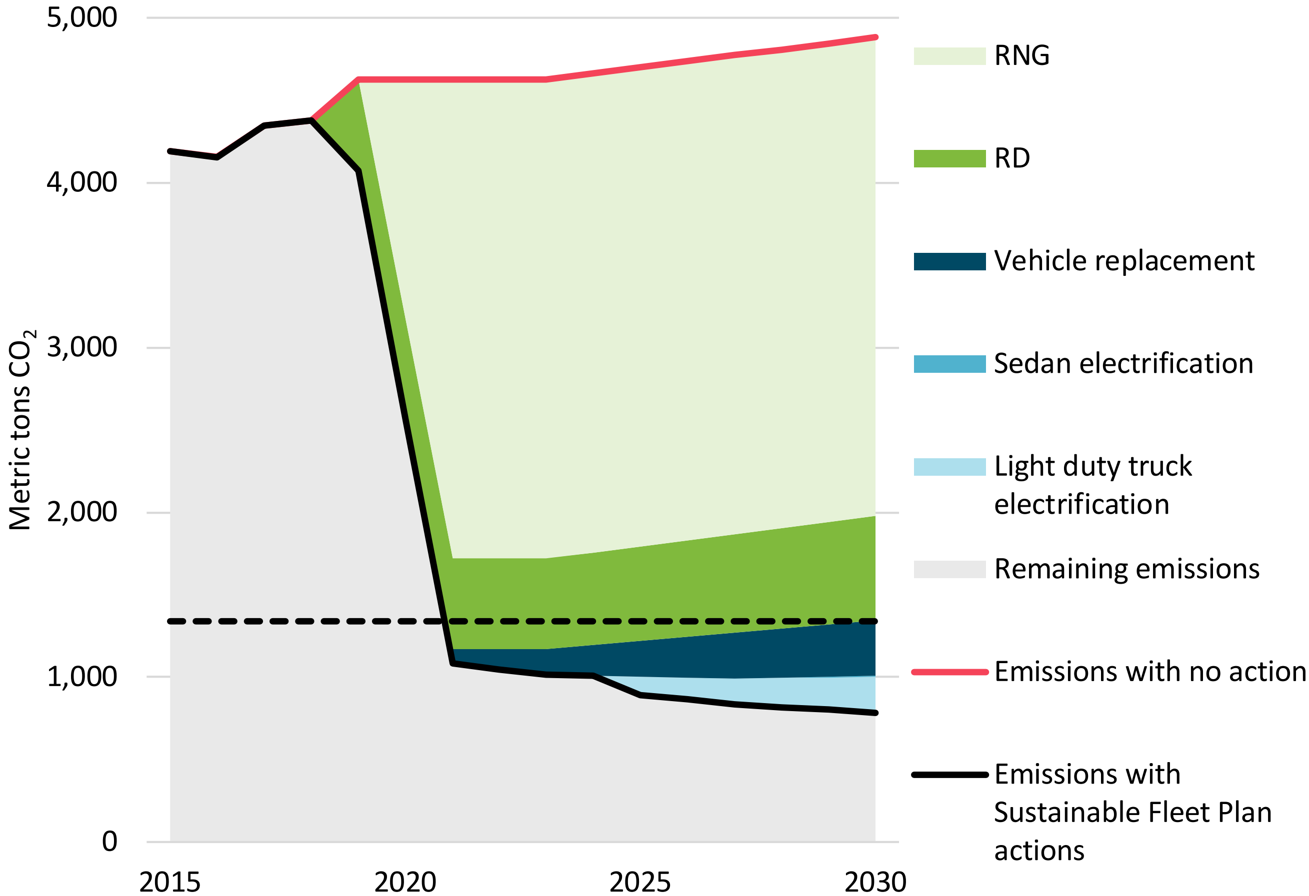
The Port of Seattle's Century Agenda establishes the goal of reducing emissions from Port-owned sources, like the AV fleet, 50 percent below 2005 levels by 2030. One of the key motivations for creating this plan is to quantify how much the strategies proposed here will contribute to meeting that goal.

This section describes the emission reduction potential associated with some of the strategies proposed above. Some operational strategies, like improving data quality, investing in telematics, or implementing driver trainings, will help reduce emissions but their effects are difficult to quantify. We did not attempt to estimate the emission reduction potentially associated with these strategies. Instead, we focused on analyzing the strategies for which the emission reduction and cost implications are more certain. These strategies are:

- Replacing fossil natural gas with RNG
- Replacing conventional diesel with RD
- Modernizing the fleet by replacing aging vehicles as well as right-sizing and standardizing vehicles when they are replaced
- Accelerating the conversion of AV fleet sedans to EVs and continuing to purchase carbon-free electricity

The cumulative emission reduction potential from these strategies is shown in Figure 10. **The combined effect of the strategies considered here has the potential to reduce AV fleet emissions to about 84 percent below 2015 levels by 2030.**

Figure 10. 2030 GHG emission reduction potential of Aviation SFP strategies



Renewable fuels are key to the Port's efforts to reduce fleet emissions. RNG has a significant and immediate impact on AV fleet emissions, reducing emissions by about two thirds, or 3,000 metric tons. Unlike other strategies that require time to phase in or for the vehicle fleet to turn over, the emissions benefits from RNG are realized as soon as a fuel source is procured. Likewise, RD has the potential to immediately reduce about 600 metric tons of GHG emissions per year between 2020 and 2030.

Vehicle replacement and right-sizing also have the potential for large emissions reduction benefits, with almost 400 metric tons of emission reduction by 2030. While slower to be realized, the cumulative effects of fleet modernization and right-sizing are comparable to those from purchasing renewable diesel by 2030. Unlike CNG and RNG, vehicle replacement reduces fuel use, potentially also saving cost in addition to reducing emissions.

Accelerated vehicle electrification showed the smallest benefit of the strategies analyzed here. This is because of the relatively small number of sedans in the AV fleet compared to other types of vehicles like SUVs and trucks (as shown in Figure 4).[11,12]

Although electric versions of SUVs and trucks are not currently available, they are likely to become widely available within several years. Because the AV fleet includes many SUVs and trucks, we estimated the potential benefit of electrifying these vehicles, assuming the Port begins purchasing EV trucks and SUVs in 2024. This date is a representative estimate that could shift by a year or two depending on the availability of this technology. As shown in Figure 10, the emission reduction potential for EV trucks and SUVs is much greater than that from sedans in the AV fleet, potentially exceeding 200 tons of CO_2 emissions avoided per year by 2030.

Costs

Many of the strategies described above save money for the Port while also reducing greenhouse gas emissions. This section describes the potential cost savings associated with several of the Port's sustainable fleet strategies.

Right-sizing the fleet

Fixed costs are a significant portion of the Port's expenditure on fleet vehicles. As shown in , for the average fleet, fixed costs like depreciation, insurance, license, and registration, are more than 75 percent of the total cost of vehicle ownership. The Port incurs these costs for every vehicle in the fleet regardless of how much a vehicle is driven. These fixed costs can be over $30,000 over the 15-year lifetime of a sedan or a pickup truck. As a result, every vehicle that the Port is able to remove from the fleet or avoid purchasing b ecause the need for the vehicle can be met through some other means like pooling has the potential to save the Port tens of thousands of dollars.

Right-sizing vehicles

Smaller and more efficient vehicles can reduce fleet costs while also limiting greenhouse gas pollution. To analyze the lifecycle cost and carbon impacts of different vehicle choices, we used the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool[13] developed and maintained by Argonne National Laboratory.

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[11] The potential benefit from electrifying sedans assumes that the AV fleet dramatically increases the rate of sedan electrification starting in 2021. Achieving these benefits will require a large increase in the amount of EV charging available to fleet vehicles. Without this investment, the emission reduction achieved through electrification will almost certainly be smaller than shown in Figure 10.

[12] Figure 10 does not include the potential benefits associated with electrifying larger passenger vehicles, like SUVs, vans, and light trucks. There are not currently widely-available electric options for these vehicle types. However, many manufacturers have announced new electric versions of these types of vehicles that will be available soon, possibly as early as 2021 or 2022. With a wider range of EVs available, the potential benefit from electrification will increase. However, so too will the limitations from the lack of available EV charging for AV fleet vehicles.

[13] https://greet.es.anl.gov/afleet_tool

Table 1: Total cost of ownership and carbon reduction potential of light-duty vehicles over a 15-year vehicle replacement cycle

	Sedan			Truck / SUV	
Make & model	Toyota Corolla	Toyota Prius	Nissan Leaf	Ford F150	Toyota Rav4 hybrid
Fuel type	Gasoline	Gasoline hybrid	EV	Gasoline	Gasoline hybrid
Costs (thousand $)					
Depreciation	18.2	23.0	26.8	20.4	27.1
Fuel	4.0	2.6	1.1	5.7	3.4
Maintenance and repair	6.2	6.1	5.7	7.4	6.1
Insurance, license, and registration	13.8	13.8	13.8	13.8	13.8
15-year total cost of ownership	**42.3**	**45.6**	**47.4**	**47.3**	**50.5**
Lifetime CO_2 emissions (metric tons)	14.2	9.3	0.0	20.2	12.1
Cost per ton of CO_2 savings ($)	**NA**	**656**	**354**	**NA**	**386**

The total cost of ownership (TCO) for various fleet vehicle options are shown in Table 1.[14] For sedans, both a Nissan Leaf electric and a gasoline hybrid Prius are more expensive than the gasoline counterpart, a Toyota Corolla. The TCO for a hybrid vehicle is 8 percent higher than the comparable conventional vehicle, while the TCO for an EV is 12 percent higher. The cost benefit from fuel savings from the gasoline hybrid and EV is relatively smaller than the higher purchase price of those vehicles. The AFLEET tool shows a small benefit in maintenance costs for the EV but not enough to balance the increased initial cost.

Each EV sedan displaces about 14.2 metric tons of CO_2 over its 15-year life, while a hybrid sedan displaces about 4.9 metric tons of CO_2. Comparing these to the cost premium of the electric fuel vehicles, the cost per ton of carbon reduction is $354 per ton for an EV sedan and $656 per ton for a hybrid sedan.

We also compared the TCO of a gasoline hybrid SUV, the Toyota Rav4 hybrid, with that of a Ford F150 pickup truck. Replacing an F150 with a Rav4 represents not just an improvement in efficiency but a reduction in vehicle size consistent with the AV fleet's right-sizing efforts. It should be noted, however, that not all pickup trucks are candidates for right-sizing.

As with sedans, the gasoline hybrid SUV had a higher TCO, by 7 percent, than the gasoline counterpart. Each gasoline hybrid SUV displaces 8.1 tons of CO_2 over 15 years, resulting in a cost of $386 per ton of carbon reduction.

While Table 1 shows that EVs and hybrids are more expensive than comparable conventional vehicles, the difference is small and sensitive to modeling assumptions. Vehicle purchase is the largest cost for any vehicle in our model, and the prices used were those for new model year 2020 vehicles. However, initial costs could be lower if the AV fleet purchases used vehicles. Moreover, the costs for EVs relative

[14] As with the analysis of the greenhouse gas benefits from vehicle right sizing, this analysis focuses only on replacement of gasoline vehicles. These vehicles tend to have more regular replacement cycles and less specialized use cases. Also, the cost of installing EV charging infrastructure is not included in this analysis of total cost of ownership. Ideally, this analysis would include an averaged, amortized cost associated with installing this infrastructure Port-wide. However, there is significant uncertainty about these potential costs.

to conventional vehicles are expected to fall in the coming years as batteries continue to get cheaper. The main cost savings of EVs and gasoline hybrids is in fuel. Vehicles that are used more consume more fuel, and thus the cost savings for EVs is greater for high-use vehicles.

Purchasing Renewable Fuels

Renewable natural gas (RNG)

In April 2020, the Port signed a 10-year contract for RNG and began receiving RNG for our bus fleet as well as our boilers on October 1, 2020. While the RNG is not dispensed directly into our buses, the Port's contract resulted in RNG being added to natural gas lines in the U.S., thus displacing fossil-based natural gas, essentially resulting in net zero carbon emissions from the Port's bus fleet. Also, because this renewable fuel is being used in on-road vehicles, the Port's use of RNG in our bus fleet generates federal credits under the national Renewable Fuels Act. There credits ensure that the Port pays the same price for RNG as it does for natural gas.

Renewable Diesel

In 2018 and 2019, RD averaged $2.62 more expensive per gallon that conventional diesel ($5.18 per gallon versus $2.56 per gallon). The AV fleet is projected to consume 54,000 gallons of diesel in 2019, increasing to 66,000 gallons in 2030. The total cost of purchasing RD to meet this level of demand is roughly $280,000 in 2019 to $340,000 in 2030. This represents a price premium of $140,000 in 2019 and $170,000 in 2030 relative to conventional diesel. However, it should be noted that future prices for renewable diesel, especially as far as 2030, are extremely uncertain.

Renewable Electricity

The carbon benefits of EVs depend on the carbon intensity of the electricity used to charge those vehicles. Historically, the Port has utilized very low-carbon electricity and purchased renewable electricity when necessary.

Of the three utilities that serve the airport, PSE has the highest amount of fossil fuels in its electricity generation mix. The Port purchases electricity generated by renewable sources through PSE's Green Direct program. The cost premium for this program is $0.05 per kWh. The carbon intensity of the electricity that the Port would receive without the Green Direct purchase agreement is 446 grams per kWh. Dividing the incremental cost by the carbon emission reduction, the cost of the Green Direct program is $112 per ton of CO_2 emissions avoided.

Other barriers to implementation

Lack of EV charging

The Port currently purchases EV sedans when possible. However, fleet managers cannot purchase EVs unless charging infrastructure is in place to serve those vehicles as soon as they enter the fleet. Charging infrastructure is currently limited at Port facilities, which prevents the AV fleet from purchasing EVs. It can take two years or more to install additional EV charging, whereas fleet procurement needs and vehicle staging locations can change on shorter timescales. A group requesting an EV could get assigned to a new location in the time it takes to create and execute a project to install charging for that vehicle.

Lack of data

Lack of data is one of the biggest barriers to implementing the strategies described in this plan. In some cases, the Port is not currently collecting necessary data. In other cases, like vehicle fuel use, while the

AV fleet is collecting data, that data is difficult to access, analyze, and visualize. Without sufficient data, it is difficult to prioritize between strategies or to target investments to get the highest return in cost savings and emission reduction.

Opportunities for improving the AV fleet's data include:

- **More accurate fueling data**. Improvements could include better integration of on-site and off-site fueling transactions as well as more automation to prevent data entry issues. Like most fleets, the Port currently contracts with a third party for fuel data management software that is integrated with fuel purchasing cards. Data system improvements could be implemented as part of an updated fuel management vendor contract.
- **More insight into vehicle utilization**, including where vehicles are used and how much idling occurs. This data could be captured with a telematics program.
- **Better data analytics tools** that can automate data analysis and visualization.

Recommendations and next steps

Creating this plan has been a collaborative process between the Port's sustainability teams and fleet managers, including both AV and Maritime divisions. The information shared in that process and the data analysis to support this plan demonstrates that fleet managers have already begun the process of reducing GHG emissions from the Port's fleet. However, there are several areas where fleet managers could use more support to more quickly and effectively reduce fleet GHG emissions and cost.

Pursuing the following steps will ensure that the Port continues to operate a sustainable and efficient fleet:

- **Develop an EV readiness strategy.** AV Env and the AV fleet manager will collaborate on a plan to guide the deployment of EV charging infrastructure and vehicles, building off the findings of this Sustainable Fleet Plan. This plan will evaluate current and future charging needs, prioritizing opportunities for EV charging based on GHG reduction potential, installation cost, and infrastructure availability. This plan will help speed the AV fleet's transition to EVs while also preparing for the future deployment of EV trucks and vans that are not yet commercially available.
- **Support the fleet manager's efforts to replace older, less efficient vehicles with cleaner alternatives**. Port leadership should allocate funding to replace aging, inefficient vehicles as budget allows.
- **Continue purchasing renewable fuels,** including RNG and RD.
- **Support fleet manager in right-sizing fleet and vehicles**. Port executive leadership team members should encourage directors to work with the fleet manager to match vehicles to staff needs and avoid purchasing unnecessary vehicles and "pool" vehicles where possible.
- **Align internal policies and purchasing procedures with sustainable fleet goals.** The Port's FMOT should work with CPO and the F&B department to simplify the vehicle purchase process and better incorporate fleet management needs into the budgeting process and timelines.

CHAPTER 2

Maritime Sustainable Fleet Plan

Developed by Maritime Maintenance and Maritime Environment & Sustainability

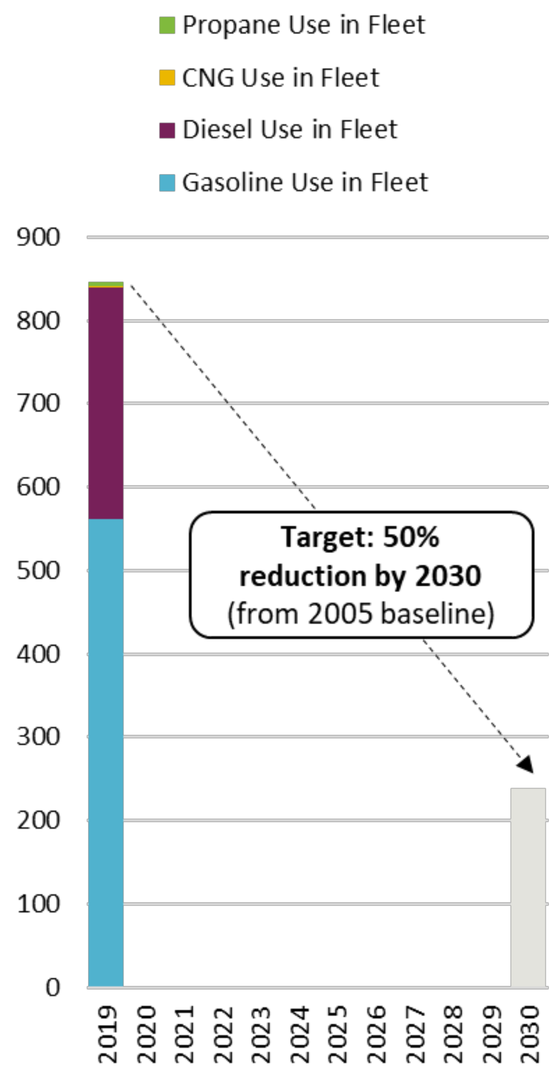
Chapter 2: Maritime Sustainable Fleet Plan

Developed by Marine Maintenance and Maritime Environment & Sustainability

About the Maritime Sustainable Fleet Plan

The Port is committed to be the greenest port in North America. This commitment is reflected in the Century Agenda strategic objectives and significant investment in environmental programs. In 2017, Port of Seattle Commission adopted GHG reduction targets to deeply "decarbonize" maritime activity and achieve carbon neutral or carbon negative emissions from port-owned or controlled sources by 2050. In the interim, the Port aims to cut emissions in half from the 2005 baseline by 2030. In the Port's Maritime and Economic Development Divisions -- the scope of this chapter – mobile fuel use from fleet vehicles and equipment accounts for nearly one third of all port-owned or controlled emissions. In fact, emissions from fleet vehicles and equipment have increased slightly since 2005, leaving a significant gap to close between current levels of fuel use and emissions and the Port's 2030 and 2050 targets. Additionally, in April 2021, Port Commission adopted a renewed Northwest Ports Clean Air Strategy (NWPCAS), which includes a shared objective for the port authorities to adopt zero-emissions vehicles, equipment, and vessel fleets by 2050, and adopt zero-emission vehicles or use renewable fuels for passenger fleets by 2030.

Figure 11. Fleet Emissions with the scope of the Maritime Sustainable Fleet Plan



The Maritime SFP chapter, co-developed by Marine Maintenance and the Maritime Environment & Sustainability (ME&S) departments, recommends strategies that can reduce emissions from fleet vehicles and equipment and transition light-duty passenger vehicles to electric or renewable fuels over the next 10 years. The strategies identified in this chapter will help the Port meet both climate and clean air goals and its operational needs through sustainable fleet management.

Scope of the Maritime Sustainable Fleet Plan

The Maritime SFP chapter supports the ongoing work of the Marine Maintenance (MM) Fleet manager and is focused on fleet vehicles and equipment used by the Maritime Division, EDD, and Corporate Division. This chapter does not cover fleet assets associated solely with SEA, which are separately managed by the AV Fleet manager and discussed in Chapter 1.

The fleet assets covered by the Maritime SFP are further divided into two fleet categories: maritime (MAR) and corporate (COR).

- The "**MAR fleet**" includes vehicles and equipment that serve the Maritime Division and EDD.

- The "**COR fleet**" includes vehicles and equipment that support services that cross the Port's operating divisions (AV, EDD, and Maritime). This category includes vehicles used by PCS, Engineering, ECT, External Relations, and Executive Services.

As mentioned in the Executive Summary, there are some exceptions where vehicles that primarily operate in and around SEA are included within the scope of the Maritime SFP. This overlap occurs primarily within the COR fleet, which includes the Engineering and PCS departments. These departments serve all of the operating divisions of the Port. Because there is overlap in vehicle location and area of operation, fleet assets were categorized into the MAR, COR, or AV fleets based on their subclass billing code used in accounting. In this way, the fleets are split based on the division or department that pays for the asset and by which fleet manager controls purchasing decisions. Assets with subclass codes associated with the AV Division are not included in the scope of the Maritime SFP. Assigning vehicles to a fleet category by subclass code was necessary because there currently is not a field in the fleet asset database that consistently assigns a vehicle to one fleet manager or one location.

Table 2 outlines the business units within the MAR and COR fleet distinction. While both the MAR and COR fleets are managed by the MM fleet manager, distinguishing between the two fleets is important because replacement of COR assets is funded separately from assets that fall under MAR or AV.

Table 2: Definition of the Maritime and Corporate Fleets

MAR Fleet	COR Fleet
Includes vehicle and equipment assets that support: • Bell St Common Areas • Bell Street Vessel Operations • Container Management • Container Terminal 5 • Container Terminal 18 • Cruise, Docks, Bulk, Industrial Administration • Fishermen's Terminal Commercial Fishing Operations • Maritime Industrial Center Commercial Fishing Operations • Pier 69 Facilities Management • Piers & Properties Maintenance • Salmon Bay Marina Operations • Seaport Environmental Services • S&P Maritime Security • Stormwater Utility Administration • Terminal 91 Cruise • Terminal 91 Operations	Includes vehicle and equipment assets that support: • Capital Development Administration • Engineering • Executive Services • External Relations • ICT • PCS

Overview of the Maritime and Corporate Fleets

Fleet Management Policy

The Fleet Management Policy (EX-17) establishes port-wide operating procedures for fleet vehicle utilization, acquisition, operation, assignments, maintenance, and disposal. It also includes a Green Fleet policy. MAR and COR fleet assets are managed by the MM Fleet Manger, who is responsible for the following per EX-17:

- Managing and coordinating all maintenance for fleet assets.
- Coordinating acquisition of fleet assets between the requesting department and purchasing.
- Assigning all fleet asset tag numbers, which are unique identifiers for each vehicle or piece of equipment.
- Coordinating disposal of all fleet assets in accordance with the Port's disposition policy.
- Notifying Accounting of changes to capital assets of the fleet.
- Requesting and reviewing prospective vehicle acquisition and long-term lease requests in coordination with the annual budget review and budget planning processes.
- Participating in FMOT, which maintains the Fleet Management Policy and ensures it is current and applicable to laws and operational needs.

Fleet Assignments and Purchase Process

Port fleet vehicles are assigned to divisions in several different ways to meet Port business and operational needs, as outlined in EX-17 and summarized below:

- **Department Assigned Fleet Assets** – Port fleet and special purpose assets assigned to a specific department or worksite. These fleet assets are restricted for use by the specific department and are not available for daily use by other Port drivers.
- **Assigned Take-Home Vehicles** – A Port vehicle for which a Port employee has been granted written permission by the Division Director to take a Port Vehicle between the Port and their residence on a daily basis.
- **Assigned Vehicle** - A Port vehicle which has been assigned to a specific driver for Port business purposes; not to be taken overnight, for commuting, or for non-Port business.
- **Pool Vehicle** – Port vehicles assigned to a location or department that are available for general check-out by Port drivers on a daily basis. Pool vehicles exclude vehicles assigned to an individual, skilled crafts or trades groups, or Port Fire or Police personnel.
- **Temporary Take-Home Vehicle -** A vehicle for which a Port driver has requested and been granted permission to take to their residence for one or more nights or to attend Port business in another county, state, or country.

For department-assigned fleet assets, each department has a representative responsible for working with the Fleet manager to assess the vehicle and equipment needs for the department, purchase or reassign assets, validate the location, and notify the fleet manager of any changes in ownership, assignment, damage, maintenance needs or lost or stolen assets.

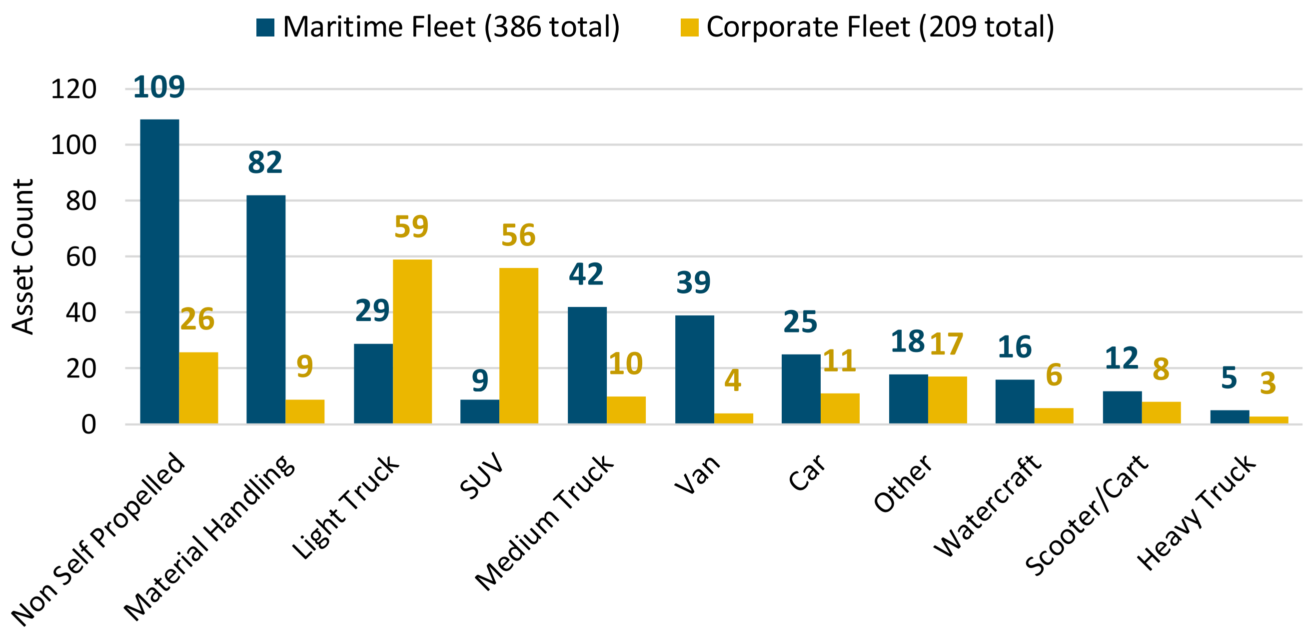
The fleet manager and department should work together on purchasing decisions. The department and fleet manager will discuss and agree on what vehicles need to be procured, then the fleet manager includes the vehicle purchase in the proposed annual budget for the following year. Most purchase requests are made through the Port's small capital budget funding cycle, but this process can depend on the cost of the vehicles or equipment.[15] When new vehicles are received, those being replaced are removed from the fleet. Challenges to this process arise when departments bypass the fleet manager in purchasing, such as by expensing small equipment (less than $20,000) without consulting the fleet manager or by including equipment purchases as part of a large capital project budget. Purchasing vehicles without involving the fleet manager leads to less uniformity in the Port's equipment. It can also create surprises when the fleet manager is not told about equipment purchases until the equipment needs maintenance. Standardizing purchase procedures to centralize the role of the Fleet manager is a critical step to ensure the recommendations of this plan are incorporated into vehicle and equipment purchasing decisions.

Fleet Description

The MM fleet manager manages nearly 600 vehicle and equipment assets across the MAR and COR fleet categories. These assets serve a variety of operational needs from boats used to inspect docks and service port marinas to cars, vans, and pickup trucks that allow staff to conduct field work and travel between job sites. Fleet assets primarily use gasoline and diesel, with more diesel assets and heavy diesel equipment in the MAR fleet compared to the COR fleet. Marine Maintenance has dispensed B20 diesel since 2008 and began dispensing RD in late 2019. A very small percentage of assets run on electricity or propane, but the fuel use is negligible compared to gasoline and diesel assets. Marine Maintenance disposed of all compressed natural gas (CNG)-powered vehicles and equipment in 2019.

The **MAR fleet has nearly 400 assets** in operation, including light and heavy-duty trucks, passenger cars, SUVs, watercraft, and a range of other equipment used for maintenance, construction, and material handling. The **COR fleet includes over 200 assets** in operation, including trucks, SUVs, passenger cars, vans, electric scooters and carts, watercraft, and other equipment primarily used for grounds keeping and maintenance. More detail on the descriptions of these asset types is included in Table 3.

Figure 12. Fleet Composition: Maritime and Corporate Fleets



[15] Requests for equipment that costs more than $300,000 per vehicle are handled through the Port's large capital budget process. Items that cost less than $20,000, like scooters, can be expensed.

Table 3: Vehicle and Equipment Asset Type Descriptions

Asset Type	Description
Car	Includes subcompact to full-size passenger cars, such as a Honda Civic, Toyota Prius, or Ford Taurus.
SUV	Includes Chevrolet Blazers, Chevrolet Suburban, Ford Escape, Ford Explorer, Ford Edge, Jeep Cherokee, Toyota Rav4 Hybrid
Van	Includes passenger and cargo vans up to a Gross Vehicle Weight Rating (GVWR) of 16,000 pounds (lbs.), such as Dodge Sprinter, Mercedes Sprinter, Dodge Caravan, Ford Transit Van/Cargo Van
Light Trucks	Includes Class 1-2 trucks with a GVWR under 10,000 lbs., such as Chevrolet Silverado, Ford F150, Ford F250
Medium Trucks	Includes Class 3-6 trucks with a GVWR between 10,0001-26,000 lbs., such as utility box trucks, Ford F450, Ford F550
Heavy Trucks	Includes Class 7-8 trucks with a GVWR above 26,000 lbs., such as dump trucks, sweepers, and sewer cleaners
Material Handling	Includes forklifts, manlifts, and hoists
Non Self Propelled	Includes assets that do not move. Some non self propelled assets consume fuel, such as generators and air compressors. Others do not use fuel, such as trailers, chassis, barricades, and light posts.
Watercraft	Includes workboats and outboard motors.
Scooter/Cart	Includes electric scooters and carts, such as an EZ Go Scooter, John Deere Electric Gator, golf cart, or Polaris GEM.

With more vehicles and equipment in its fleet, the MAR fleet consumes more fuel than the corporate fleet. The MAR fleet consumed 41,000 gallons of gasoline and 20,000 gallons of diesel in 2019. Light to medium trucks and vans consumed the most gasoline in the MAR fleet, and heavy and medium trucks consumed the most diesel. The COR fleet consumed 17,500 gallons of gasoline and 7,400 gallons of diesel. Light trucks and SUVs consumed the most gasoline in the COR fleet, and heavy and medium trucks consumed the most diesel. By department, Marine Maintenance is the biggest consumer of both gasoline and diesel in the maritime fleet. In the corporate fleet, Engineering consumes the most gasoline across its light trucks, SUVs, and cars. Vehicles used by PCS account for all of the diesel used by the COR fleet.

Figure 13. Gasoline Use by Asset Type, 2019

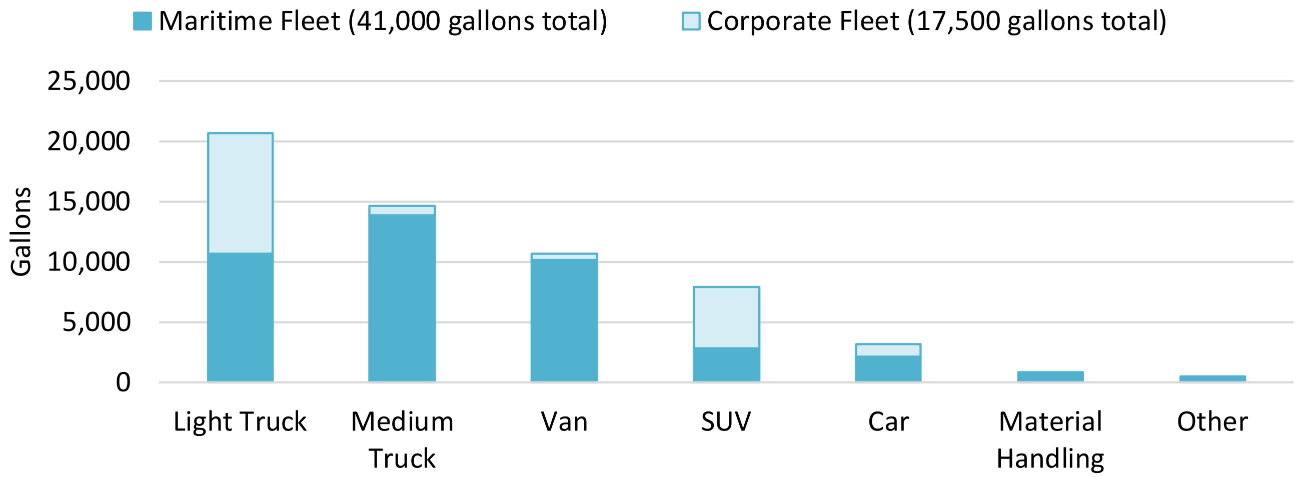
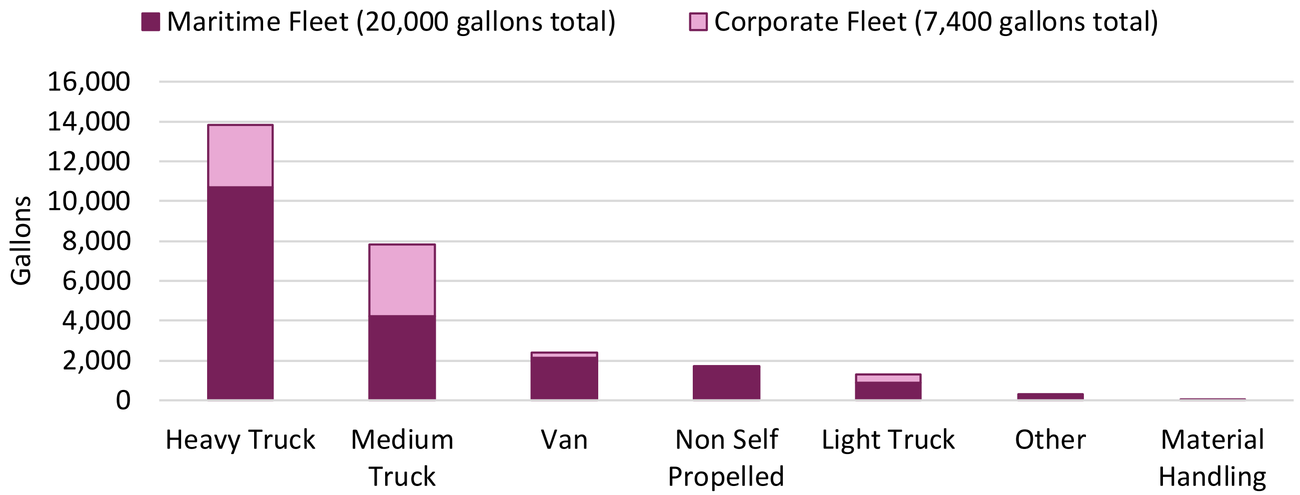


Figure 14. Diesel Use by Asset Type, 2019



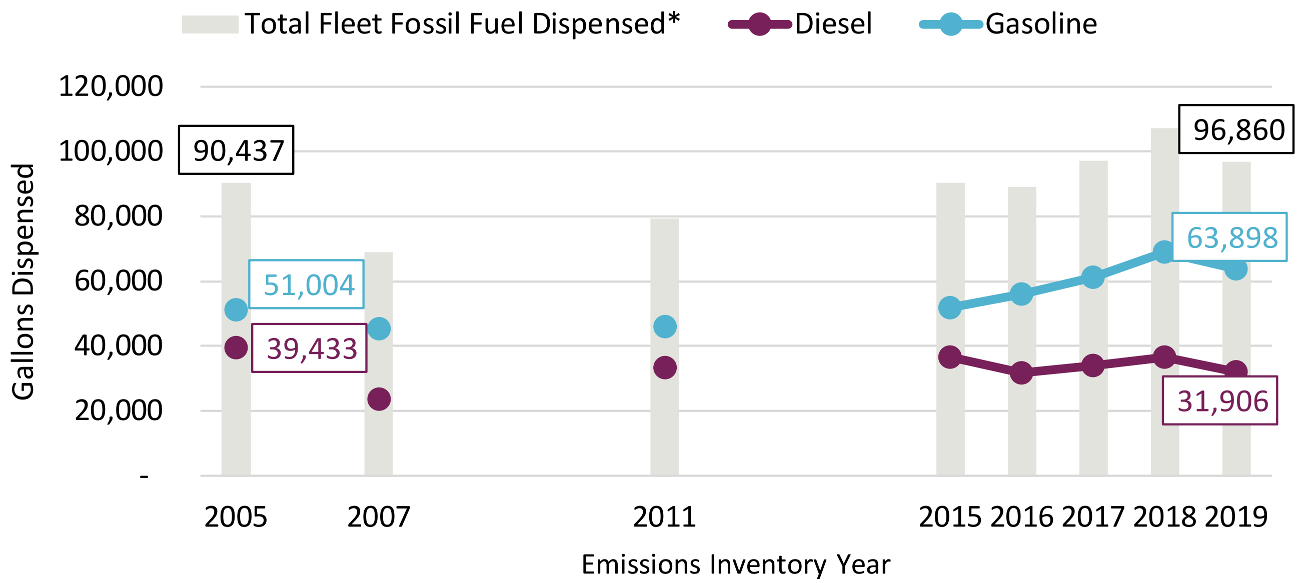
Why We Need Sustainable Fleet Strategies

Gasoline use has increased

While fuel use can vary year to year, total gallons of fuel used by MAR and COR fleet vehicles is 7 percent higher in 2019 than the 2005 baseline. When this trend is broken down by fuel type, gasoline consumption drives the increase, with 25 percent more gallons of gasoline dispensed in 2019 compared to 2005. Diesel use (which in Figure 15 includes conventional diesel, B20, and RD) has decreased 19 percent as of 2019 compared to 2005.[16]

[16] The total gallons of fuel discussed in this section and accounted for in Figure 15 does not include fuel pumped at Aviation Maintenance. Some corporate fleet vehicles regularly fuel at the Aviation fuel tanks, that fuel consumption in captured in Figure 13 and Figure 14, but not in Figure 15 as historical fueling data is not available.

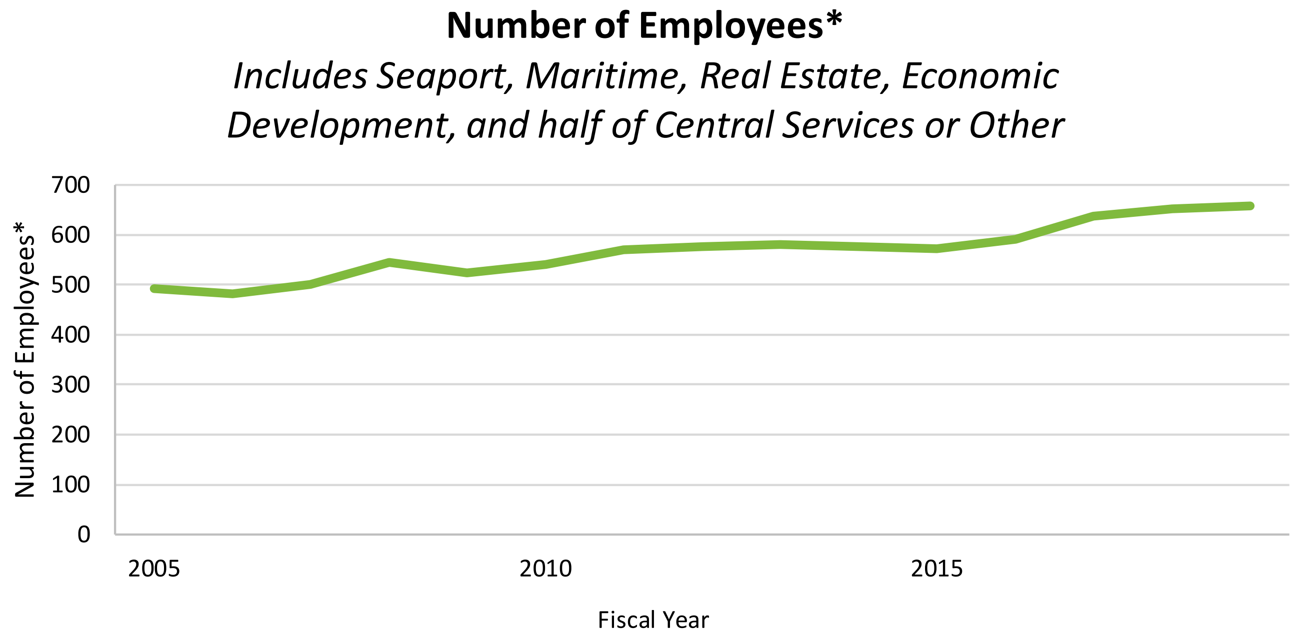
Figure 15. Maritime and Corporate Fuel Use Trends, 2005-2019



Note: Total gallons dispensed includes total gallons of all fossil fuels, including propane and CNG.

The increase in gasoline is a result of past purchase decisions. Diesel trucks can be more expensive and harder to maintain. Port staff also tended to prefer gasoline vehicles over diesel to avoid the smell of diesel fumes when idling. The number of Port employees within seaport, maritime, real estate, and economic development has also increased over the same period, including increases in the number of trades staff. With more staff driving demand for fleet vehicles, departments tend to hang on to older vehicles that continue to operate, even when vehicles are past their useful life. If the number of employees continues to increase in the future, increased needs for vehicles must be matched with aggressive funding requests to ensure on-time replacement of vehicles while still maintaining a fleet size that can meet operational needs.

Figure 16. Growth in Port Employees that use MAR/COR Fleet Assets, 2005-2019



Note: Employee total includes seaport, Maritime, Real Estate, Economic Development, and half of Central Services or Other. It does not include Aviation employees. Source: Port of Seattle 2019 Comprehensive Annual Financial Report and Port of Seattle Human Resources Database.

The fuel used to power MAR and COR fleet vehicles is a significant contributor to the Port's Scope 1 and 2 GHG emissions, contributing 32 percent of Scope 1 and 2 emissions in the 2019 Maritime GHG Emissions Inventory.[17] While fuel use has increased, emissions in 2019 from mobile fleet fossil fuel use are nearly the same as estimated emissions in 2005 due to the use of B20 diesel since 2008.[18] Diesel emissions are expected to continue to drop with the 2020 Maritime GHG Inventory as the Port will have used RD for all on-site fueling for a full year. Prioritizing diesel vehicle purchases over gasoline can decrease emissions in the short term if purchases of RD continue; however, actions are also needed to reduce gasoline and fuel use overall to meet both the Port's 50 percent by 2030 GHG emission reduction target and stay on track to be carbon neutral by 2050.

[17] The Port conducts annual GHG emissions inventories and measures emission levels from scope 1, 2, and 3 sources associated with the Port's waterfront and real estate lines of business to track progress toward achieving the Century Agenda targets. The Maritime GHG Emissions Inventory does not include emissions sources associated with SEA, which are accounted for in a separate inventory. Collectively, both inventories represent Port of Seattle's GHG emissions.

[18] GHG emissions estimates do not take into account lifecycle emissions for alternative fuels.

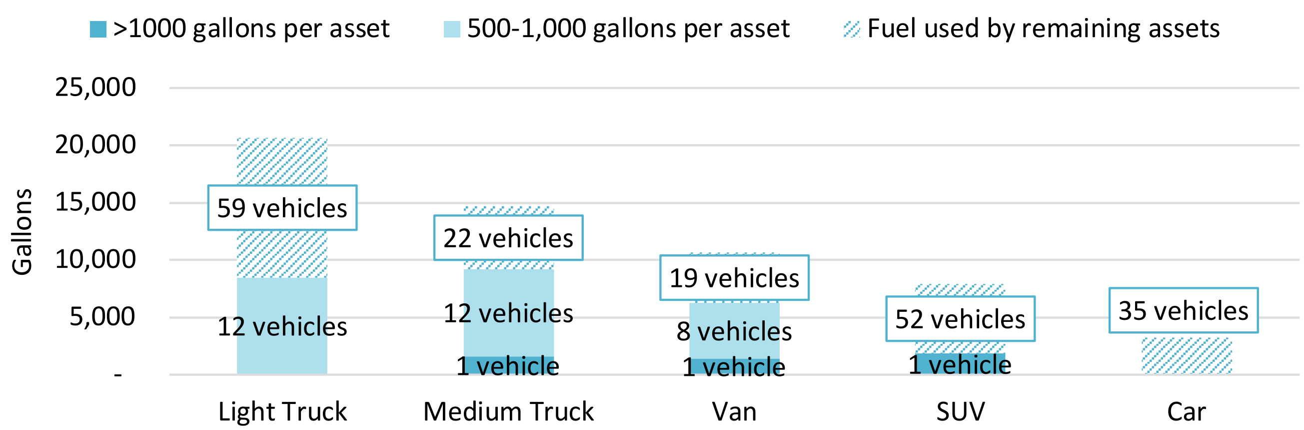
Only a few vehicles use most of the fuel

A small number of heavy fuel users account for most of the fuel used by the fleet each year. An analysis of MAR/COR vehicles found that of the 292 total rolling stock[19], only 14 percent of the vehicles accounted for half of fuel consumed in 2019. About 10 percent of rolling stock vehicles did not have records of fuel use.

Further analysis showed that fuel use per vehicle could vary widely. Some vehicles used more than 500 gallons of gasoline or diesel in 2019, and an even smaller number used more than 1,000 gallons. For gasoline assets, just 35 vehicles (out of 223 that used gasoline – 16 percent) used 45 percent of the gasoline dispensed in 2019. Heavy fuel users made even more of an impact on diesel use. Seven vehicles used more than half of the total diesel in 2019. All of these vehicles were medium or heavy trucks.

Vehicles that consume large amounts of fuel could be a source of low-hanging fruit to implement sustainable fleet strategies. These vehicles should be evaluated for replacement with more efficient or hybrid models, electrification, or opportunities to use drop-in renewable fuels.

Figure 17. Heavy Gasoline Fuel Users by Asset Type



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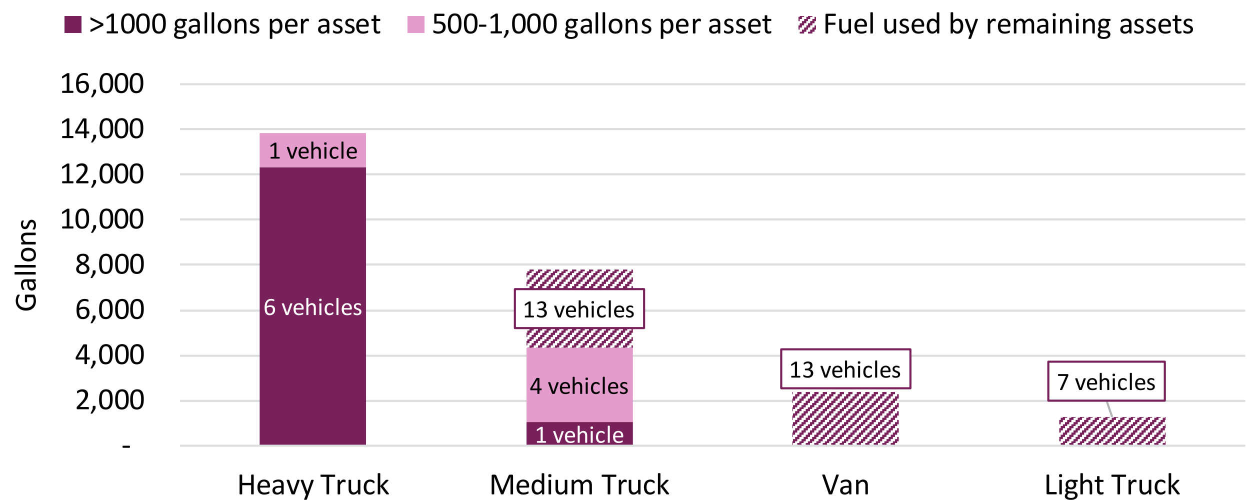
[19] Rolling stock includes cars, SUVs, trucks (light, medium, heavy), and vans. It does not include material handling, non self propelled, scooters/carts, watercraft, or other assets due to limited fueling data about these assets. Vehicles analyzed had a status of “operating” in 2019.

Figure 18. Heavy Diesel Fuel Users by Asset Type

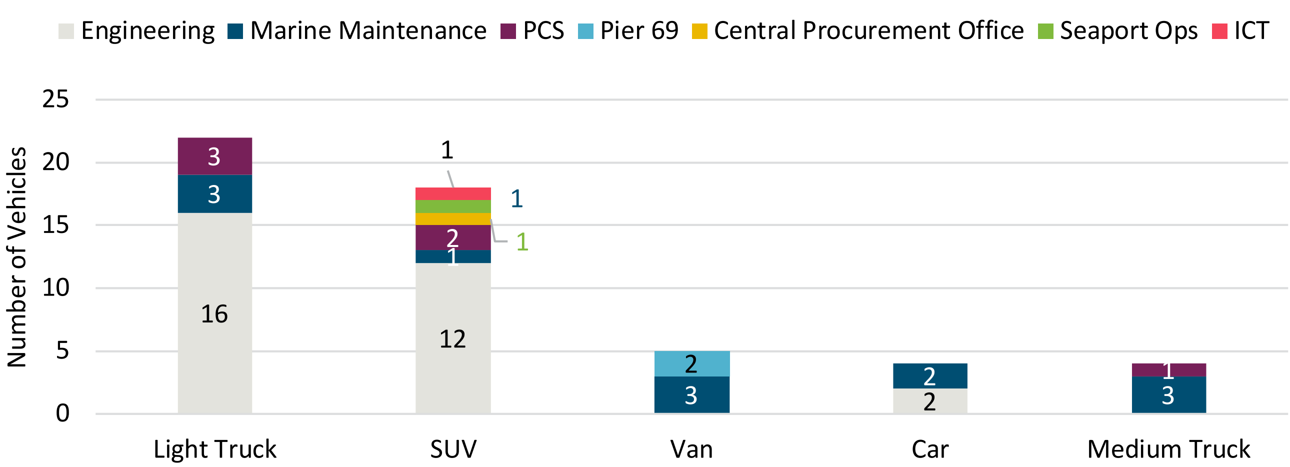


Note: MAR and COR fleet vehicles are combined for Figure 17 and Figure 18.

Some vehicles are under-utilized

On the other end of the spectrum, some assets are under-utilized in that they use only small amounts of fuel or did not have fueling data at all. In some cases, these assets may serve a specialized purpose or have hybrid engines. There are also some pieces of equipment, usually non self propelled or off-road equipment used for material handling, where fueling data is missing. These assets may fuel from a mobile fueling truck making it difficult to track fuel use for each piece of equipment. Of 254 non-hybrid rolling stock assets that did show up in the fueling data, 53 vehicles used fewer than 100 gallons of fuel in 2019. Most of these vehicles were gasoline-powered light trucks and SUVs serving Engineering, as shown in Figure 19.

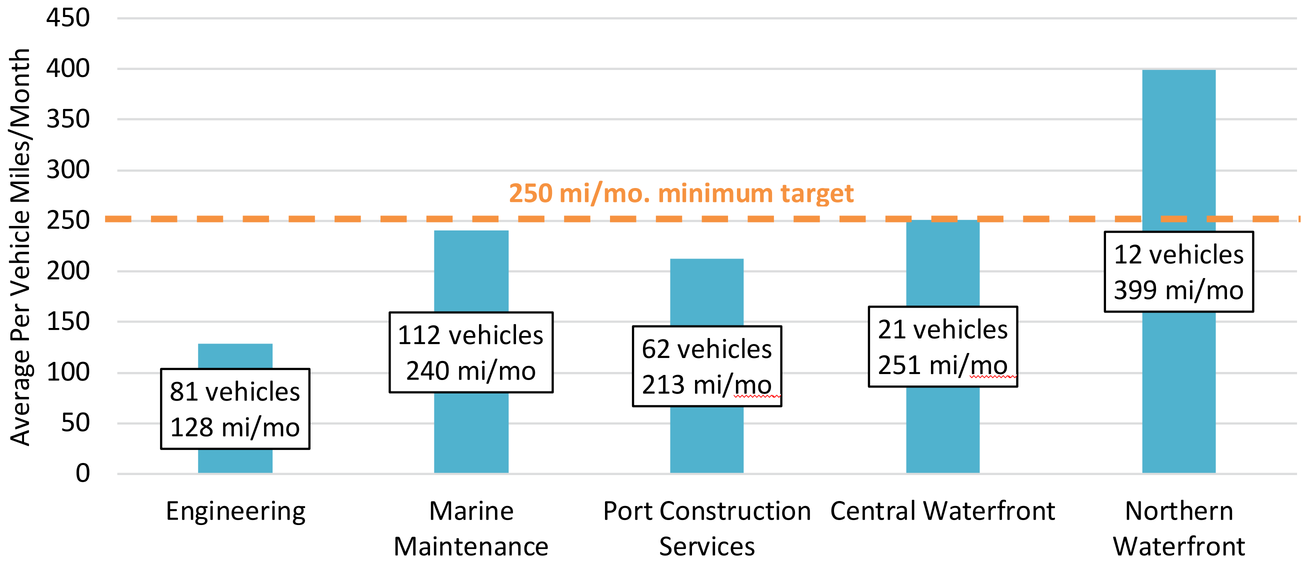
Figure 19. Count of Non-Hybrid Vehicles Using Fewer than 100 Gallons of Fuel by Department



Note: *Under-utilized assets are defined as non-hybrid assets that used fewer than 100 gallons of fuel (but more than 0) in 2019.*

An additional marker of vehicle utilization is number of miles driven per month. The State of Washington designates 250 miles per month as the standard for a fully utilized state fleet vehicle, and the Port has adopted this metric as a minimum utilization standard. An analysis of vehicle miles driven between 2017 and 2019 at different fleet locations and departments found a significant range in the number of miles a vehicle may drive in a month, and the average miles driven per month fell below the threshold for some departments or locations, as showed in Figure 20. Overall, 71 percent of vehicles analyzed drive fewer than the 250 miles per month utilization target.

Figure 20. Average Miles Driven Per Vehicle Per Month by Department/Location



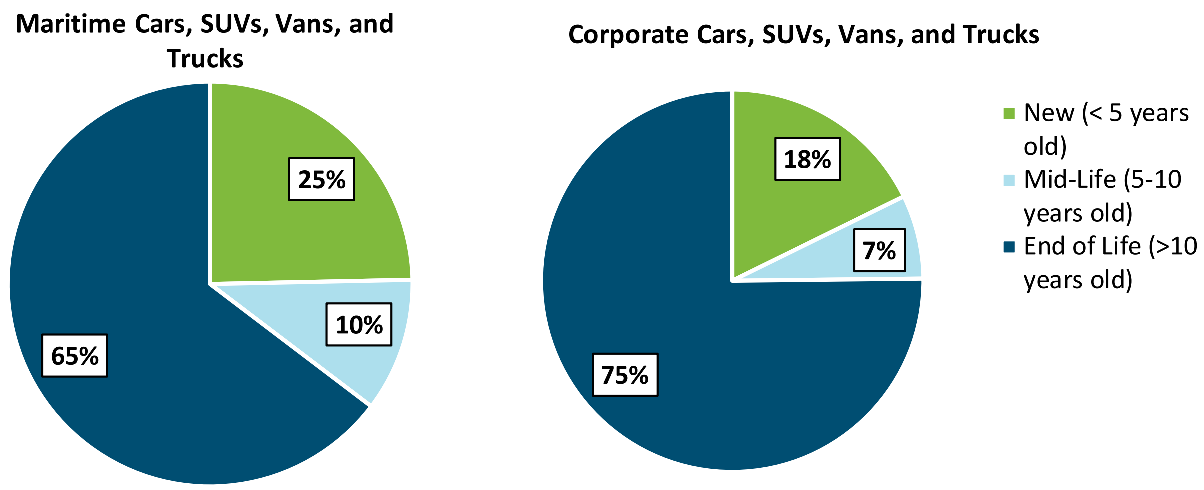
Under-utilized vehicles should be evaluated for pooling opportunities. Pooling makes vehicles available for use in a shared vehicle or equipment pool. This practice can reduce the overall fleet size, remove older vehicles without the need to budget for replacements, and increase the utilization of each vehicle. Shared equipment pools can also reduce the need to rent specialized equipment at a higher cost. In some instances, shared equipment will remain under-utilized, such as specialized equipment or equipment kept in the fleet as backup.

Vehicles are driven to failure

Vehicles nearing (or beyond) the end of their useful life operate less efficiently and have higher maintenance costs compared to new or midlife vehicles. These vehicles may also be lacking the emissions controls, improved fuel economy, and improved safety standards of newer model years. Road legal, passenger vehicles – cars, SUVs, vans, and light-duty trucks –have about a 15-year useful life, but the useful life can vary by vehicle type. With a regular schedule of vehicle replacement, at any point in time the age of the fleet should be balanced with roughly equal portions of new vehicles, midlife vehicles, and end of life vehicles. This equal balance is not the case with the MAR/COR fleets, according to the 2021 fleet replacement schedule where 60 percent of MAR/COR fleet vehicles are past their useful life, and 35 percent are 10 or more years past their useful life.

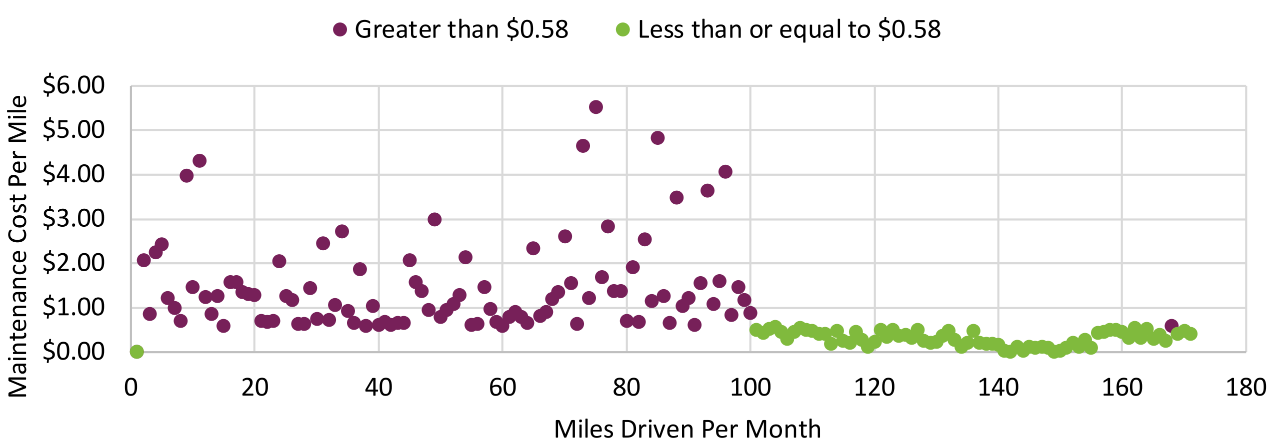
Figure 21 illustrates the relative age distribution of cars, SUVs, vans, and trucks in the MAR and COR fleets in 2019. Assuming a useful life of 15 years, 65 percent of MAR and 75 percent of COR fleet vehicles are at the end of their useful life. In an optimal replacement schedule, each age category should be equally balanced with one-third of the vehicles new, one-third mid-life, and one-third nearing the end of the vehicle's useful life.

Figure 21. Vehicle Age Distribution: Cars, SUVs, Vans, and Trucks



Replacing a vehicle requires an upfront capital investment and for departments to adequately budget and request for the replacement in capital planning. Port departments often retain older vehicles in the fleet until failure under the flawed assumption that a vehicle that still drives will cost less than a new purchase. However, as vehicles get older, the cost per mile to operate and maintain that vehicle increases. End-of-life vehicles are costing departments money that could be more effectively allocated to the purchase of replacements. Roughly two-thirds of COR vehicles and half of MAR vehicles have a per mile maintenance cost that exceeds the federal reimbursement rate for mileage driven in a personal vehicle ($0.58/mile), and about one-third nearly double the rate. Moreover, older vehicles are often not favored by drivers and not driven regularly. As a result, these vehicles are less likely to receive routine maintenance, which can lead to larger and more expensive problems when they are used. In fact, the more often a vehicle moves, the less it tends to cost per mile to maintain, as indicated in Figure 22.

*Figure 22. Miles Driven Per Month vs. Maintenance Costs Per Mile for Maritime and Corporate Fleet Vehicles**



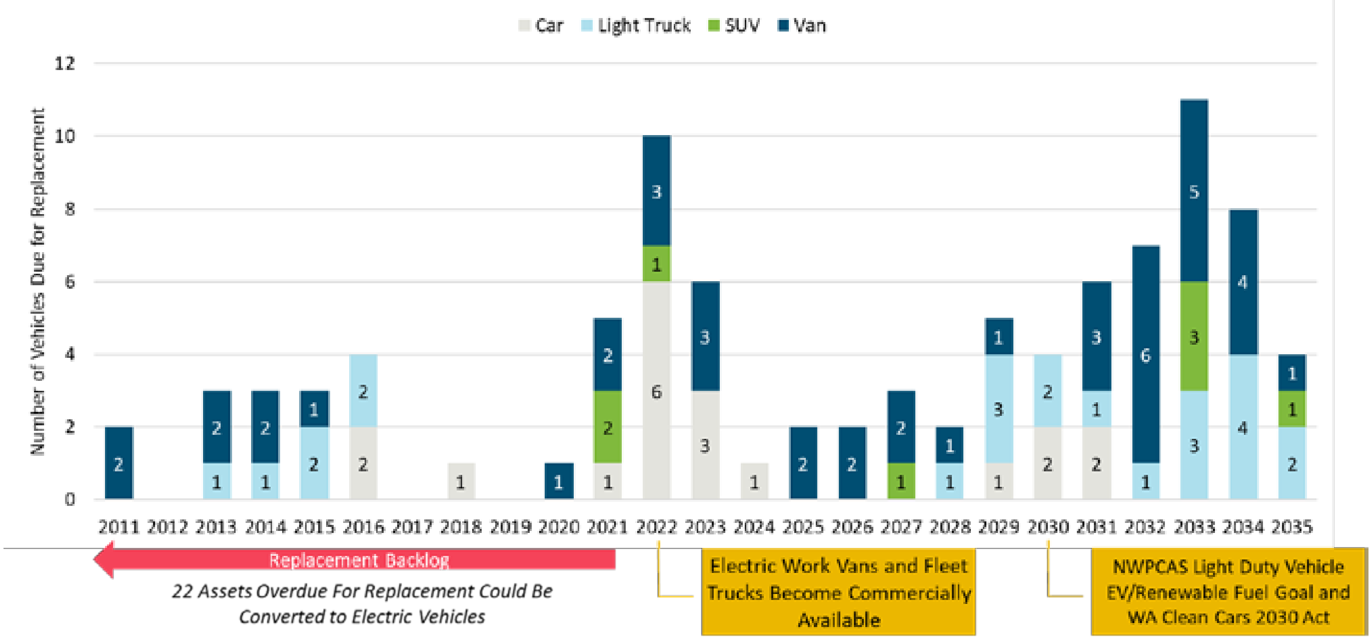
**Only includes vehicles classified as NAFA Class 1.*

Limited access to charging infrastructure prevents purchases of EVs

Figure 23. Level 2 EV charging at Fishermen's Terminal

Replacing older vehicles in the MAR/COR fleets presents an opportunity for the Port to invest in EVs. All-electric sedans (e.g., Chevy Bolt) are widely available and electric transit vans and light duty trucks are anticipated to enter the market by 2022. While Port fleet managers are tracking the availability of EVs for use in fleet, and the Port has a commitment in the 2020 NWPCAS to transition all light-duty vehicles to EV or renewable fuel by 2030, access to charging creates a 'chicken-or-the-egg' dilemma for fleet managers. Vehicles that need to be replaced could be replaced with EVs, but without EV charging stations accessible for fleet use across Maritime/EDD properties, EVs won't be able to fuel. As depicted in Figure 24, 75 percent of cars, light trucks, SUVs, and vans in the MAR fleet will be eligible for replacement by 2035, but charging infrastructure is needed to replace these vehicles with EV models. Of those vehicles, 22 are overdue for replacement at the time of writing in June 2021. These vehicles represent near-term opportunities for EV replacement if charging infrastructure were readily available for fleet use.

Figure 24. Maritime Fleet Electrification Opportunities



The Port has installed EV charging at Shilshole Bay Marina and Fishermen's Terminal, and the Port has plans to install six Level 2 charging ports at the Marine Maintenance South Yard by 2022, creating charging capacity for vehicles in Marine Maintenance's shared pool. However, charging stations are not widely available across Maritime/EDD properties, and the Shilshole and Fishermen's stations are not reserved for fleet use. Expanding charging can be a challenge as charging infrastructure may conflict with commercial uses on Maritime/EDD properties or must be prioritized as an amenity for tenants rather than fleet vehicles.

Additionally, planning for charging infrastructure will also need to consider electrification of heavy-duty equipment, such as forklifts at Fishermen's Terminal, the Maritime Industrial Center, and Terminal 91. While heavy lifts use renewable diesel, electrification offers benefits beyond emission reduction. Marine Maintenance staff would no longer need to haul fuel to each property, and it would reduce the stormwater and runoff contamination risks of liquid fueling at waterside properties. The MM fleet manager also manages 10 small workboats that could be electrified with the installation of Level II charging at Fisherman's Terminal and Shilshole Bay Marina docks.

Successful electrification of the MAR/COR fleets will require leadership commitment and investment in a unified plan to deploy electric charging infrastructure across Maritime and EDD properties.

Decentralized fleet management practices create challenges

Decentralized fleet management procedures across Port departments can create challenges for effective fleet management and limit the ability of the fleet manager to consistently implement sustainable and cost-effective strategies. Per EX-17, individual departments select and propose new vehicle purchases through the annual budget process according to the needs of each department. The fleet manager is responsible for coordinating the acquisition of fleet assets between the requesting department and purchasing, but often has limited ability to influence the quantity, make, model, or size of the vehicles requested by a department. Additionally, as mentioned in a previous section, departments are able to bypass the fleet manager for some purchases. This decentralized approach for fleet management has resulted in the Port fleet including a wide variety of vehicle models and sizes, continued a culture of retaining older, under-utilized assets that have a high cost-per-mile, and hindered the ability of the fleet manager to implement purchase standards that could reduce emissions. Successful implementation of sustainable fleet strategies will require standard requirements for vehicle purchasing and replacement and that departments consistently engage the fleet manager in fleet procurement decisions.

Inadequate access to data hinders effective fleet management

A major barrier to an effective sustainable fleet program for the Port's MAR/COR fleets is access to data. Fleet vehicles are tracked in the Maximo asset management database, but data is not readily available data at the vehicle level for fuel use and vehicle mileage readings. The process of collecting vehicle utilization data can be labor intensive and introduces many opportunities for error. For example, vehicle mileage information is based on data that employees enter by hand at the pump when fueling. Processing this data always includes a step to eliminate outlier data points and obvious errors, such as mileage readings of 9,999 or 1,234. Access to centralized and real-time data about fleet vehicles and fuel use would help the fleet manager and each department's fleet coordinator to make informed decisions about vehicle maintenance needs, replacement opportunities, and save time in locating equipment assets. Technology, called telematics, is widely available and can easily be added to all vehicle types to monitor fuel consumption, engine performance, driver behavior, vehicle location, and other metrics that could enhance fleet management.

Telematics to Target Vehicle Maintenance Needs

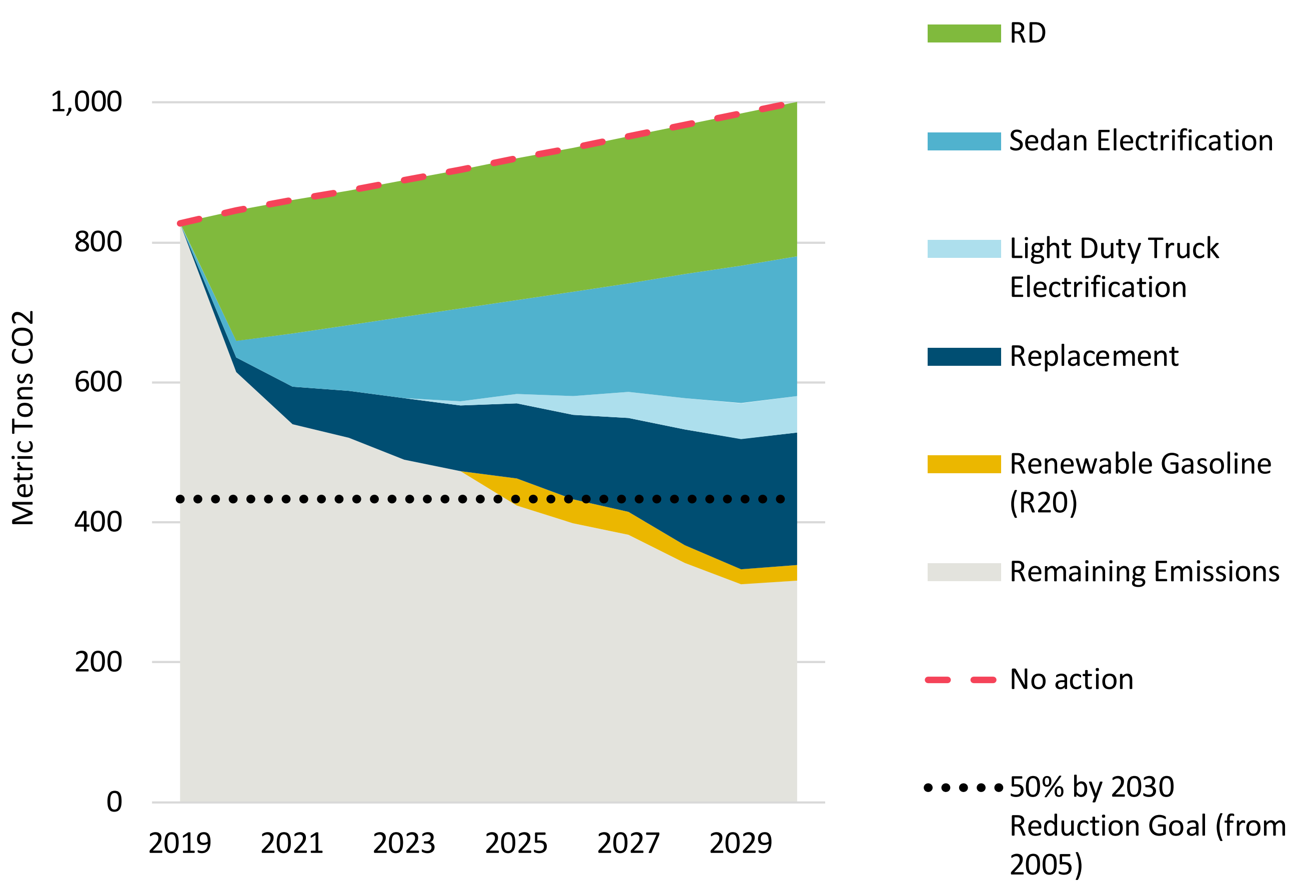
Beyond targeting fuel use and emission reduction opportunities, telematics can also enhance maintenance practices to better deliver preventative maintenance and prevent more costly equipment failures. For example, under current practices, the MM fleet manager uses time thresholds set in Maximo to identify when vehicles require an oil change. However, when an oil change is needed depends on mileage driven or engine hours operated. Without easy access to that data, vehicles brought in for an oil change on schedule may have required two oil changes during that period based on usage; and in other cases, Other vehicles will be scheduled for an oil change that is not yet needed. Telematics could provide the fleet manager daily updates on vehicle mileage and engine hours to target preventative maintenance needs.

Strategies to Reduce GHG Emissions from the Maritime and Corporate Fleets

The previous section discussed why sustainable fleet strategies are needed if the Port is to meet its Century Agenda GHG gas reduction targets and goal to be the greenest, most energy efficient port in North America. If these practices continue under a "business as usual" scenario, GHG emissions from the MAR/COR fleets are estimated to increase at a rate of 1.7 percent annually, leading the Port further away from its 2030 and 2050 GHG reduction targets. [20] The Maritime SFP chapter identifies five strategies that can reduce emissions at the level needed to meet Port targets. Analyses of 2019 fuel use, fleet composition, and replacement plans found that if implemented, the strategies could reduce emissions more than 50 percent below the 2005 baseline, meeting the Port's 2030 target and making progress toward the 2050 target to be carbon neutral or negative.

[20] The business as usual growth rate is calculated from historical GHG emission trends from 2005-2019 for the fleet vehicles and equipment, as measured in the Port of Seattle Maritime GHG Emissions Inventory. It does not account for future improvements to vehicle fuel economy, external policy changes, or other assumptions.

Figure 25. 2030 GHG emission reduction potential of Maritime SFP strategies



1. Use drop-in renewable fuels.

The Port fleet can achieve immediate emission reductions by switching to drop-in renewable fuels, which are non-petroleum-based fuels like RD and renewable gasoline, made from renewable sources, such as waste cooking oils, grease, tallow, or other renewable feedstocks. A "drop-in" renewable fuel is lower carbon compared to fossil diesel or gasoline and does not require engine modifications. Because RD is more readily available than renewable gasoline, the Port will focus on RD in the near-term for diesel vehicles that fuel onsite. The Port began dispensing RD at Marine Maintenance beginning in December 2019. Passage of a Clean Fuel Standard in Washington in 2021 should increase the availability of low carbon fuels and drive cost parity between these fuels and conventional fossil fuels.

5-Year Actions
• Dispense RD at the Port's fleet fueling stations • Expand use of renewable fuels as a fossil fuel replacement, such as renewable gasoline • Evaluate employee fuel purchase card use and encourage on-site fueling at Port fueling stations that dispense renewable fuels
GHG Reduction Potential
• RD: 220 metric tons reduced annually by 2030 • Renewable gasoline: 20 metric tons reduced annually by 2030 • Low Carbon Fuel Standard (LCFS): 33 metric tons reduced annually by 2030

2. Deploy EV charging across Maritime/EDD properties

Installing charging stations across Maritime/EDD properties is a critical step toward reducing air and greenhouse gas emissions through the electrification of MAR/COR fleets and also for achieving the objective in the 2020 NWPCAS to transition light-duty fleet vehicles to electric or renewable fuels by 2030.

Under current practices, EV charging states budgeted and developed property by property. A coordinated approach through a formal EV charging infrastructure program is needed to ensure that charging installations are designed to meet fleet operational needs into the future and also to accelerate investment in charging infrastructure as a first step to widespread electrification of fleet vehicles. An EV readiness plan for Maritime/EDD properties would identify charging infrastructure locations, electrical capacity needs, and timing of installations. For example, an EV readiness plan could identify strategic locations to install DC faster chargers to create a fueling experience similar to how fleet drivers already visit the Marine Maintenance South Office to fill up at the Horton Street Fueling Island. Electrical capacity needs for EV charging also needs to be incorporated into larger Port decarbonization planning in the Seattle Waterfront Clean Energy Strategy, which launched in 2020 and will be completed in 2022.

5-Year Actions

• Complete installation of Level 2 charging at the Marine Maintenance South Yard by 2022
• Develop an EV readiness plan to expand EV charging stations at key maritime locations to enable fleet electrification (plan development: 2021, starting in implementation: 2022)
• Establish a formal EV infrastructure charging program
• Integrate EV and fleet charging electrical capacity needs into ongoing studies, including the Seattle Waterfront Clean Energy Strategy, Maritime Industrial Center and Fishermen's Terminal Arc Flash Study, and Terminal 91 Power Study
• Evaluate and establish Level 3 (fast-charging) fueling sites:
    o Horton Street – Auto Shop Yard (2023)
    o Marine Maintenance North (2024)
    o Marine Maintenance Emerson (2025)
    o Terminal 91 (2026)
• Utilize overnight charging (Level 2) at specific locations:
    o Bell Street Garage (2023)
    o Marine Maintenance North (2024)
    o Horton Street Back Lot (2024)
    o P69 Apron (2025)

3. Transition to EVs.

Replacing fossil fuel vehicles with EVs at the end of their useful life can reduce fuel use while providing an emission reduction benefit. The Port will transition all gasoline-powered light-duty vehicles (fleet sedans and SUVs) to EVs by 2030. Fleet managers will continue to monitor and evaluate the development of electric or hybrid-electric technology for vans, trucks, heavy duty vehicles, small workboats, and specialized equipment. As discussed previously, investment in EV charging infrastructure is needed as a first step to support the widespread conversion of fleet vehicles to EVs.

5-Year Actions
• Begin fleet asset conversions to EVs • Pilot use of non-sedan EVs and equipment, including purchasing of electric light-duty trucks and vans and electric outboard engines for small workboats. • Identify opportunities to electrify of Port-owned diesel equipment (e.g., heavy forklifts) at Fishermen’s Terminal, Maritime Industrial Center, and Terminal 91 • Track technology developments in heavy-duty EVs and equipment as relevant to Port fleet applications • Beginning in 2026, all MAR/COR fleet sedans and SUV's will be replaced with a battery EV
GHG Reduction Potential
• Sedan electrification: 200 metric tons reduced annually by 2030 • Truck electrification: 52 metric tons reduced annually by 2030

4. Right-size vehicles and the fleet.

The Port’s fleet includes older, underutilized vehicles. Right-sizing is applied in two ways: (1) Replacing older vehicles with a newer, more fuel-efficient option that can meet the same operational need or, (2) eliminating under-utilized vehicles from the fleet and pooling vehicles to maximize use per asset. Right-sizing of vehicles ensures that the new vehicle purchased, or the vehicle replaced, matches the specific purpose or operational need. For example, if a sedan or smaller SUV can meet the same operational need as a truck, the smaller vehicle will use less fuel per mile, saving fuel costs and emissions. Right-sizing of the fleet ensures that the fleet size is streamlined to reduce unnecessary maintenance and management costs while still meeting the needs of Port departments and to access fleet vehicles and equipment. Under-utilized and redundant fleet vehicles can be removed from the fleet if other vehicles are available to meet operational needs. Pooling vehicles to be accessed across departments is one strategy to right-size the fleet. Centralized fleet management is critical to incorporate right-sizing into vehicle and equipment procurement. Fleet managers should be empowered to oversee and standardize vehicle replacement decisions.

5-Year Actions
Right-size vehicles: • Assign life cycle limits to vehicle types and classes (e.g., 15-year useful life for light-duty cars, trucks, and vans) and continue moving toward on-time replacement of older, less efficient vehicles to align with lifecycle limits • Accelerate replacement of past-due assets • Implement an asset selector list for fleet managers to standardize and right-size new vehicle purchases **Right-size the fleet:** • Centralize the Pier 69 vehicle pool to increase utilization and retire older vehicles • Implement automated key lock and scheduling system to streamline employee access to shared vehicle pools and utilization tracking • Maximize vehicle utilization with expanded pooling of vehicles and equipment across all Maritime/EDD worksites, reducing 1:1 vehicle assignments, and optimizing pool size • Facilitate equipment sharing across work groups to reduce need for costly rentals of specialized equipment the Port already owns
GHG Reduction Potential
• Replacement: 189 metric tons reduced annually by 2030

Near-Term Opportunity: Pier 69 Motor Pool

The Pier 69 motor pool has 15 vehicles available by reservation. Usage records show that some vehicles are not fully utilized, and newer vehicles are often favored for reservations. Motor pool reservations also dropped significantly in 2020 as most employees at Pier 69 teleworked during the COVID-19 pandemic. Higher rates of telework are anticipated to continue after the workplace disruption is lifted with the expansion of alternative work arrangements. The MM fleet manager has identified 3 vehicles that can be immediately retired from the Pier 69 fleet without need for replacement and will evaluate 2 additional vehicles to retire in 2022. Retiring all 5 vehicles would offset $175,000 in capital requests for fleet purchases and increases the overall utilization of remaining vehicles.

5. Use technology to gather data and improve efficiency.

Fleet technology, such as telematics and anti-idling technology, can improve access to data and save fuel in support of more efficient fleet operations and management. Telematics provides data on how a vehicle operates, including utilization, speed, location, and fueling events. It can support fleet right-sizing by identifying under-utilized vehicles or vehicles that routinely travel to the same locations. It also can improve access to more accurate information about fuel consumption, mileage, and miles per gallon to more effectively track vehicle efficiency, maintenance needs, and replacement schedules. Anti-idling technology includes after-market solutions that can be installed on a vehicle to limit idling, which saves fuel and reduces emissions. Anti-idling technology and telematics are available and compatible for most vehicle types.

5-Year Actions
• Pilot telematics on a portion of the fleet • Implement new fleet management software • Expand telematics to all appropriate assets • Install anti-idling technology on targeted assets with high idle uses • Use motor pool software and hardware to manage pools for efficiency • Incorporate telematics data into fleet management approaches to optimize utilization and maintenance

6. Educate Port drivers on eco-driving and fleet use practices.

As new types of vehicles enter the fleet, including EVs, drivers must be trained to operate them safely and sustainably. Driver behavior can also reduce or improve a vehicle's fuel economy. Information on how to maximize a vehicle's fuel economy through eco-driving should be required training for Port employees. Telematics data can be used to target specific training needs. Additionally, departments will need to be informed of new right-sizing guidance on motor pool use and standardization procedures for purchasing.

5-Year Actions
• Incorporate eco-driver training into Port employee training modules • Establish outreach program for sustainable driver education • Educate port drivers on how to drive and charge electric fleet vehicles • Use telematics to target training topics and needs • Provide department-specific driver training focused on specific vehicle types and use cases • Continue employee and public engagement on sustainable fleet issues • Measure and report on efficacy of ongoing driver training

Implementation

Implementation of the Maritime SFP strategies and actions in this chapter will require coordination between The Maritime and Aviation Division's Fleet managers, Marine Maintenance, Maritime Environmental and Sustainability, and departments within the Port's Maritime, Economic Development, and Corporate divisions that use fleet vehicles and equipment. Roles and responsibilities are outlined below:

- **Port Executive Leadership** involvement is critical to advocate for investments in sustainable fleet strategies and sponsor projects, like the installation of EV charging, that align with the recommended actions.
- **The Marine Maintenance Fleet manager** and staff will lead implementation of sustainable fleet strategies, in coordination with the Aviation Maintenance fleet manager, including purchasing renewable fuel and replacing and right-sizing vehicles and equipment.
- **The Maritime Environment & Sustainability Department** will coordinate with Marine Maintenance to support implementation, updates, monitoring, and reporting.
- **Other Port Departments that use** fleet vehicles and equipment will work with the Fleet manager to identify and budget vehicle and equipment needs that align with the Sustainable Fleet Plan.

Cost Considerations and Co-Benefits

Achieving the Century Agenda target of a 50 percent reduction in fleet vehicle and equipment emissions by 2030 will require significant investment in fleet administration and vehicle replacement over the next ten years. Some strategies, like right-sizing the fleet, eco-driving, using data to drive decision-making, can create cost-saving opportunities over time. However, with so many vehicles in the MAR/COR fleets beyond their useful life, an increase in capital funding is needed to ramp up replacement in the near-term. Over time, capital funding needed will level out as new vehicles are purchased, older vehicles are retired, and right-sizing strategies are implemented to increase utilization of the shared vehicle pool. Table below shows the proposed five-year Capital Improvement Program (CIP) needs for the MAR/COR fleets.

Table 4: Five-Year CIP Needs for Maritime SFP Implementation

Item	2022	2023	2024	2025	2026
Maritime Fleet Assets	$2,530,000	$2,075,000	$1,780,000	$1,540,000	$1,090,000
EDD Fleet Assets	$0*	$0*	$90,000	$30,000	$0
EV Charging Infrastructure[1]	$100,000	$250,000	$250,000	$250,000	$150,000
Fleet Telematics[2]	$50,000	$75,000	$75,000	$100,000	$100,000
Motor Pool / Fleet Software[3]	$75,000	$25,000	$25,000	$25,000	$25,000
3rd Party Fleet Benchmarking	$100,000	$0	$0	$0	$0

**Fleet reductions are recommended*

(1) EV Charging Infrastructure includes the Marine Maintenance South Auto Yard Study and Level 3 charger; Marine Maintenance North study and Level 3 Charger; Marine Maintenance Emerson study and Level 3 Charger; Terminal 91 Level 3 Charging Equipment; Pier 66, Pier 69, and Marine Maintenance South back yard Level 2 charging equipment.

(2) Fleet telematics represents an ongoing cost billed monthly per vehicle

(3) Motor pool/fleet software represents a small capital purchase in year one and ongoing licensing fees.

Additionally, in the near-term, EV purchases are likely to remain more expensive than comparable internal combustion engine options. However, TCO of electric options, which factors in the acquisition cost as well as operating costs like fuel and maintenance, is declining. EVs will also need charging infrastructure, requiring additional investment and planning. As the Port looks to lead on transitioning to zero-emission operations and help demonstrate technologies for tenants and the maritime industry, it’s important that purchase decisions consider the emission reduction benefits offered and opportunities to pilot and share lessons from new, zero-emission equipment technologies.

Further, the Port should prioritize investment in telematics and data management software as these tools are critical to ensure cost-effective implementation of sustainable fleet strategies moving forward. Data from telematics can help the Port better understand the total cost of ownership of fleet vehicles, track metrics and progress against a baseline, and make more strategic decisions to implement fleet strategies that can cost-effectively meet the Port’s emission reduction targets.

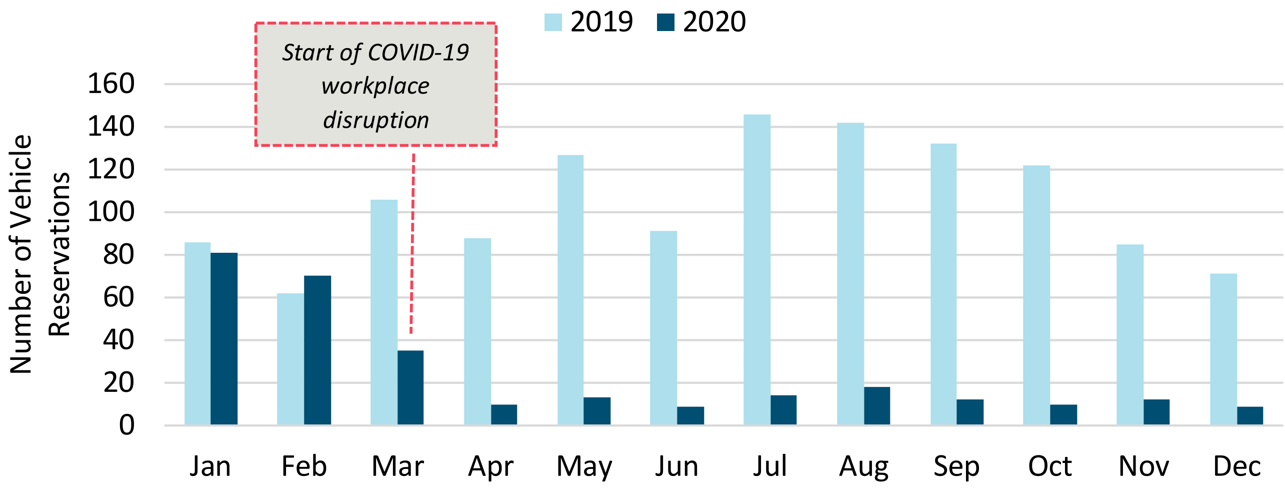
The Maritime SFP strategies also offer opportunities for cost savings and improved operational efficiency of the fleet:

- EVs require less maintenance than diesel or gasoline vehicles
- EVs and electrified heavy equipment eliminates air pollutant emissions at the tailpipe in addition to GHG reduction
- Electrified heavy equipment eliminates the need to transport liquid fuels to waterside terminals and reduces operating costs
- Motor pooling and equipment sharing reduces fleet capital costs by minimizing new vehicle purchases, streamlining access to vehicles for employees, and reducing rental costs for specialized equipment
- On-time replacement of vehicles increases safety, reduces risk of major component failures, and improves customer morale
- Fleet software and telematics saves staff time in data analysis, targets preventative maintenance needs, and can identify further operational efficiencies

Impact of COVID-19 on the Future of MAR/COR Fleet Vehicles

The Maritime SFP chapter was developed over 2020 and into 2021 during the COVID-19 pandemic. The pandemic immediately changed the Port's day-to-day operations. During this time and potentially into the future, fewer Port employees are working onsite and most meetings, with the exception of essential site visits, have occurred virtually. These changes impact fleet vehicle use and already resulted in about a 20 percent decrease in fleet fuel consumption over 2020 and significantly reduce vehicle pool usage for Pier 69, as shown in Figure 26. The full extent of the long-term impacts from COVID-19 are not yet known, but may continue to impact fleet vehicle needs, management considerations, and replacement budgets for years to come. Implementation of the sustainable fleet strategies will consider the impacts of COVID-19 and recommended strategies will be reevaluated as more information develops and as needed.

Figure 26. Monthly Reservations of the Pier 69 Motor Pool, 2019 vs. 2020



CONCLUSION

With over 1,500 assets in total, the Port of Seattle has a uniquely large and diverse fleet across the organization. Fleet vehicles and equipment are critical to ensuring smooth operations across the Port. These vehicles and equipment also contribute to 22 percent of the GHG emissions with the Port's direct control. Action is needed to reduce emissions from both the AV and MAR/CORP fleets to achieve the Port's GHG reduction targets set in the Century Agenda.

Both the Aviation and Maritime chapters discuss the many challenges and opportunities for sustainable fleet management at Port of Seattle. Key strategies recommended in both plans include using drop-in renewable fuels, transitioning to EVs and expanding EV charging, right-sizing vehicles and pooling vehicles in the fleet to achieve efficiencies, using technology to gather data, and expanding driver education to cover eco-driving practices. Implementing the recommendations for the AV fleet can reduce GHG emissions by 4,000 metric tons by 2030 and implementing the recommendations for the MAR/COR fleets can reduce GHG emissions by over 600 metric tons. The projected emission reduction opportunity of the sustainable fleet strategies exceeds the 50 percent by 2030 Century Agenda target for fleet and makes progress toward the Port's goal of carbon neutrality by 2050. The strategies also operational efficiencies, cost savings, and health and safety benefits beyond GHG reduction. Implementation of these strategies will be led by the Aviation and Maritime fleet managers but will also require cross-departmental coordination and leadership support.

APPENDIX

APPENDIX

Emission reduction calculation methodology: AV Fleet

The following section describes the methodology used to create the long-term emissions reduction estimates for the AV fleet (as depicted in Figure 2).

Future fuel use

On-road gasoline and diesel were extrapolated based on projected aircraft operations at SEA Airport. Historical average on-road diesel and gasoline use per thousand annual aircraft operations was calculated. This average fuel use per operations was then projected forwards based on expected aircraft operations in the SEA Sustainable Airport Master Plan technical memo 3.1. This memo provides anticipated aircraft operations in 2027 and 2032; years between 2017 (the most recent year for which annual operations data were available) and 2027 as well as 2027 and 2032 were linearly interpolated.

CNG use was assumed constant at the average annual consumption realized between 2015 and 2019. The AV operations department does not currently anticipate changes to the airport's current busing operations that serve the rental car facility and the employee parking operation.

RNG

It was assumed that the AV fleet would enter a contract for RNG in mid-2020. After this point, the RNG contract would remain in place through 2030. We assume no net emissions associated with CNG use during this time.

RD

This analysis assumes that the AV fleet maintains its current contract for procuring RD throughout the analysis period. During this time, net emissions from fleet diesel use are assumed to be zero.

Replacement

The analysis of fleet modernization and replacement focused only on gasoline vehicles. Because diesel emissions are assumed to be reduced using renewable diesel, the emission benefits of modernizing diesel vehicles would be effectively zero in this analysis. However, modernizing and right-sizing diesel vehicles is still important for reducing fuel use to minimize cost.

Determining the potential benefit from diesel vehicle replacement would also be much more difficult than for gasoline vehicles. Gasoline vehicles have shorter and more regular replacement cycles. Light-duty gasoline vehicles also fall much more easily into specific use cases (sedan, SUV, etc.) than do diesel vehicles, many of which are special-purpose. As such, it would require more specialized knowledge of the fleet to determine likely diesel replacement vehicles on a vehicle-by-vehicle basis.

Fleet managers maintain 10-year replacement plans for larger fleet customers. These plans indicate what vehicles fleet managers plan to replace in each year. These plans were used to estimate future changes in the AV fleet vehicle composition.

The make and model for all replacement vehicles was drawn from the following:

- Sedans: Toyota Prius
- SUVs: Toyota Rav4 hybrid
- Vans: Ford Transit Connect

- Light trucks: Ford F-150
- Police vehicles: Ford Interceptor hybrid

This is obviously an over-simplification, as some vehicle replacements might require vehicles outside of this list. However, this level of simplification was necessary to make the problem of determining the future AV fleet composition more tractable. Moreover, this approach is in line with the recommended fleet management strategy of limiting the makes and models of vehicles in the fleet. The list of candidate replacement vehicles was developed in coordination with fleet managers.

Fuel economy for each of the five candidate replacement vehicles was obtained from the U.S. EPA (2020 model years from fueleconomy.gov). For simplicity, the fuel economy of new vehicles was assumed constant from 2020 through 2030 (i.e. the fuel economy of a new van in 2030 was assumed to be the same as that of a new 2020 Ford Transit Connect). Fuel economy for every vehicle currently in the AV fleet scheduled for replacement through 2030 was also obtained from the same source.

For each fleet customer, the average fuel economy for each class of vehicle was determined. For example, the average fuel economy was calculated for all vehicles in the AV Maintenance fleet that are scheduled to be replaced with a Rav4 hybrid. The difference between this average and the fuel economy of the new vehicle is the assumed efficiency benefit that occurs each time a vehicle of this type is scheduled for replacement.

Full 10-year replacement plans were only available for a subset of AV fleet customers: AV maintenance, police, engineering, and PCS (the last two of which are managed by the Maritime fleet manager). All other departments were assumed to achieve efficiency improvements from replacement equal to the average of the benefit realized by the engineering and PCS departments. Engineering and PCS were taken as being more representative of the remainder of the fleet not captured in long-range replacement plans; both AV maintenance and Port police have larger and more specialized vehicle fleets than other portions of the fleet. These departments without replacement plans are assumed to begin seeing replacement benefits in mid-2021, with the benefits continuing through 2030.

Electrification

The process for calculating the benefits of accelerated electrification is very similar to that described above for vehicle replacement. However, in the case of electrification, all sedans are assumed to be replaced with EVs rather than Toyota Priuses. This accelerated electrification is assumed to start in mid-2021 and continue through 2030.

Emission reduction calculation methodology: MAR/CORP fleet

The following section describes the methodology used to create the long-term emissions reduction estimates for the MAR/CORP fleet (as depicted in Figure 3).

No Action

GHG emissions in the “no action” scenario assumed that fleet fuel use for the MAR and COR fleets would continue into the future following current trends. The analysis assumed emissions would increase 1.7 percent per year, based on the historical trend of increasing fleet emissions in the annual Maritime

GHG emissions inventory. While purchases of RD began in late 2019, the no action scenario did not assume RD purchases would continue.

RD

This analysis assumes that Marine Maintenance would continue procuring RD to meet all on-site fueling needs of the MAR/COR fleet. Net emissions from on-site fleet diesel use are assumed to be zero. MAR/COR vehicles driven offsite may also purchase fuel from commercial fueling stations. Diesel fuel use tracked via purchase cards was assumed to be fossil diesel.

Renewable gasoline

The analysis for the renewable gasoline wedge assumes that Marine Maintenance would begin purchasing a 20% renewable gasoline blend (R20) by 2025, replacing all onsite gasoline fueling gallons with R20. Net emissions from R20 were assumed to be 20% less than conventional gasoline. The analysis assumed only a 20% renewable blend based on City of Seattle's renewable gasoline contract where only R20 is currently available for purchase. Similar to RD, as MAR/COR vehicles driven offsite may also purchase fuel from commercial fueling stations, gasoline use tracked via purchase cards was assumed to continue to be conventional gasoline.

LCFS Legislation in WA

The LCFS analysis assumes passage of an LCFS with starting in 2023 to reach 10 percent reduction in carbon intensity of transportation fuels by 2030. The carbon intensity decline was calculated linearly by reducing the diesel and gasoline emissions factors by 1.25 percent each year.

Replacement

Following the same methodology as the AV fleet, the analysis of fleet modernization and replacement focused only on gasoline vehicles.

Fleet managers maintain 10-year replacement plans for larger fleet customers. These plans indicate what vehicles fleet managers plan to replace in each year. Reductions in fuel use from vehicle replacements, and associated emissions reductions, were calculated from the Marine Maintenance Fleet Manager's replacement plans for MAR/COR vehicles. Following a similar methodology to the AV analysis, replacement vehicles included Rav 4 Hybrid, Prius, F150, and Transit Connect van.

Table 4 summarizes the replacement options, miles per gallon assumptions, and replacement scenario rules used in the analysis.

Table 5. MAR/COR GHG Emissions Wedge Analysis Replacement Scenario Methodology

Replacement options	EPA combined MPG	Source	Replacement Scenario Rules
Rav 4 hybrid	30	fueleconomy.gov	Replacement scenario, replaces SUVs and LD trucks
Prius	52	fueleconomy.gov	Replacement scenario, replaces sedan cars
Transit Connect	26	fueleconomy.gov	Replacement scenario, replaces van
F150	22	fueleconomy.gov	Replacement scenario, replaces truck

There are limitations to this analysis. For example, it does not capture the impact of right-sizing – retiring older vehicles and redistributing the motor pool so that vehicles aren't replaced 1:1. Additionally, fuel economy of new vehicles was assumed constant from 2020 through 2030 (i.e. the fuel economy of a new van in 2030 was assumed to be the same as that of a new 2020 Ford Transit Connect).

The fuel savings from each replacement was calculated following the same methodology as the AV fleet, described in the previous section.

Electrification

Electrification analyses followed a similar methodology as vehicle replacement.

- **Sedan electrification:** Reductions in fuel use from vehicle replacement calculated from fleet manager replacement plans. All vehicles identified for replacement with a Toyota Prius are instead replacement by a Nissan Leaf.
- **Light-duty truck electrification:** Same as Sedan Electrification with the addition that vehicles scheduled for replacement with Asset Type = Truck are replaced by an electric F-150 starting in 2024.

Total Cost of Ownership modeling

AFLEET parameters

The AFLEET tool is highly customizable, and we adjusted the modeling parameters to model AV fleet purchases as closely as possible. Those parameters included:

- Vehicle models analyzed were the same as those considered for the analysis of vehicle replacement (described above).
- Vehicle pricing for these vehicles was drawn from the Washington State Department of Commerce's Contract Automobile Request System (CARS).[21] Prices are as of April, 2020.
- Vehicle fuel economy was drawn from fueleconomy.gov
- Assumed 3,000 miles of annual vehicle travel

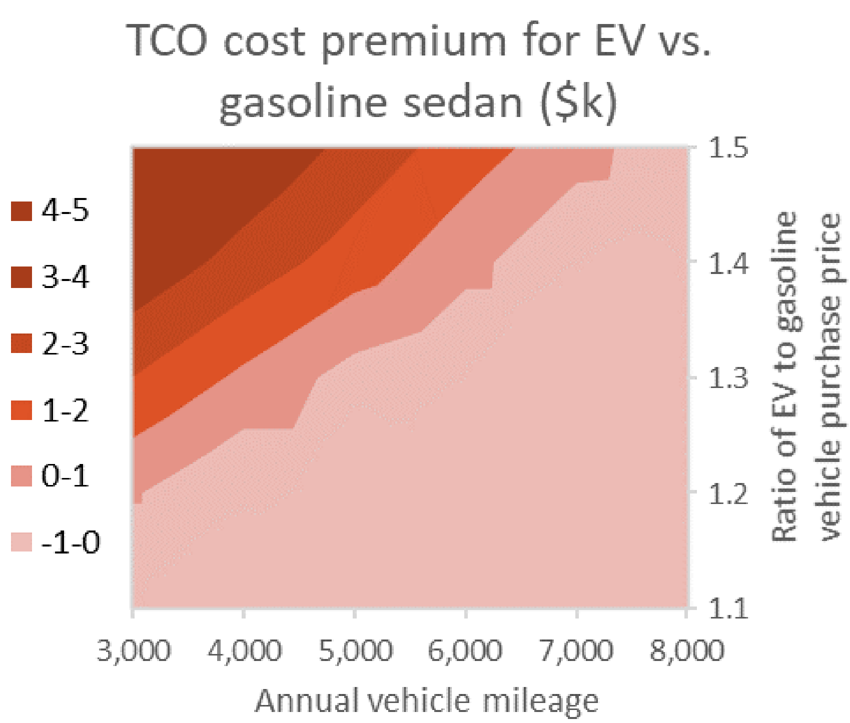
[21] https://des.wa.gov/services/travel-cars-parking/vehicle-purchasing

- Assumed depreciation (approximate replacement timeframe) of 15 years for all
- Electricity generation resource mix from the Bonneville Power Administration[10], which provides approximately 97 percent of the airport's electricity
- Electricity costs as the rate charged to airport tenants as of April 2020: $0.088 per kWh
- Gasoline costs as the 10-year average cost of regular gasoline prices on the West Coast minus California[11]: $3.35

Sensitivity analysis

Figure 26 shows the combined effect of purchase price and vehicle utilization on the difference in TCO of an EV versus a conventional sedan. The dynamics for other vehicles, like SUVs and pickup trucks, are similar. As vehicles are driven more (moving from left to right on the graph), the cost difference between EV and conventional models decreases. At about 7,000 annual miles, the TCO of an EV is the same as that of a conventional alternative with current vehicle purchase prices. The purchase price of a new EV is currently about 1.5 times that of a conventional alternative. However, as this gap closes, either because of EV technology improvements or because the AV fleet finds ways reduce the cost of new EV purchases, the TCO of EVs approaches that of conventional vehicles. When the purchase price of EVs is 20 percent or less above that of conventional vehicles (a price ratio of 1.2), the TCO of EVs is lower than conventional sedans even with as few as 3,000 annual vehicle miles.

Figure 27. Difference in TCO for an EV and conventional sedan as a function of EV purchase price premium (vertical axis) and vehicle utilization (horizontal axis). Colors show difference in 15-year TCO, in thousand dollars.



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