MAINE
CLEAN TRANSPORTATION ROADMAP FOR MEDIUM- AND HEAVY-DUTY VEHICLES

Case Study: Fleet 3

prepared for

Governor's Office of Policy Innovation and the Future

MaineDOT

Maine Governor's Energy Office

prepared by

Cambridge Systematics

CALSTART

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TABLE OF CONTENTS

Summary **1**

Introduction **1**

Fleet Information 2

Vehicle Recommendations 2

Charging and Infrastructure **4**

Fleet Electrification Overview 4

Charging Equipment 5

Managed Charging 6

On-Route versus Depot Charging 7

Fueling/Charging Cost Analysis 9

Daily Charging Load Profiles 9

EVSE Financing **11**

Federal Incentives 11

State Incentives 12

Results **13**

Total Cost of Ownership 13

Fleet Emissions 18

Implementation Considerations **19**

Energy Storage and Resiliency 19

Preheat/Precool 19

"Vampire" Energy 20

References **20**

LIST OF TABLES

Table 1	Fleet 3 Vehicle Inventory	2
Table 2	Tractor-Trailer Electric Vehicle Replacements	3
Table 3	Efficiency Maine Incentive Levels	12
Table 4	Class 8 Tractor Trailer Itemized Cumulative Costs over 12 Year Vehicle Life	16
Table 5	Class 8 Tractor Trailer Itemized Cumulative Costs over 12 Year Vehicle Life	18
Table 6	Internal Combustion Engine Fleet Emissions	18

LIST OF FIGURES

Figure 1	Types of Chargers	6
Figure 2	Alternative Fuels Database Detailed Charger Information	8
Figure 3	Daily Charging Load Profiles—All Vehicles	10
Figure 4	Warehouse 2 Annual Energy Cost Under Diesel and EV Scenarios	10
Figure 5	Warehouse 2 Energy Cost Per Distanced Traveled	11
Figure 6	Tractor Trailer Warehouse 1—Fleet Costs over Time	14
Figure 7	Tractor Trailer Warehouse 1—Itemized Fleet Costs	15
Figure 8	Tractor Trailer Warehouse 2—Fleet Costs Over Time	16
Figure 9	Tractor Trailer Warehouse 2—Itemized Fleet Costs	17

SUMMARY

Fleet 3 is a retail goods delivery freight fleet serving the State of Maine. The fleet has two warehouses: Warehouse 1 in Penobscot County with seven tractor trailers and Warehouse 2 in Aroostook County with two tractor trailers. Both electric and hydrogen fuel cell replacement recommendations are provided for Fleet 3's tractor trailers.[1]

The trailers based in Warehouse 1 travel approximately 220 miles per day and return to a depot overnight. These travel patterns and overnight dwell times are well-suited to electric or hydrogen vehicles and transitioning to these zero-emission alternatives would result in immediate fuel and maintenance cost savings. Despite that, a zero-emission replacement is not projected to produce lifetime savings due to high upfront capital costs for electric and hydrogen trucks.

The trailers based in Warehouse 2 travel approximately 560 miles per day. A zero-emission replacement would be projected to produce lifetime savings for this duty cycle starting in the 9th year; however, these vehicles would need to be charged along their route, which may not be feasible or cost-effective at this time. Alternatively, Fleet 3 could consider hydrogen fuel cell vehicles where longer ranges are available; more significant fueling station infrastructure challenges exist at this time.

INTRODUCTION

The Maine Clean Transportation Roadmap for Medium- and Heavy-Duty Vehicles ("roadmap") charts a path for Maine to decarbonize the trucks and buses moving people and goods within and through the state. As part of the roadmap, the project team has conducted a series of case studies with Maine businesses to identify real world opportunities and challenges for fleet electrification. The case studies are intended to 1) serve the participating fleets by providing customized fleet electrification assessments; and 2) augment the roadmap by evaluating electrification use cases, total cost of ownership, and barriers in the context of actual Maine business operations.

[1] Fleet 3 additionally has a fleet of delivery box trucks, which are not included in this analysis.

Fleet Information

Fleet 3 operates seven tractor trailers out of Warehouse 1 in Penobscot County, ME and two tractor trailers out of Warehouse 2 in Aroostook County, ME. These trucks are used for delivering retail goods. Trucks based at Warehouse 2 also transport goods between warehouses overnight. Table 1 provides an inventory of Fleet 3's vehicles.

TABLE 1 FLEET 3 VEHICLE INVENTORY

Vehicle Group	Vehicle Quantity	Vehicle Class	Fuel Type	Manufacturing Year (average)	Average Annual Miles	Owned or Leased Vehicles
Class A Tractor	7	Class 8–Over 33,000 lbs.	Diesel	2022	55,000	Owned
Class A Tractor	2	Class 8–Over 33,000 lbs.	Diesel	2021	140,000	Leased

Vehicle Recommendations

To adequately define the needs of a fleet, the vehicles used are categorized into duty cycles. Duty cycles are classifications that describe both the *vehicle*, by type and class, and *how it is operated*, including typical miles traveled, type of use (local versus highway), and fuel consumption.

Vehicle recommendations are not exhaustive of all options that may be on the market; selections are included based on those most likely to meet Fleet 3's duty cycles.

Fleet 3 operates seven trailers out of Warehouse 1 that drive an average of 220 miles per day and dwell for 11.5 hours overnight and two trailers out of Warehouse 2 that drive an average of 560 miles per day and dwell for three hours overnight.

The recommended electric trailers in Table 2 represent the high-end of ranges available on the market. The vehicles at Warehouse 2 can be charged using DC fast charging during their three-hour dwell time. For routes over the maximum range, Fleet 3 can take advantage of public DC fast chargers along their routes to quickly recharge. This is explained further in the Charging and Infrastructure section.

Alternatively, Fleet 3 can explore the hydrogen fuel cell options listed in Table 3. Hydrogen fuel cells allow for faster refueling and longer ranges in some cases. Fuel cell vehicles require a source of hydrogen for refueling, which could be either privately or publicly owned. The U.S. Department of Energy (DOE) has awarded projects to expand a nationwide hydrogen refueling corridor, however the capital to install and run a hydrogen refueling station is significant, in the million-dollar range. Many fleets could benefit from public hydrogen stations, paying for the fuel but not the infrastructure.

TABLE 2 TRACTOR-TRAILER ELECTRIC VEHICLE REPLACEMENTS

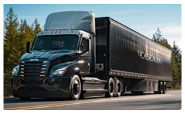
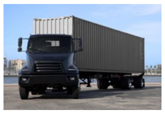
Make	BYD	Freightliner	Tesla	XOS	Nikola	Volvo
Model	8TT	eCascadia	Semi	HDXT	TRE BEV	VNR Electric
Availability	Now	Now	Coming Soon	Now	Now	Now
Class/Size	Class 8	Class 8	Class 8	Class 8	Class 8	Class 8
Range	200 miles	230 miles	500 miles	230 miles	350 miles	275 miles
Payload	78,765 lbs.	60,000 lbs.	44,000 lbs.	56,000 lbs.	40,000 lbs.	66,000 lbs.
Energy Capacity	422 kWh	438 kWh	1000 kWh	N/A	753 kWh	565 kWh
Level 3 Charging Time (350 kW power)	1.5 hours	1.5 hours	1 hour (Using Tesla Semi Charger)	N/A	2.5 hours	2 hours
Website	8TT	eCascadia	Semi	HDXT	TRE BEV	VNR Electric
Vehicle Photo						

TABLE 3 TRACTOR-TRAILER HYDROGEN FUEL CELL VEHICLE REPLACEMENTS

Make	Hyundai	Kenworth	Nikola
Model	XCIENT Tractor	T680	Tre FCEV
Availability	Now	Now	Now
Class/Size	Class 8	Class 8	Class 8
Payload	N/A	82,000 lbs.	30,000 lbs.
Range	250 miles	450 miles	500 miles
Fuel Tank Capacity	68 kg	58 kg	70 kg
Charging Time	20 min	20 min	20 min
Website	XCIENT	T680	TRE FCEV
Vehicle Photo			

CHARGING AND INFRASTRUCTURE

Fleet Electrification Overview

Fleet electrification involves coordination between the fleet and their electric utility, contractors, developers, vehicle original equipment manufacturers, and electric vehicle service providers to determine the power, quantity, and arrangement of electric vehicle supply equipment (EVSE), or vehicle charging, for a particular site. Once vehicle quantity and duty cycles are defined, the quantity and power of EVSE needed can be determined. In most fleet charging configurations, it is typical to install one dedicated charging plug per electric vehicle (EV). This is to support overnight charging, when electricity rates are low and vehicles are ordinarily not in operation; overnight charging typically lends itself to less costly EVSE due to the lower power usage required to charge a vehicle over a long dwell time. For use cases with higher energy needs and/or less available dwell time for charging, higher-power chargers may be required to meet the energy needs of EVs.

Regardless of the quantity or power of charging equipment, it is important to keep in mind the additional space necessary for charging dispensers, transformers, and other considerations which may change a site's traffic pattern or "flow."

It is recommended that any chargers installed are networked, which means they include the capability to communicate over cellular networks. Most businesses choose to install networked chargers, due to access control, ensuring that only the fleet's service vehicles can charge at these chargers. Alternatively, fleets can install "behind the fence" non-networked charging in a secure location only accessible to fleet vehicles, assuring the same charging restrictions and availability. However, networked chargers can provide a bevy of technical information, including duration of charge and charge rate, useful for operational planning and decision- making.

Inductive (wireless) charging equipment, which uses an electromagnetic field to transfer electricity to an EV without a cord, is now commercially available as an aftermarket add-on, and has the potential to support rapid medium- and heavy-duty vehicle (MHDV) charging at depots and in warehouse environments where trucks park for extended periods of time, such as loading bays.

Spreading a charging schedule across as many hours as possible will often lead to the lowest capital and operational cost; thus, it is important to weigh various charging solutions against business needs. The next section describes in greater detail some solutions for how this can be addressed.

Charging Equipment

EV charging equipment is classified by battery charging rates. Time to charge will vary depending on battery state of charge, total energy storage, the type of battery, and the type of charging equipment. Charging time can range from less than 20 minutes to 20 hours or more, depending on these factors.

There are three types of charging: Level 1, Level 2, and Level 3 (direct current or DC fast). Level 1 charging is the slowest method and uses a standard alternating current (AC) wall outlet. It adds 2 to 5 miles of range per hour of charging. Because of its slow rate, Level 1 charging is typically only used at home for personal vehicles or workplaces. Level 2 is another AC method that is significantly faster than Level 1. Level 2 is the most common method of charging as it allows most light- and medium-duty vehicles to charge overnight while also being significantly cheaper and easier to install than Level 3 chargers. Level 2 chargers are most commonly found serving commercial vehicles and in public places like parking garages, shopping centers, and tourist attractions. Level 3 DC fast charging is the fastest method of charging, but also the most expensive for both the charger and infrastructure required. These chargers are typically only recommended for heavy-duty trucks and vehicles that dwell for a few hours or less.

Across the United States, there are four major plug types: J1772 (“J-plug”), Tesla (also known as North American Charging Standard or NACS, or SAE J3400), CHAdeMO, and CCS.

- The J1772 standard is used for Level 1 and 2 AC charging.
- Tesla is used for Level 2 and 3.
- CHAdeMO and CCS are used primarily for Level 3 DC fast charging.

While other proprietary plugs exist for MHDVs, these four represent the majority of those in use. The U.S. Department of Transportation National Electric Vehicle Infrastructure (NEVI) Program has standardized federally funded plugs across Level 2 and Level 3 charging, helping build out a national network of publicly-available charging equipment with predictable plug configurations.

In 2022, Tesla opened its previously proprietary charging standard to other EV manufacturers. In the coming years, its NACS will become the most prevalent charger connection. This connector is also referenced as SAE J3400. All connector types are shown below in Figure 1, but fleets should anticipate a growing share of vehicle options to utilize the NACS standard.

Industry leaders have introduced the concept of the Megawatt Charging Solution, designed to provide higher levels of power needed by MHDVs over a shorter period of charging time. Megawatt chargers require significant infrastructure investment (1–3 million volt-amperes or MVA) and may allow for faster adoption of EVs for long-haul trucking. However, most local and regional delivery businesses can be supported by Level 2 or DC fast chargers.

FIGURE 1 TYPES OF CHARGERS

Type	Level 1 Charging	Level 2 Charging		Level 3 DC Fast Charging			Megawatt
Connector	 J1772	 J1772	 Tesla/ NACS/ SAE J3400	 CHAdeMo	 CCS	 Tesla/ NACS/ SAE J3400	 MCS
Voltage	120 V AC	208–240 V AC		400 V–1000 V DC			1–3 kV A
Power Output	1 kW	7 kW–19 kW		50–350 kW			900 kW+

Managed Charging

Energy management can greatly decrease operational costs associated with fleet electrification. Managed charging, sometimes called "smart charging," entails the purchase and use of EVSE that can actively track and modulate charging, and a subscription for energy management software provided by the EVSE manufacturer or network provider to keep consumption levels within a predetermined range. While there are additional up-front and monthly costs associated with these technologies, their long-term benefits should also be considered from a total cost of ownership perspective.

Depending on the design of local electricity rates, electricity pricing can be based upon the time of day during which electricity is used, where marginal pricing is greater during times of high demand and lower when strain to the grid is at its lowest. Fleets may also be exposed to demand charges, which are increased electricity chargers incurred from large, simultaneous power draws—such as when multiple heavy-duty trucks plug into fast charging at the same location at the same time. However, charging when electricity costs are lowest is not always feasible or operationally convenient for fleets. Managed charging software automates charging to coincide with dwell times while enabling fleets to benefit from lower electric rates and/or mitigating demand charges.

Fleet 3 could utilize managed charging at Warehouse 1 where their vehicles have extended downtime. This could allow them to charge the vehicles using less equipment rather than procuring one charging port per vehicle.

On-Route versus Depot Charging

Most commercial EV deployments currently in operation rely solely on depot charging, or a "return-to-base" schedule where a fleet keeps vehicles parked at one location owned/leased by the organization operating those vehicles. While policy efforts and Federal funding are advancing the development of strategically sited on-route fast charging and public charging hubs, it is recommended that current EV deployments plan for on-site depot charging, where feasible.

The Alternative Fuels Database, provided by the U.S. DOE, includes a tool to find publicly available charging stations, as does the similar PlugShare tool. Users can also map a route, similar to Google Maps, and see all charging stations along the route. These tools compile data from many networks of charging stations, such as ChargePoint, Electrify America, EVgo, and Tesla. By clicking on a charging station, one can view the number of available charging ports, as well as the type of charging connector.

It is important to note that not all charging stations listed on these sites will be appropriate for charging MHDVs. Most Class 2b and Class 3 vehicles will be able to use charging stations designed for light-duty vehicles, but Class 4–8 vehicles are often too large for typical light-duty vehicle parking spaces, and may require higher power levels to recharge quickly. It is anticipated that most public charging stations for medium- and heavy-duty trucks will require power levels of 150–350kW or more per port, paired with pull-through charging stalls and ample clearance. These may not be available at stations that appear in the DOE or PlugShare tools.

Few DC fast chargers are currently available on-route, and those that do exist may not be able to accommodate a Class 8 truck. The network of available chargers will continue to grow, however; active chargers and hours of operation are updated in these tools on a monthly basis. An example charger that would be convenient for Fleet 3 is shown in Figure 2.

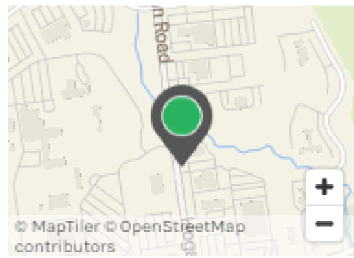
FIGURE 2 ALTERNATIVE FUELS DATABASE DETAILED CHARGER INFORMATION

QUIRK AUTO QUIRK MB2

327 Hogan Rd
Bangor, ME 04401

Directions

888-758-4389



Electric Vehicle Charging

Network: ChargePoint

Connectors: CHAdeMO CCS

EV Charging Ports: 1

Public

Mon 6:00am - 11:00pm;
Tue 6:00am - 11:00pm;
Wed 6:00am - 11:00pm;
Thu 6:00am - 11:00pm;
Fri 6:00am - 11:00pm;
Sat 6:00am - 11:00pm;
Sun 6:00am - 11:00pm

Charging Port Details

Charger Type	Ports	Connectors	Power Output
DC Fast	1	CHAdeMO: 1 CCS: 1	CHAdeMO: 62.5 kW CCS: 62 kW

Last confirmed: August 2024

Public chargers such as ChargePoint or EVgo typically require that drivers use a mobile application to interact with the charger and pay for their charge, either through the app itself, or with a credit card at the charger. In 2023, the NEVI program introduced standards for future EVSE installation including provisions that stations must implement non-proprietary charging ports, accept open-access payments such as pay by phone or contactless credit/debit card, be located along designated FHWA Alternative Fuel Corridors, and be publicly available.

Fueling/Charging Cost Analysis

A charging analysis was performed for electrification scenarios for Fleet 3 using CALSTART's Charging Infrastructure Optimization (CHARIOT) Tool. The CHARIOT tool aims to optimize Fleet 3's charging schedule, to find a schedule that works well with fleet operations while achieving lowest possible energy cost. It also provides a projected energy flow of a fleet's energy consumption and, when applicable, potential for on-site energy generation (e.g., solar power with battery storage) to get a sense of a site's energy independence and grid reliance. Fleet 3's electricity is provided by Versant.

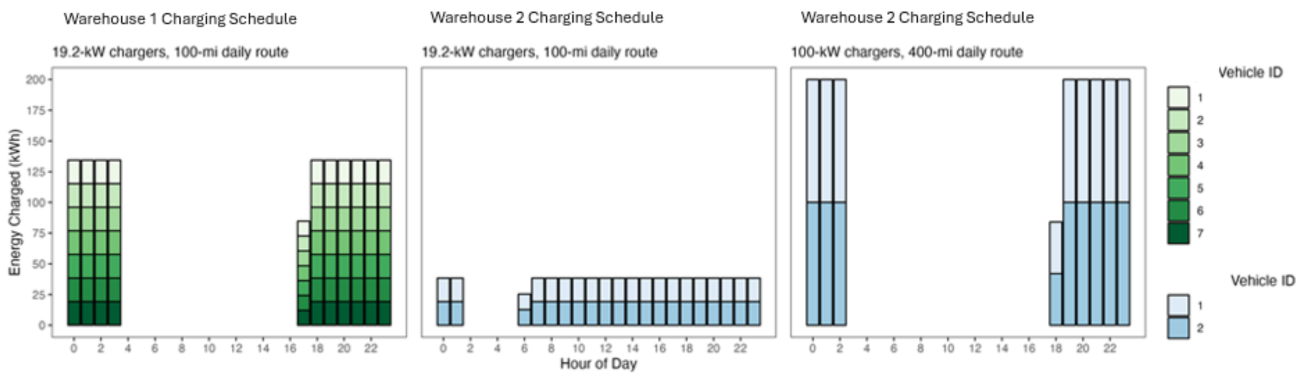
The CHARIOT tool was used twice for each warehouse: once using Versant's high peak time-of-use (TOU) rate ($3.55/kWh) and once using a flat TOU rate ($0.12/kWh).

Daily Charging Load Profiles

Load calculations were performed for Warehouse 1 and Warehouse 2. Due to the higher mileage of the two tractor trailers at Warehouse 2, a higher mileage scenario of 400 miles with a 100-kW Level 3 DC fast charger was included along with the 100 miles and a 19.2-kW level 2 scenario for both Warehouse 1 and 2. Figure 3 shows the daily charging load profiles for all vehicles for the three scenarios.

Although Level 2 charging was modeled for both sites, the Class 8 truck models listed above may not be compatible with Level 2 charging, and Fleet 3 should plan to charge using DC fast chargers. All vehicles with a 100 mile duty cycle can be charged within 3 hours at their domicile location using DC fast chargers. Figure 3 shows what daily charging profiles (energy demand by hour) might look like for this fleet.

FIGURE 3 DAILY CHARGING LOAD PROFILES—ALL VEHICLES



Based on the anticipated energy needs of two electric tractors at Warehouse 2 compared to two diesel tractors, Fleet 3 would be estimated to achieve significant reductions to their annual energy costs. Total annual energy cost and cost per mile for diesel versus electric vehicles operating out of Warehouse 2 are shown in Figure 4 and Figure 5, respectively for a flat time-of-use rate scenario. Because of the reduced cost of charging compared to diesel fuel, Fleet 3 could expect a significantly decreased cost per mile of operation.

FIGURE 4 WAREHOUSE 2 ANNUAL ENERGY COST UNDER DIESEL AND EV SCENARIOS

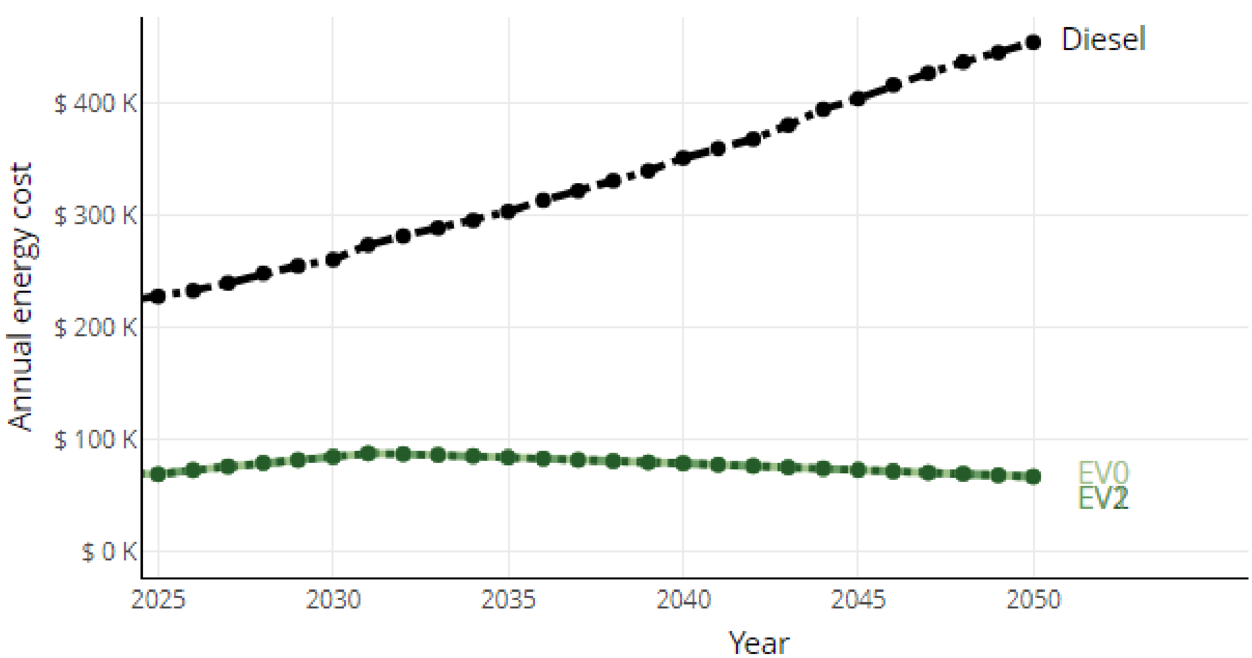
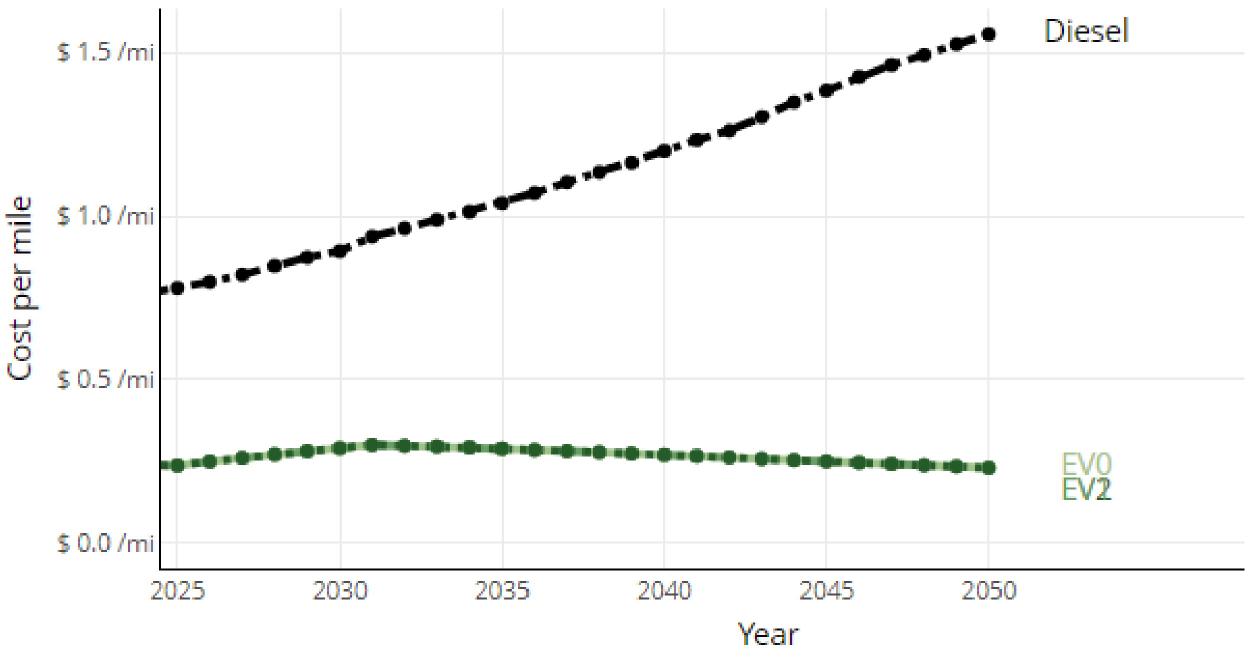


FIGURE 5 WAREHOUSE 2 ENERGY COST PER DISTANCED TRAVELED



EVSE FINANCING

Federal Incentives

Commercial Clean Vehicle Tax Credit

The Federal Government's adoption of the Infrastructure Reduction Act (IRA) enacted new Federal tax credits (IRC Section 45W) for commercial clean (electric or hydrogen fuel cell) vehicles in 2022. Eligible entities include businesses and tax-exempt organizations that purchase commercial clean vehicles between January 1, 2023, and before January 1, 2033. Heavy-duty vehicles with a gross vehicle weight rating of 14,000 lbs. or greater are eligible for a tax credit up to $40,000, or 30 percent of the incremental cost of the vehicle as compared to a gasoline or diesel vehicle, whichever is lower. Applicable electric vehicles must have a battery with at least 15 kWh of capacity and be made by a qualified manufacturer (see the IRS's list for examples). For tax exempt entities, such as schools, governments, or non-profit organizations, the tax credit is available through a mechanism commonly known as direct, or elective, pay.

Alternative Fuel Infrastructure Tax Credit

Beginning on January 1, 2023, installation of EV charging equipment is eligible for a tax credit of 30 percent of the installation costs (or 6 percent in the case of property subject to depreciation), not to exceed $100,000. Permitting and inspection fees are not included in covered expenses. As above, tax-exempt entities are eligible to claim these credits through direct or elective pay.

These tax credits are only available to business locations and tax-exempt entities with the following census tract requirements:

- A population census tract where the poverty rate is at least 20 percent.
- Metropolitan and non-metropolitan area census tract where the median family income is less than 80 percent of the State median family income level.

Fleets should work with their charging infrastructure installers to determine eligibility by identifying their census tract using this tool and determining if it is included in the IRS's list. If eligible, tax form 8911 should be completed.

State Incentives

Efficiency Maine Medium- and Heavy-Duty Vehicle Incentive Pilot

In October 2024, the quasi-state agency Efficiency Maine Trust launched a pilot program to demonstrate potential use cases and performance of zero-emission MHDVs in Maine. Awards will be issued in three rounds, with applications open through the end of February 2025, with the possibility of further rounds of funding in the future. In order to be eligible, applicants must be based in Maine and already own a Class 3 to 7 vehicle in their fleet. The maximum award for different vehicle classes is shown in Table 3.

TABLE 3 EFFICIENCY MAINE INCENTIVE LEVELS

Vehicle Class	Maximum Award
Class 3	40% of purchase price up to $40,000
Class 4	40% of purchase price up to $60,000
Class 5	50% of purchase price up to $80,000
Class 6	50% of purchase price up to $100,000
Class 7	50% of purchase price up to $120,000

Along with awards for vehicle purchases, the program also offers incentives for Level 2 charging and professional services such as consulting. For further information, and to apply, fleets should visit the program website.

RESULTS

Total Cost of Ownership

Calculating the total cost of ownership (TCO) for a vehicle offers fleet owners information to evaluate direct and indirect costs of EV purchases, as well as potential savings over the life cycle of purchased vehicles. The transition to EVs involves a shift in perspective regarding TCO components. Traditional internal combustion engine (ICE) vehicle costs are usually presented as capital cost for vehicles and dollar per gallon ($/gal) costs for fuel, as well as lifetime maintenance expenses. An analysis of TCO for EVs must consider power output, $ per kilowatt, grants and incentive programs, and planning and installing EVSE. While EVs are typically more expensive upfront, they are often less expensive to operate and maintain than comparable ICE vehicles; in many cases, these operational savings can offset higher upfront costs across the lifespan of the vehicle, resulting in a positive TCO.

TCO is calculated by combining the vehicle capital and operating costs over a set period of operations. For this analysis, the vehicle price points came from industry averages. Calculations assume a purchase in 2025 and a 12-year vehicle life, which is average across Maine trucks in this class. The results represent one vehicle in each duty cycle. Calculations accounted for the Efficiency Maine Trust vehicle incentives and the Federal Commercial Clean Vehicle tax credit. The results are estimates and actual cost differences may vary.

Each TCO scenario is modeled with a capital procurement cost for the diesel versus electric model and does not include any vehicle resale or residual values. The Federal tax credit is detailed in the Federal Incentives section and, along with Maine state incentives, is taken into consideration when modeling cumulative costs over time. For simplicity, the TCO calculation includes procurement of EVSE and infrastructure upgrades based on the cost of a single port. Infrastructure upgrade costs are calculated per location, not per vehicle. Those costs are modeled in the Fueling/Charging Cost Analysis section. The included costs are vehicle procurement, sales tax, Federal excise tax, maintenance, fuel, and insurance costs.

Tractor Trailor—Warehouse 1

Fleet 3's seven Class 8 tractor trailers at Warehouse 1 have an average annual mileage of 55,000 miles and operate an average of 250 days per year, meaning their daily driving distance is about 220 miles. Figure 6 shows cumulative costs over time and Figure 7 shows itemized total costs.

FIGURE 6 TRACTOR TRAILER WAREHOUSE 1—FLEET COSTS OVER TIME

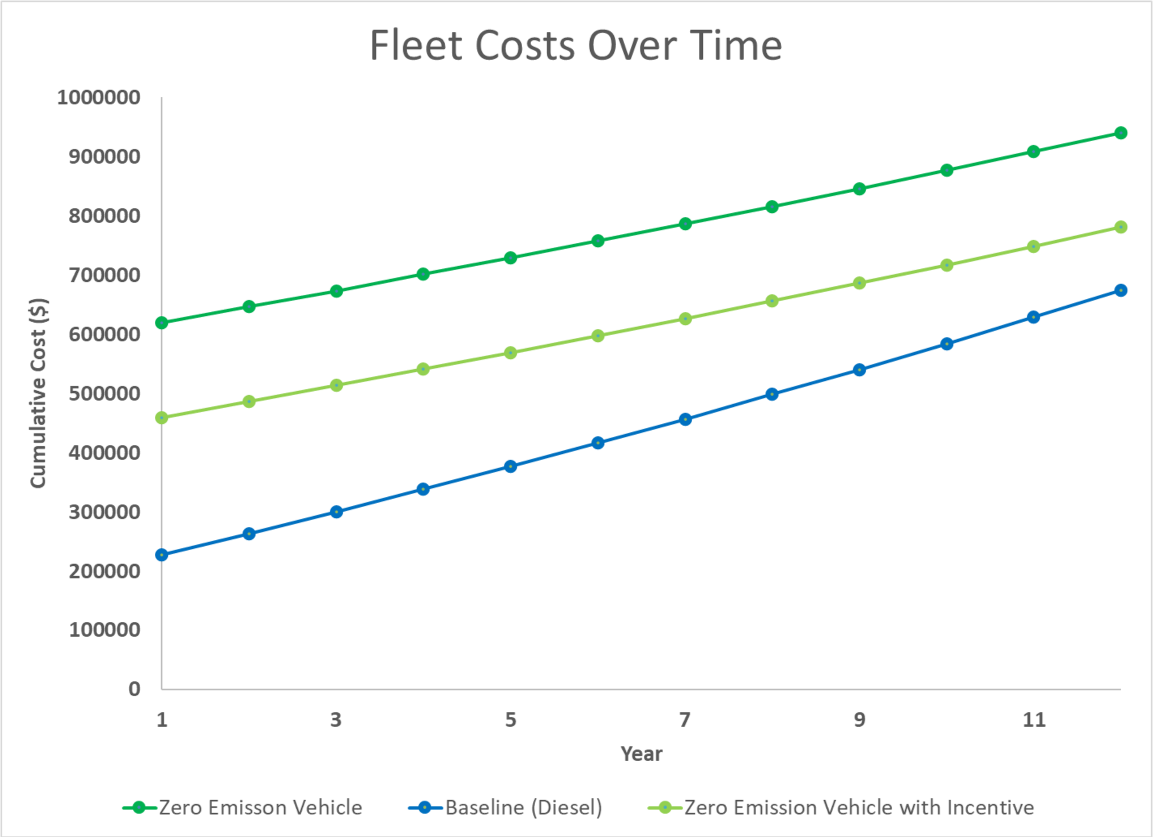
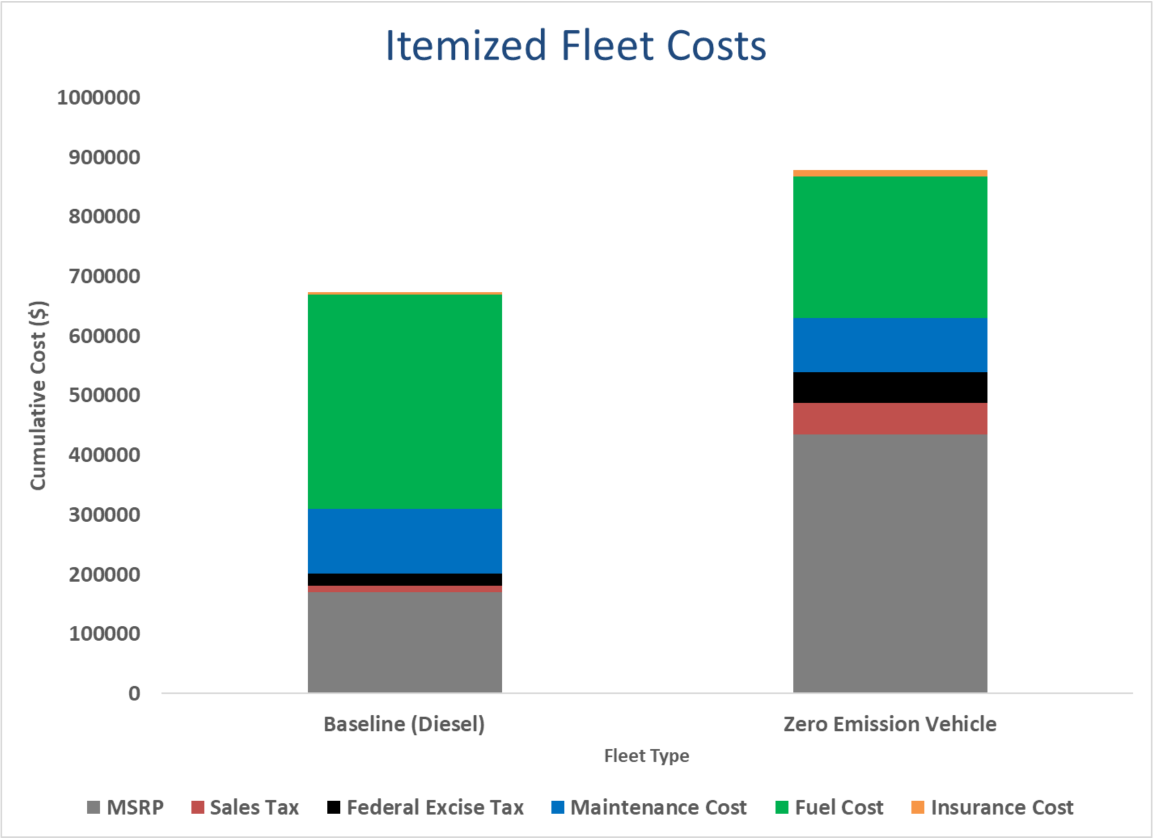


FIGURE 7 TRACTOR TRAILER WAREHOUSE 1—ITEMIZED FLEET COSTS



This TCO analysis compares a Class 8 diesel-powered tractor trailer priced at $170,300 with an electric tractor trailer priced at $435,000. It assumes a $4.00/gallon price of diesel and an $0.18/kWh price of charging. The infrastructure cost is priced at $87,050 for the costs of one Level 3 DC fast charging port hardware, installation and local infrastructure, and utility side make-ready costs. This cost is included in the upfront capital costs of the vehicle purchase.

The modeled incentive is $120,000 off the vehicle purchase price, reducing the capital procurement cost to $315,000. The Commercial Clean Vehicle Tax Credit removes $40,000 more (30 percent of the manufacturer's suggested retail price or MSRP, capped at $40,000), reducing the procurement cost further to $275,000.

The results indicated that the tractor trailer's payback period exceeds its expected life with and without incentives included due to higher upfront capital costs. The electric tractor trailer still produces an estimated 39 percent reduction in annual fuel costs ($8,361) and an estimated 18 percent reduction in annual maintenance costs ($1,650). Itemized costs are shown in Table 4.

TABLE 4 CLASS 8 TRACTOR TRAILER ITEMIZED CUMULATIVE COSTS OVER 12 YEAR VEHICLE LIFE

Cost Components	Baseline	ZEV
Manufacturer's Suggested Retail Price	$170,299	$435,000
Sales Tax	$10,644	$27,188
Federal Excise Tax	$20,436	$52,200
Maintenance Cost	$108,900	$90,750
Fuel Cost	$358,938	$236,973
Insurance Cost	$4,445	$11,354
Infrastructure Costs	$0	$87,050

Tractor Trailor—Warehouse 2

Fleet 3's two tractor trailers at Warehouse 2 have an average annual mileage of 140,000 miles and operate an average of 250 days per year, meaning their daily driving distance is about 560 miles. Figure 8 shows cumulative costs over time and Figure 9 shows itemized total costs.

FIGURE 8 TRACTOR TRAILER WAREHOUSE 2—FLEET COSTS OVER TIME

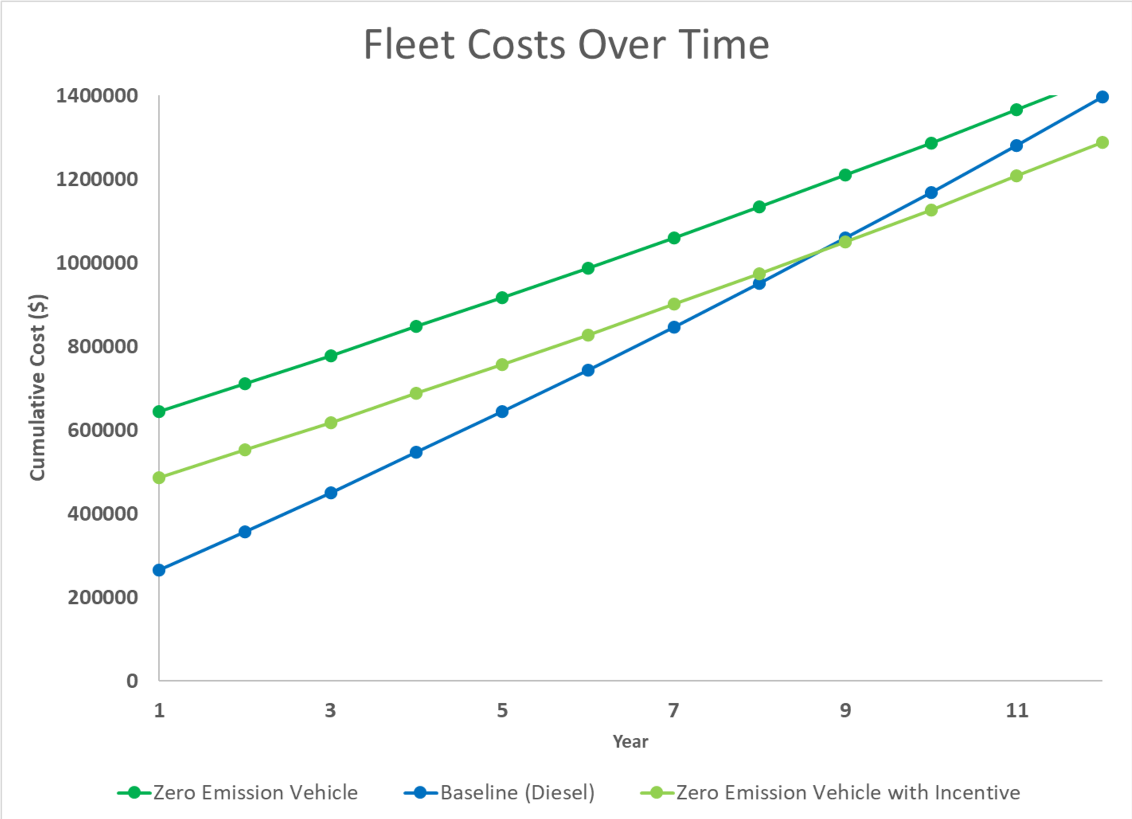
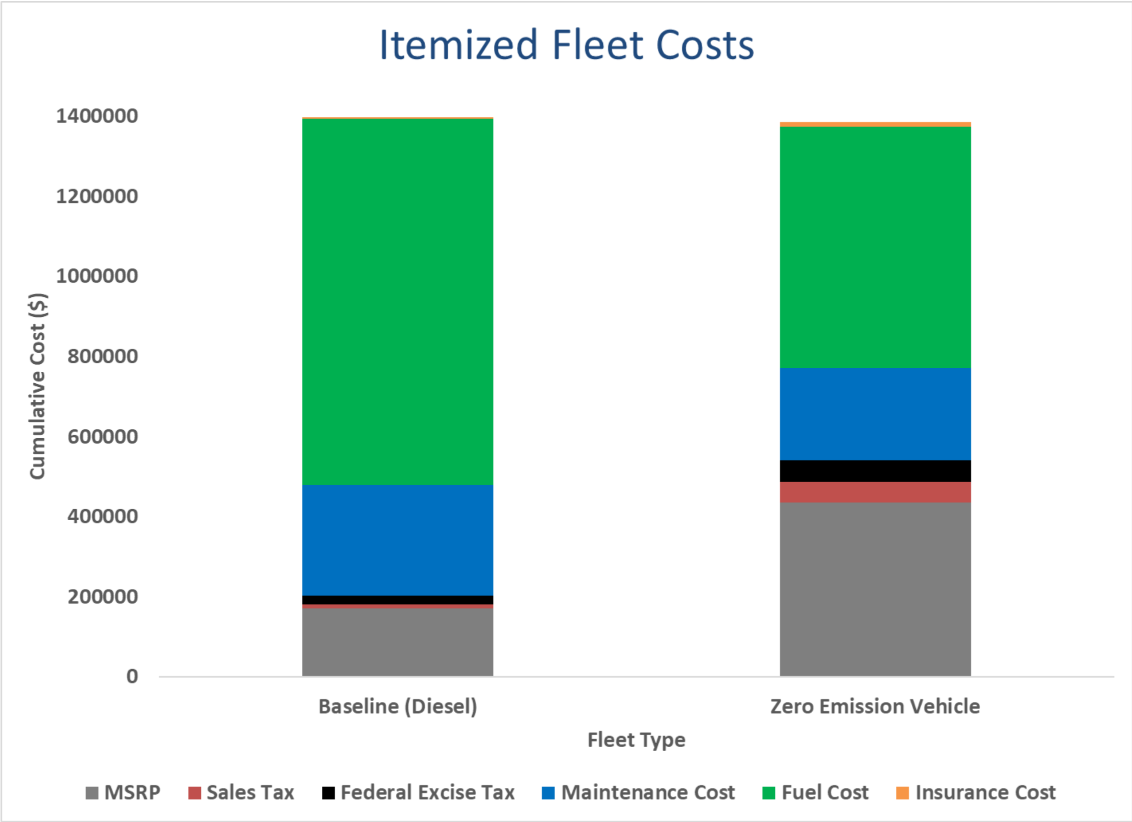


FIGURE 9 TRACTOR TRAILER WAREHOUSE 2—ITEMIZED FLEET COSTS



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The modeled incentive is $120,000 off the purchase vehicle price, reducing the capital procurement cost to $315,000. The Commercial Clean Vehicle Tax Credit removes $40,000 more (30 percent of the MSRP capped at $40,000), reducing the procurement cost further to $275,000.

The results indicated that the tractor trailer reaches cost parity in the 9th year after purchase. The electric tractor trailer produces an estimated 39 percent reduction in annual fuel costs ($21,283) and an estimated 18 percent in annual maintenance costs ($4,200). Itemized costs are shown in Table 5.

TABLE 5 CLASS 8 TRACTOR TRAILER ITEMIZED CUMULATIVE COSTS OVER 12 YEAR VEHICLE LIFE

Cost Components	Baseline	ZEV
MSRP	$170,299	$435,000
Sales Tax	$10,644	$27,188
Federal Excise Tax	$20,436	$52,200
Maintenance Cost	$277,200	$231,000
Fuel Cost	$913,659	$603,204
Insurance Cost	$4,445	$11,354
Infrastructure Costs	$0	$87,050

Fleet Emissions

Maine's transportation sector is the largest source of greenhouse emissions in the State, and medium- and heavy-duty trucks account for 27 percent of these emissions.[2] Providing power to vehicles via electricity is significantly less polluting than diesel fuel, especially in areas served by low-carbon sources of electricity generation. Renewable resources powered 64 percent of Maine's total electricity net generation, and wind provided the largest share at 23 percent of the State's total net generation, in 2022.[3]

An analysis of Fleet 3's direct exhaust emissions was performed using the U.S. Environmental Protection Agency's Diesel Emission Quantifier tool. The analysis combines the average annual mileage traveled by all nine vehicles in the fleet. Converting Fleet 3's vehicles to ZEVs would eliminate all of these direct emissions.

TABLE 6 INTERNAL COMBUSTION ENGINE FLEET EMISSIONS

Pollutant	Annual Emissions (Short Tons/Year)	10-year Emissions (Short Tons)
Carbon Monoxide (CO)	1.322	13.22
Nitrogen Oxides (NO_x)	1.510	15.1
Particulate Matter (PM)	0.002	0.02
Carbon Dioxide (CO_2)	2,323	23,228

2 Rocky Mountain Institute. "RMI Analysis: With Smart Policy, Truck Electrification Is Within Reach." Accessed October 2024.

3 U.S. Energy Information Administration. State Profile and Energy Estimates. Accessed October 2024.

IMPLEMENTATION CONSIDERATIONS

Energy Storage and Resiliency

Power outages are always a possibility at fleet depots, regardless of grid advancements and fidelity. Fleets should consider contingencies for maintaining operations of electric trucks in the event of a long-term power outage. Today's electric vehicles do not necessarily require electricity from the grid to be available to properly fuel. There are means of fueling battery-electric vehicles using energy storage solutions, most commonly batteries, which are safer than storing flammable fossil fuels on site. Critical vehicle operations may consider other forms of backup power to ensure charging access, including generators.

Many consumers have asked whether EVs can be used in an emergency to provide backup power to homes, offices, and other facilities. For a vehicle to provide backup power, there are several additional considerations: whether the vehicle is designed for 'bidirectional charging', meaning that the vehicle can output power, and whether the facility has appropriate two-way charging equipment. The Ford F-150 Lightning is equipped to support bidirectional charging, and Ford supports claims that the truck can provide up to 100 kWh of power on a single charge, which is enough to power an average house for three days (30 kWh per day).

Preheat/Precool

One consideration often overlooked in commercial EV operation is the energy use associated with climate control, either for the operator or for the goods themselves. Idle time spent bringing a cab to a comfortable riding temperature uses energy otherwise intended for moving the vehicle along its intended route. The energy used to heat or cool the vehicle cabin may consume a significant amount of the vehicle's battery capacity. Preconditioning while vehicles are connected to chargers at the depot is a simple approach to providing comfortable conditions and extending driving range during winter and summer. These types of considerations are important to factor in, and experiment with, during a fleet's initial deployment.

"Vampire" Energy

Vehicles of all kinds are meant to be driven; they benefit from regular usage by foregoing the potential negative impacts of remaining idle for extended periods. One such impact to commercial EVs is what is known as "vampire" energy, where a vehicle's battery will slowly deplete while it remains unplugged and idle. This is normal behavior and not an indication that anything is malfunctioning. Rather, this is an expected effect resulting from a combination of onboard electronics that remain on or in stand-by, as well as the natural chemical reactions occurring in a vehicle's battery.

Best practices for long-term battery health include keeping a vehicle's battery charged to 80 percent when possible and taking measures to ensure its state of charge does not regularly fall below 20 percent while idle. Managed and networked charging infrastructure can help fleets keep battery state of charge within this optimal range. For smaller EV deployments and fleets involving just a few vehicles, this also may be achievable through effective training and communication with staff on-site.

REFERENCES

CALSTART's Zero-Emission Technology Inventory (ZETI) is a public online interactive dashboard containing the status and anticipated timing of commercial availability for zero-emission MHDVs across a range of vehicle platforms and key global regions. ZETI was the primary tool used to find equivalent medium and heavy-duty electric vehicle models that could replace the current fleet inventory.