Power MI Fleet

Consumers Energy Fleet Concierge

Small Rural Fleet Electrification Analysis and Implementation Plan

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Glossary of Terms

AC	Alternating Current	**ICE**	Internal Combustion Engine
AFV	Alternative Fuel Vehicle	**Kg**	Kilogram
BEB	Battery-Electric Bus	**kW**	Kilowatt
BEV	Battery-Electric Vehicle	**kWh**	Kilowatt-hour
CaaS	Charging-as-a-Service	**lbs.**	Pounds
CO_2	Carbon Dioxide	**MW**	Megawatt
DCFC	Direct Current Fast Charging	**MWh**	Megawatt-hour
DERA	Diesel Emissions Reduction Act	**NEMT**	Non-Emergency Medical Transport
EGLE	Michigan Department of Environment, Great Lakes, & Energy	**NOx**	Nitrogen Oxides
EPA	Environmental Protection Agency	**OEM**	Original Equipment Manufacturer
EVSE	Electric Vehicle Supply Equipment	**PEV**	Plug-In Electric Vehicle
EV	Electric Vehicle	**PHEV**	Plug-In Hybrid Electric Vehicle
FTA	Federal Transit Administration	**PPE**	Personal Protection Equipment
FY	Fiscal Year	**TCO**	Total Cost of Ownership
GHG	Greenhouse Gas	**VW**	Volkswagen
GSTU	General Service Secondary Time of Use	**ZEV**	Zero-Emission Vehicle

Executive Summary

Michigan's largest energy provider, Consumers Energy, established their PowerMIFleet Fleet Concierge Program to evaluate whether commercial or municipal customers identified by Consumers Energy could realize the benefits of electrifying all or a portion of their fleet. As part of this evaluation, needs and constraints were determined, and a business case was developed for fleet electrification. Consumers Energy connected CALSTART with a small rural fleet in Michigan, to perform an evaluation on their fleet operations.

By electrifying every vehicle, the fleet could save more than $515,080 in operating costs from utilizing zero-emission vehicles (ZEVs)—including fuel and maintenance costs but excluding vehicle purchase price—over the vehicles' 7-year lifetime

The fleet currently operates nine shuttle buses. The COVID-19 pandemic has affected the fleet's ridership levels, providing just under 43,000 rides in 2021. The fleet has no previous experience with battery-electric vehicles (BEVs).

The fleet's operations run five days a week (Monday through Friday), except for two vehicles that run six days a week (Monday through Saturday) as a passenger on-demand response service to their community. Currently, their internal combustion engine (ICE) fleet is made up of two makes and models across the Class 4 vehicle classification. To ensure the smoothest transition to BEVs and taking into consideration current commercial driver licensing (CDL) issues, two separate vehicle replacement scenarios were proposed as direct replacements based on current and future capacity, American Disabilities Act, and daily range needs of the fleet and vehicle availability. Scenario 1 replaces all current gas vehicles with Class 4 battery-electric buses (BEBs), and Scenario 2 proposes a hybrid option where all current gas vehicles are replaced with five Class 4 BEBs and four Class 2 battery-electric vans. A fleet electrification roadmap was developed for the fleet for each scenario where a total of nine battery-electric shuttle buses, or a mix of five BEBs and four battery-electric vans, will be deployed in cycles over a 2-year term (2023-2024). Funding opportunities to support the increased cost of electrification include but are not limited to Federal Transit Administration (FTA) Low-No funding, which has an expected $5.6 billion in funding across the next five years, and Consumers Energy PowerMIFleet rebates.

A vehicle assessment and duty cycle analysis showed that for Scenario 1, the fleet would require at least 388 kilowatt-hours (kWh) per day, which equates to 1.97

megawatt-hours (MWh) of energy requirements per week, or approximately 106 MWh per year, to meet the electrical charging needs of a fully electrified fleet. For the Scenario 2/hybrid option, the fleet would require at least 274.5 kWh per day, or 1.46 MWh of energy requirement per week and approximately 76 MWh per year to meet the charging needs of a fully electrified fleet. To ensure the fleet is positioned for the right electric vehicle supply equipment (EVSE) that sets them up for success today and over the next two years (2023-2024), CALSTART utilized the overall energy demand impact and the average daily mileage per vehicle to determine the appropriate level of charger (Level 1, Level 2, or Level 3) that meets the needs of the 2-year electrification plan, while also working to keep overall estimated deployment costs low and manageable based on available funding. Level 2 chargers have been proposed as part of the fleet's electrification planning for both vehicle replacement scenarios. Over the course of the next two years, nine Level 2 single-port chargers would be deployed for each scenario, following a plan that allows the fleet to take advantage of available infrastructure funding and incentives. The fleet's managed charging plan suggests overnight charging between the hours of 11:00 p.m. and 7:00 a.m. to take advantage of Consumers Energy General Service Secondary Time of Use (GSTU) lowest off-peak rates at $0.067811 per kilowatt (kW) or less, with current operations not requiring the immediate need for day-time opportunity charging. Based on overnight charging and Consumer's GSTU Tier 3 rate schedule, the estimated annual cost for electric fuel is $9,779 for Scenario 1's nine BEBs, and $7,849 for Scenario 2's hybrid of five BEBs and four battery-electric vans—a savings of more than 71% per year for Scenario 1 and 77% per year for Scenario 2.

To fully execute the vehicle and infrastructure deployment plan, the costs to completely electrify the fleet's nine-vehicle fleet could cost an estimated $2,876,621 for Scenario 1 and $1,841,800.5 for Scenario 2. Of this total cost, $2,310,296 in funding has been identified as available through the FTA and Consumers Energy's PowerMIFleet programs for Scenario 1, and $1,482,440 in funding has been identified in Scenario 2. Under the FTA's Low-No program, Scenario 1's remaining costs of $556,324 could be covered by an MDOT local match of 20% or more, and Scenario 2's remaining costs of $359,360 could also be covered by an MDOT local match of 20% or more, leaving both scenarios with a $0.00 remaining balance.

The estimated overall direct investment of $2,876,620.5 (Scenario 1) and $1,841,800.5 (Scenario 2) to fully electrify the fleet makes for a positive business case. Based on total cost of ownership (TCO) calculations, the fleet could save an estimated $452,921 (Scenario 1) and $515,080 (Scenario 2) in lifetime savings across the nine-vehicle fleet—not including the purchase price of the vehicle. This is the estimated savings in operating costs, including fuel and maintenance costs, from utilizing zero-emission vehicles (ZEVs) over the vehicle's 7-year lifetime. An investment in transitioning the fleet to 100% electric provides greenhouse gas emissions savings of greater than 1,793,744 kilogram of carbon dioxide (CO2), which is the equivalent CO2 reduction to what 11,816 trees would consume over seven years (Keystone 10 Million Trees Partnership, n.d.).

Project Overview

Michigan's largest energy provider, Consumers Energy, is working to advance clean transportation with its new PowerMIFleet project, which will provide $3 million in infrastructure rebates and fleet consultation support by means of the Consumers Energy Fleet Concierge Program. The Fleet Concierge Program is designed to help fleet owners and operators adopt zero-emission vehicles (ZEVs) and reduce operating and maintenance costs. Under this program, CALSTART is working to advance fleet electrification planning for medium- and heavy-duty fleets operating within Consumers Energy territory under a Fleet Concierge support contract. Recognizing that deployment of ZEVs requires individual attention at the fleet level, this program examines each fleet's electrification needs while ensuring the greatest success and outcomes for all involved parties: the fleet, the utility, and all selected partners and vendors.

Consumers Energy connected CALSTART with a small rural fleet in Michigan, to support their fleet concierge needs. In fiscal year (FY) 2021, the fleet applied for a Federal Transit Administration (FTA) Low-No grant. Unfortunately, the fleet was not awarded this funding, so it is considering Consumers Energy, FTA, and other funding opportunities in future years.

As a deliverable to the Fleet Concierge Program, CALSTART is providing the fleet with a full fleet electrification plan for converting their entire fleet to battery-electric buses (BEBs) (Scenario 1) or a hybrid of BEBs and battery-electric vans (Scenario 2). This plan specifically recommends a fleet electrification execution plan, including timelines and cash flow considerations based on vehicle and infrastructure needs as well as available known funding for both scenarios. At the time of this publication, the fleet's Vehicle 7 was out for most of 2021 due to repairs, so for vehicle replacement prioritization, Vehicle 7 was moved to the top of the vehicle replacement timeline.

The plan will provide the fleet with the following items:

- **Vehicle Electrification Options:** Identification of recommended and available ZEVs that meet the current needs of the transit agency's existing fleet operations: passenger capacity, duty cycle, use case, considerations of federal testing completion at the Bus Research Testing Center, and emissions calculations.

- **Charging Solutions:** Identification of the best electric vehicle supply equipment (EVSE) solutions and proposed site layout that meets the immediate and future needs of the transit agency while minimizing infrastructure costs.

- **Charging Strategy:** Identification of the right utility rate structure and optimum charge times to meet the transit agencies business model requirements while minimizing electricity costs.

- **Total Cost of Ownership (TCO) Estimate**: Identification of the TCO analysis for internal combustion engine (ICE) vehicles vs. ZEVs based on operations and maintenance across the 7-year anticipated operational life of each vehicle.

- **Funding Availability:** Identification of all available funding programs that will help to offset the overall costs of vehicle and infrastructure deployment.

- **Fleet Electrification Roadmap:** Identification of a fleet electrification conversion execution plan that includes timeline and cash flow considerations.

CALSTART completed this project in four phases and 12 tasks (**Figure 1**).

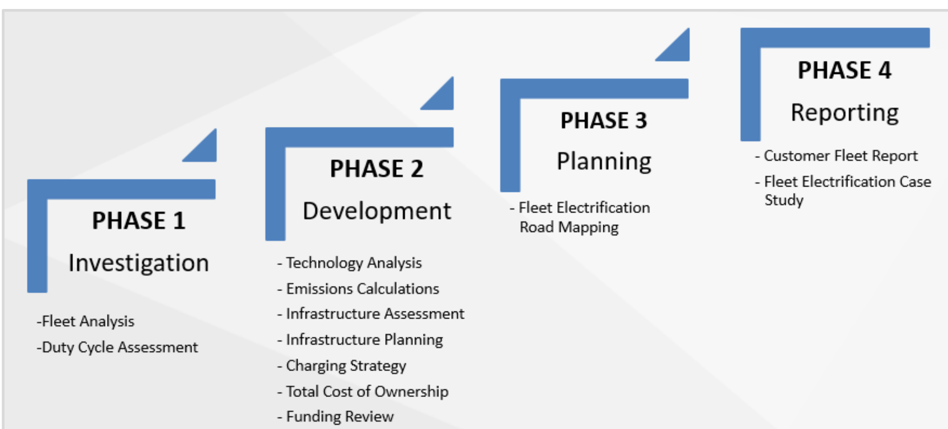

Figure 1. CALSTART's Four Phase Fleet Concierge Process

Working in collaboration with the fleet and Consumers Energy, CALSTART determined the fleet's future vehicle needs, estimated the overall energy demand for a future 100% electric fleet, and developed a well-defined roadmap for full fleet electrification. The findings are included within this report.

Fleet Electrification Vehicle and Duty Cycle Assessment

Fleet Overview

The small rural fleet, which consists of nine shuttle buses that support on-demand response operations, is located in Michigan. The fleet provided just under 43,000 rides in 2021, which was slightly less than previous years due to COVID-19. Their goal is to provide safety, comfort, and satisfaction to customers.

Vehicle Electrification Replacement Strategy

At the time of developing this report, the fleet is operating all its nine-vehicle revenue fleet, with one revenue vehicle used as a spare to spread mileage across vehicles or where needed for repairs. The fleet operates its fleet (**Table 1**) from one central location.

Table 1. Current Vehicle Fleet

MANUFACTURER	MODEL	QUANTITY	CLASS OF VEHICLE	MODEL YEAR	FUEL TYPE
Ford	E-450 Champion	1	4	2017	Gas
Ford	E-450 ElDorado	1	4	2013	Gas
Ford	E-450 ElDorado	2	4	2018	Gas
Ford	E-450 ElDorado	2	4	2019	Gas
Ford	E-450 ElDorado	3	4	2020	Gas

For the purposes of this project, CALSTART built the fleet's vehicle electrification replacement strategy considering all nine vehicles in their fleet based on current fleet assessment data, as well as commercial driver licensing (CDL) issues. A detailed analysis of each vehicle was performed to gain a full understanding of the fleet's vehicle electrification needs. Analysis of the fleet included detailed information for each vehicle, such as the model year of the vehicle, the ideal replacement year, dwell times, daily mileage, fuel type, and capacity, among other information. This information provides insight on the duty cycles or the period(s) each vehicle is in operation and is important when not only selecting proposed battery-electric vehicle (BEV) replacements but also for determining an efficient vehicle charging strategy, charger level requirements, and charging timeframes.

Table 2 contains the detailed fleet information, which is listed in order of replacement priority. Due to repairs and time out of service in 2021, Vehicle 7 will be the first vehicle replaced, followed by the remaining revenue vehicles based on end of life, with oldest being replaced before newest. The 2021 average daily mileage was used for all of the fleet's current vehicles.

Table 2. Fleet Replacement Plan and Associated Duty Cycles

VEHICLE NO.	MAKE	MODEL	CLASS OF VEHICLE	MODEL YEAR	CURRENT FUEL TYPE	DAILY MILES *(2021 averages)*	DWELL TIMES
7	Ford	E-450 Champion	4	2017	Gas	50	1700-1300
9	Ford	E-450 ElDorado	4	2013	Gas	50	1130-0615
8	Ford	E-450 ElDorado	4	2018	Gas	50	1600-0630
12	Ford	E-450 ElDorado	4	2018	Gas	75	1700-1130
1	Ford	E-450 ElDorado	4	2019	Gas	80	1615-1030
14	Ford	E-450 ElDorado	4	2019	Gas	SPARE CURRENTLY	0000-2359
2	Ford	E-450 ElDorado	4	2020	Gas	70	1615-0800
4	Ford	E-450 ElDorado	4	2020	Gas	45	1330-0615
6	Ford	E-450 ElDorado	4	2020	Gas	65	1700-0945

Fleet Electrification Infrastructure Assessment

Small Rural Fleet Bus Depot Location

CALSTART has performed a detailed site analysis for the small rural fleet bus depot. It is assumed that all vehicles and associated infrastructure will be located at this location (**Figure 2**).

Figure 2. Small Rural Fleet Bus Depot

Site Analysis

Evaluation of this site was performed virtually with the fleet, with CALSTART and the fleet discussing the fleet's current parking capabilities. The fleet currently houses all nine of its buses in a bus facility housing bay. Due to space constraints after transitioning to buses with longer chassis, six buses are parked in the housing bay, while the remaining three are parked in single stalls.

To accommodate charging infrastructure for a fully electric fleet, CALSTART recommends the following strategies for both vehicle replacement scenarios:

- **Scenario 1:** Lightning eMotors E-450 buses with nine Level 2 16.8 kilowatt (kW) BTC Power charging stations (one charging station per electric bus).
    - Given that each of the nine Lightning eMotors E-450s will have its own BTC Power Level 2 (16.8 kW) charger, CALSTART recommends that the fleet continue its current bus parking strategy, with one charging station installed for each of the six buses parked in the housing bay

and one charging station installed for each of the three buses parked in the single stalls.
    - If, however, installing the charging stations in the single parking stalls creates further space constraints, CALSTART recommends the fleet park all nine Lightning eMotors E-450 buses in the housing bay, with one charger installed and available for each.

- **Scenario 2**: Five Lightning eMotors E-450 buses and four Ford E-Transits with nine Level 2 16.8 kW BTC Power charging stations (one charging station per electric vehicle (EV)).
    - For this scenario, CALSTART recommends the fleet follow the Scenario 1 parking strategy detailed above.

For either vehicle replacement and infrastructure scenario, CALSTART recommends that the fleet contact Consumers Energy to explore any make-ready upgrades that may be necessary to accommodate the installation of nine Level 2 16.8 kW chargers, including any on-site retrofits, electrical panel upgrades, or other required infrastructure improvements.

Daily Operation and Charging Schedule

For purposes of this project, CALSTART completed the daily operation and charging analysis based on all nine of the fleet's vehicles (see **Table 1**). Once replaced with BEVs, seven vehicles are expected to operate on a planned daily schedule that operates five days a week (Monday – Friday), or 260 days a year with no weekend service, and two vehicles will operate six days a week (Monday – Saturday), or 312 days a year with no Sunday service. To ensure full-service operations and to meet the current duty cycles, overnight charging at the depot should be sufficient to support the fleet's service needs without any opportunity charging required. It is important to note that this charging strategy is based on the actual daily miles traveled by each vehicle provided by the fleet to CALSTART.

> **Opportunity Charging:** As standard practice until battery range increases beyond 120 miles, BEBs whose daily mileage exceeds 110 miles daily should take advantage of direct current fast charge (DCFC) Level 3 opportunity charging during a scheduled lunch or daily break period.
>
> **Overnight Charging:** All BEBs should charge overnight as part of standard practice to ensure vehicles have a full charge at the start of operations the next day. Overnight charging also allows for slower charge rates that assist in extending battery life. This approach allows operators to pre-condition their vehicle for the right ambient temperature at the start of a shift while the vehicle is still on the charger, which reduces the use of the vehicle battery for this purpose.

At the end of daily operations, all nine vehicles return to the depot, at which time all cleaning and scheduled maintenance occurs. Once complete, the buses can be parked at their assigned parking space and placed on a charger for overnight charging. To ensure the most efficient energy use and lowest cost to the fleet for the electricity needed for charging, CALSTART identified a managed charging schedule where the fleet should take advantage of Consumers Energy's off-peak demand schedule and begin charging no earlier than 11:00 p.m. and end charging no later than 7:00 a.m. the next morning. In doing so, the fleet will be taking advantage of Consumers' General Service Secondary Time of Use (GSTU) rate structure where electricity rates are at their lowest. In addition, to mitigate any electricity demand load issues, it is recommended that the fleet stagger charge start times by at least 10 minutes. The fleet should take advantage of managed charging solutions offered by the EVSE supplier to schedule their charging around the lowest cost opportunity (see Appendix A – 24 Hour Load (Managed Charging))

Estimated Daily Mileage and Efficiency

As presented in **Table 2** above, each of the nine vehicles operate at varying lengths of time and miles daily. The fleet's operations are demand responsive and therefore CALSTART utilized the data provided by the fleet to understand average milage. Vehicle efficiency, or energy use per mile, of the replacement BEVs for this analysis was based on the industry average kilowatt-hours (kWh) by vehicle class. Based on the fleet's current operations, duty cycle assessment, and near term (through 2023) vehicle availability, it makes sense to replace the fleet with Class 4 vehicles (Scenario 1). Due to a shortage in CDL drivers with Passenger Endorsement, the fleet is considering downsizing some of their vehicles as a solution to this hiring issue. CALSTART has completed another analysis to inform the fleet what this change would entail. In this second scenario, it makes sense to replace the fleet with Class 2 and Class 4 vehicles (Scenario 2). The charging strategy described in this section is applicable to both of these scenarios with only overnight, off-peak charging necessary to sustain the fleet's operations. Each BEV placed into service will need to receive a 100% charge before entering service each day to achieve best efficiencies (**Table 3**).

Table 3. Vehicle Efficiencies by Vehicle Class

VEHICLE CLASS	AVERAGE ENERGY USE (kWh/mile)
Class 2	0.346
Class 4	0.8

Overall Energy Demand and Estimated Load Profile

To understand what the overall energy demand needs would be for the fleet's site, CALSTART ran a load profile study for each of the replacement vehicles by class (**Table 4**). The load profile projected the estimated energy needs per operational day based on the energy use per mile multiplied by the number of miles each vehicle is driven per day.

Under Scenario 1, where all nine vehicles are converted to a Class 4 BEV, the total overall energy demand is estimated to be 388 kWh or 0.388 megawatt-hours (MWh) per day.

Table 4. Scenario 1: Estimated Load Profile by Vehicle Replacement Class

VEHICLE NO.	VEHICLE CLASS	ENERGY USE (kWh/mile)	DAILY MILEAGE (miles)	ENERGY DEMAND (kWh/day)
7	4	0.8	50	40
9	4	0.8	50	40
8	4	0.8	50	40
12	4	0.8	75	60
1	4	0.8	80	64
14	4	0.8	0	0
2	4	0.8	70	56
4	4	0.8	45	36
6	4	0.8	65	52
			TOTAL kWh/day	**388**

In Scenario 1, this total equates to 1.97 MWh of energy requirements per week or approximately 105.54 MWh per year. **Table 5** provides a breakdown of the fleet's estimated overall energy demand under Scenario 1.

Table 5. Scenario 1: Estimated Overall Energy Demand

TOTAL VEHICLES	9
TOTAL DAILY ENERGY DEMAND (kW)	388
TOTAL DAILY ENERGY DEMAND (MW)	0.388
TOTAL WEEKLY ENERGY DEMAND (MW)	1.97

Under Scenario 2, where five vehicles are converted to a Class 4 BEV and four vehicles are converted to a Class 2 BEV, the total overall energy demand is estimated to be 274.5 kWh or 0.2745 MWh per day (**Table 6**).

Table 6. Scenario 2: Estimated Load Profile by Vehicle Replacement Class

VEHICLE NO.	VEHICLE CLASS	ENERGY USE (kWh/mile)	DAILY MILEAGE (miles)	ENERGY DEMAND (kWh/day)
7	2	0.346	50	17.3
9	4	0.8	50	40
8	2	0.346	50	17.3
12	4	0.8	75	60
1	2	0.346	80	27.68
14	4	0.8	0	0
2	2	0.346	70	24.22
4	4	0.8	45	36
6	4	0.8	65	52
			TOTAL kWh/day	**274.5**

In Scenario 2, this equates to 1.46 MWh of energy requirements per week or approximately 76.03 MWh per year. While the goal of moving part of the fleet to Class 2 vehicles is to mitigate the CDL issue, moving four of the nine vehicles in the fleet to Class 2 BEVs also reduces the amount of energy needed by an estimated 25%. Occupancy is also affected as a Class 2 vehicle carries fewer passengers and as demand for transit grows either new routes or additional vehicles would be needed to support additional passengers. **Table 7** provides a breakdown of the fleet's estimated overall energy demand under Scenario 2.

Table 7. Scenario 2: Estimated Overall Energy Demand

TOTAL VEHICLES	9
TOTAL DAILY ENERGY DEMAND (kW)	274.5
TOTAL DAILY ENERGY DEMAND (MW)	0.2745
TOTAL WEEKLY ENERGY DEMAND (MW)	1.46

To ensure that the fleet is positioned for the right EVSE equipment that sets them up for success today and over the next two years (2023-2024), CALSTART utilized the overall energy demand impact and the average daily mileage per vehicle to determine the appropriate level of charger that meets the needs of the 2-year electrification plan, while also working to keep overall estimated deployment costs low and manageable based on available funding.

A 16.8 kW Level 2 single port charger, provided by BTC Power, was chosen as a charger type to provide power to all nine vehicles based on their energy needs. Charging at 16.8 kW keeps overall energy demands low. However, this charging level then requires longer charging periods, which the fleet's operations currently allow for between the off-peak charging hours of 11:00 p.m. and 7:00 a.m. The plan as proposed would be for the fleet to acquire up to nine of these chargers to cover immediate operational needs and to protect for future needs.

Analysis of Electric Rate Structures and Energy Costs

After a complete review of Consumers Energy rate structures, it was determined that Consumers' GSTU rate structure will best service the fleet. This approach allows for the fleet to take advantage of the off-peak billing rates of $0.056707 and $0.067811 during the summer (June – September) and winter (October – May) months, respectively. CALSTART projected annual utility expenses assuming the needs of nine zero-emission replacement vehicles and charging conducted with nine 16.8 kW chargers. These projections assume that charging will occur between the off-peak hours of 11:00 p.m. and 7:00 a.m., which is the time of day when the lowest utility rates are in effect.

To project the full cost of electricity, the additional charges, which include System Access Charge, Energy Efficiency, Energy Assistance, Financial Comp, and Power Plant, need to be considered. Based on all the information shared by both Consumers Energy and the fleet, its annual cost for electric fuel for the nine vehicles is estimated to be $9,788.83 and $7,848.68 under Scenarios 1 and 2, respectively. In 2021, the fleet spent $34,074 on fuel, so converting to electricity for fuel should save them potentially $24,285 or $26,225 per year—cutting their fuel costs by almost 71% or more for Scenario 1 and 77% in Scenario 2. This amount is based off reduced operations due to COVID-19, and the percentage savings should increase as operations return to normal. Details on the projected electricity fuel costs can be seen in **Tables 8 and 9** below.

Table 8. Scenario 1: Projected Electricity Fuel Costs (2021 Average Daily Miles)

TOTAL MONTHLY ENERGY DEMAND	Overnight 5 days (7 veh) MW	Overnight 5 days (7 veh) kW	Overnight 6 days (2 veh) MW	Overnight 6 days (2 veh) kW	Opportunity MW	Opportunity kW	Overnight Winter ($0.067811/kW)	Overnight Summer ($0.056707/kW)	Opportunity Winter ($0.087262/kW)	Opportunity Summer ($0.085363/kW)	System Access Charge	Energy Effiency	Energy Assistance ($0.87/meter)	Financial Comp ($0.000098/kW)	Power Plant ($0.001256/kW)	TOTAL
JAN	6.3	6300	2.288	2288	0	0	$ 582.36		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.62	$ 7.91	$ 833.55
FEB	6	6000	2.112	2112	0	0	$ 550.08		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.59	$ 7.54	$ 800.87
MAR	6.9	6900	2.376	2376	0	0	$ 629.01		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.68	$ 8.67	$ 881.02
APR	6.3	6300	2.288	2288	0	0	$ 582.36		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.62	$ 7.91	$ 833.55
MAY	6.6	6600	2.288	2288	0	0	$ 602.70		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.65	$ 8.29	$ 854.30
JUN	6.6	6600	2.288	2288	0	0		$ 504.01		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.65	$ 8.29	$ 755.61
JUL	6.3	6300	2.288	2288	0	0		$ 487.00		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.62	$ 7.91	$ 738.19
AUG	6.9	6900	2.376	2376	0	0		$ 526.01		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.68	$ 8.67	$ 778.02
SEP	6.6	6600	2.288	2288	0	0		$ 504.01		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.65	$ 8.29	$ 755.61
OCT	6.3	6300	2.288	2288	0	0	$ 582.36		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.62	$ 7.91	$ 833.55
NOV	6.6	6600	2.288	2288	0	0	$ 602.70		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.65	$ 8.29	$ 854.30
DEC	6.6	6600	2.376	2376	0	0	$ 608.67		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.65	$ 8.29	$ 860.27
TOTAL ANNUAL (2022)	**78**	**78000**	**27.544**	**27544**	**0**	**0**	**$ 4,740.26**	**$ 2,021.04**	**$ -**	**$ -**	**$ 2,410.08**	**$ 407.88**	**$ 93.96**	**$ 7.64**	**$ 97.97**	**$ 9,778.83**

Table 9. Scenario 2: Projected Electricity Fuel Costs (2021 Average Daily Miles)

TOTAL MONTHLY ENERGY DEMAND	Overnight 5 days (7 veh) MW	Overnight 5 days (7 veh) kW	Overnight 6 days (2 veh) MW	Overnight 6 days (2 veh) kW	Opportunity MW	Opportunity kW	Overnight Winter ($0.067811/kW)	Overnight Summer ($0.056707/kW)	Opportunity Winter ($0.087262/kW)	Opportunity Summer ($0.085363/kW)	System Access Charge	Energy Effiency	Energy Assistance ($0.87/meter)	Financial Comp ($0.000098/kW)	Power Plant ($0.001256/kW)	TOTAL
JAN	3.9165	3916.5	2.288	2288	0	0	$ 420.73		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.38	$ 4.92	$ 668.70
FEB	3.73	3730	2.112	2112	0	0	$ 396.15		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.37	$ 4.68	$ 643.86
MAR	4.2895	4289.5	2.376	2376	0	0	$ 451.99		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.42	$ 5.39	$ 700.46
APR	3.9165	3916.5	2.288	2288	0	0	$ 420.73		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.38	$ 4.92	$ 668.70
MAY	4.103	4103	2.288	2288	0	0	$ 433.38		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.40	$ 5.15	$ 681.60
JUN	4.103	4103	2.288	2288	0	0		$ 362.41		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.40	$ 5.15	$ 610.63
JUL	3.9165	3916.5	2.288	2288	0	0		$ 351.84		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.38	$ 4.92	$ 599.80
AUG	4.2895	4289.5	2.376	2376	0	0		$ 377.98		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.42	$ 5.39	$ 626.45
SEP	4.103	4103	2.288	2288	0	0		$ 362.41		$ -	$ 200.84	$ 33.99	$ 7.83	$ 0.40	$ 5.15	$ 610.63
OCT	3.9165	3916.5	2.288	2288	0	0	$ 420.73		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.38	$ 4.92	$ 668.70
NOV	4.103	4103	2.288	2288	0	0	$ 433.38		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.40	$ 5.15	$ 681.60
DEC	4.103	4103	2.376	2376	0	0	$ 439.35		$ -		$ 200.84	$ 33.99	$ 7.83	$ 0.40	$ 5.15	$ 687.56
TOTAL ANNUAL (2022)	**48.49**	**48490**	**27.544**	**27544**	**0**	**0**	**$ 3,416.45**	**$ 1,454.65**	**$ -**	**$ -**	**$ 2,410.08**	**$ 407.88**	**$ 93.96**	**$ 4.75**	**$ 60.90**	**$ 7,848.68**

Fleet Electrification Deployment Plan and Roadmap

Vehicle Deployment Plan

The fleet's transition to BEBs will begin in 2023. Based on the fleet's vehicle replacement plan communicated to CALSTART, a vehicle deployment plan (**Table 10**) was developed for the fleet to achieve 100% zero-emission by 2024. The deployment plan was completed for both Scenarios 1 and 2 (100% Class 4 and a mix of Class 2 and 4, respectively). In 2023, four revenue vehicles will be replaced, and in 2024 the five remaining revenue vehicles in their nine-vehicle fleet will be replaced.

Table 10. Scenario 1 and 2: Vehicle Deployment Plan

REPLACEMENT YEAR	CALENDAR YEAR	NUMBER OF VEHICLES
1	2023	4 Revenue
2	2024	5 Revenue
	TOTAL VEHICLES	**9**

The fleet is currently made up of two vehicle makes and models. The battery-electric models were chosen as replacements (**Tables 11 and 12**) based on vehicle availability that meets the current and forecasted vehicle capacity needs, as well as limiting the number of vehicle variances to further vehicle maintenance efficiencies and repair part supply.

Table 11. Scenario 1: Proposed Vehicle Replacement Plan

CURRENT VEHICLE (Make/Model)	REPLACEMENT VEHICLE (Make/Model)
Ford F-450 Champion	Lightning eMotors E-450
Ford F-450 ElDorado	Lightning eMotors E-450

Table 12. Scenario 2: Proposed Vehicle Replacement Plan

CURRENT VEHICLE (Make/Model)	REPLACEMENT VEHICLE (Make/Model)
Ford F-450 Champion	Ford E-Transit
Ford F-450 ElDorado	Ford E-Transit and Lightning eMotors E-450

Once the plan is fully executed, the fleet would have a battery-electric revenue fleet made up of nine Class 4 shuttle buses (Scenario 1), or five Class 4 shuttle buses and four Class 2 BEVs (Scenario 2). Suggested vehicle replacements include the Ford E-Transit (Scenario 2 only) and Lightning eMotors E-450s. Each of these vehicles is currently available on the market and have a proven track record of operational success.

Vehicle Product Review

CALSTART suggests the following vehicles, which are available on the market today, for consideration in this project.

Lightning eMotors E-450

The Lightning Electric E-450 is Ford's versatile and trusted platform equipped with a state-of-the-art electric powertrain that provides a quiet, smooth, and familiar driving experience for drivers. Available in 80-mile and 120-mile range versions, this vehicle provides practical, reliable service while producing zero emissions on the road. Charging is simple and quick, with both Level 2 AC charging and DCFC supported.

Ford E-Transit

The Ford E-Transit is designed to meet operational needs by offering three cargo van roof heights, three body lengths, and can be customized as a cutaway, chassis cab, or cargo van. With a 68 kWh battery, the e-Transit has an estimated 126 miles range and, in addition to depot charging, is compatible with Ford's BlueOval Public Charging Network. At no extra charge, Ford Pro e-Telematics is available for the first three years to streamline vehicle performance, and Ford offers an Electric Vehicle Component Coverage warranty of eight years or 100,000 miles, whichever is less.

Phoenix Motors Zeus 400

The Phoenix Motors Zeus 400 is designed for shared mobility and commuter transportation, the Zero Emission Utility Shuttle (ZEUS) has a range of up to 150 miles and is built using Ford's E-450 platform. This vehicle can accommodate a maximum of 23 ambulatory passenger seats. Configuration options include ADA seating or options to include a 72-inch luggage rack. Phoenix Motors offers a 5-year/60,000 drive system and provides an extended battery warranty of eight years/300,000 miles.

GreenPower EV Star

The EV Star is a multi-purpose, zero-emission, Class 4 min-E Bus. It has a range of up to 150 miles and offers dual charging capabilities as a standard feature. The EV Star can be used for paratransit, employee shuttles, micro-transit, and vanpool service. The seating layout is customizable to an operator's needs with multiple configurations and American Disabilities Act (ADA) positions and can accommodate up to 24 passengers. The EV Star is the only Buy America compliant and Altoona tested vehicle in its class with the highest score of 92.2. The EV Star chassis is the base chassis for the entire EV Star product line.

Infrastructure Installation Plan

The fleet's charging infrastructure installation plan (**Table 13**) will begin in 2023, and the year-by-year breakdown of infrastructure deployment (**Tables 14 and 15**) is based off their vehicle replacement plan (see **Tables 11 and 12**) and available funding opportunities for infrastructure. The infrastructure installation plan is the same for both Scenarios 1 and 2. In years 2023 – 2024, to meet the fleet's daily operational charging needs, nine Level 2 BTC Power 16.8 kW single-port chargers should be acquired.

Table 13. Scenarios 1 and 2: Infrastructure Installation Plan

INSTALLATION YEAR	CALENDAR YEAR	NUMBER OF LEVEL 2	NUMBER OF LEVEL 3
1	2023	4	0
2	2024	5	0
	TOTALS	**9 (9 ports)**	**0 (0 ports)**

This overall infrastructure plan was developed considering individual vehicle-based charger level needs (kWh), dwell times, and daily mileage range requirements by each vehicle. For vehicles with an energy demand of less than 20 kWh across the eight hours of off-peak overnight charging, a Level 2 charger was selected. Currently, the entire fleet requires only Level 2 chargers, which reduces infrastructure costs.

Table 14. Scenario 1: Proposed Infrastructure Plan

YEAR 1 - 2023					
IDAR Vehicle No.	**Replacement Sequence**	**Current Model**	**Replacement Make/Model**	**Current Charger Needs**	**Charger Deployment**
7	1	F-450 Champion	LM E-450	LVL 2	LVL 2
9	2	F-450 Eldorado	LM E-450	LVL 2	LVL 2
8	3	F-450 Eldorado	LM E-450	LVL 2	LVL 2
12	4	F-450 Eldorado	LM E-450	LVL 2	LVL 2
YEAR 2 - 2024					
IDAR Vehicle No.	**Replacement Sequence**	**Current Model**	**Replacement Make/Model**	**Current Charger Needs**	**Charger Deployment**
1	5	F-450 Eldorado	LM E-450	LVL 2	LVL 2
14	6	F-450 Eldorado	LM E-450	LVL 2	LVL 2
2	7	F-450 Eldorado	LM E-450	LVL 2	LVL 2
4	8	F-450 Eldorado	LM E-450	LVL 2	LVL 2
6	9	F-450 Eldorado	LM E-450	LVL 2	LVL 2

Table 15. Scenario 2: Proposed Infrastructure Plan

IDAR Vehicle No.	Replacement Sequence	Current Model	Replacement Make/Model	Current Charger Needs	Charger Deployment
YEAR 1 - 2023					
7	1	F-450 Champion	Ford e-Transit	LVL 2	LVL 2
9	2	F-450 Eldorado	LM E-450	LVL 2	LVL 2
8	3	F-450 Eldorado	Ford e-Transit	LVL 2	LVL 2
12	4	F-450 Eldorado	LM E-450	LVL 2	LVL 2
YEAR 2 - 2024					
IDAR Vehicle No.	**Replacement Sequence**	**Current Model**	**Replacement Make/Model**	**Current Charger Needs**	**Charger Deployment**
1	5	F-450 Eldorado	Ford e-Transit	LVL 2	LVL 2
14	6	F-450 Eldorado	LM E-450	LVL 2	LVL 2
2	7	F-450 Eldorado	Ford e-Transit	LVL 2	LVL 2
4	8	F-450 Eldorado	LM E-450	LVL 2	LVL 2
6	9	F-450 Eldorado	LM E-450	LVL 2	LVL 2

Charging Station Product Review

Today, there are a wide array of available charging stations on the market. When choosing a station, it is important to understand the power levels in kW, the quality of the product based on user feedback, and costs. After a thorough review, CALSTART suggests the following charging stations for consideration in this project.

Level 2

BTC Power 16.8 kW

Based in Santa Ana, California, BTC Power manufactures high-performance DC charging systems. This single port 70A Level 2 charger works with all J1772 compliant vehicles and supports OCPP 1.5 and 1.6 open communication platforms.

JuiceBar 19.2 kW

JuiceBar's 19.2 kW 80-amp Level 2 charger is applicable for fleets that can utilize a higher Level 2 power without requiring a Level 3 upgrade. The charger is TUV Rheinland-certified for safety and quality, and is UL 2231-1, UL 2231-2, and UL 2594 certified for electric vehicle (EV) supply circuits and EVSE. It is great for vehicles that can accept high power charging and future proofing installations.

Clipper Creek 19.0 kW

Clipper Creek's 19.2-kW 70-amp Level 2 charger is the world's first UL listed electric vehicle charging station manufactured in America. The CS-100 is Clipper Creek's most powerful UL listed Level 2 EVSE offering 19.2 kW for EV charging. The CS-100 works with all SAEJ1772 compliant vehicles. It is great for vehicles that can accept high power charging and future proofing installations.

2-Year Fleet Electrification Roadmap (2023-2024)

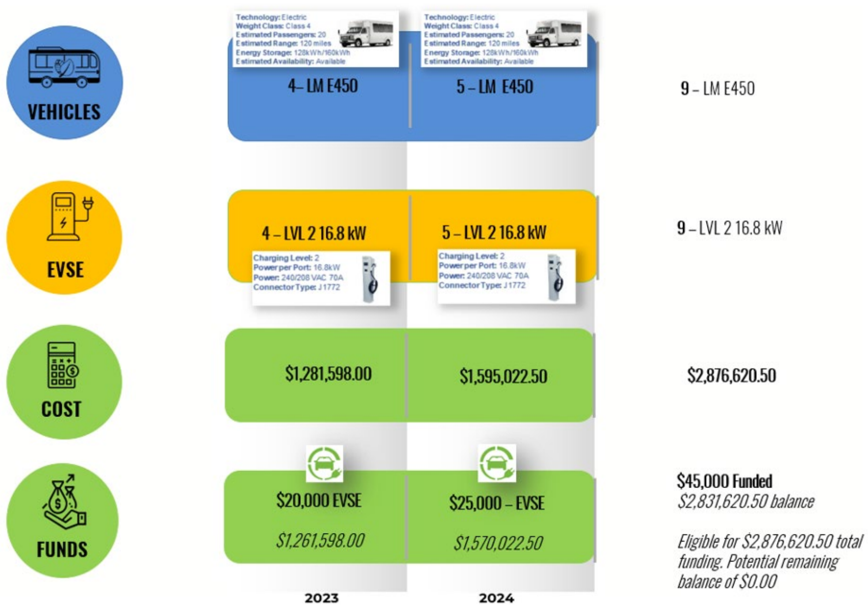

Figure 3. Scenario 1: 2-Year Fleet Electrification Roadmap

Figure 4. Scenario 2: 2-Year Fleet Electrification Roadmap

Total Cost of Ownership (TCO)

As the nation moves forward with zero-emission powertrains, the fleet is taking the right steps in planning for at-scale zero-emission deployments ahead of time, allowing them to take advantage of strong incentive programs and federal funding that will help further offset the cost of at-scale deployments. CALSTART conducted a TCO estimate of all nine vehicles in their existing fleet across the top proposed battery-electric replacement models: Lightning eMotors E-450 and Ford E-Transit Connect. The TCO calculation was run on the planned Scenarios 1 and 2 (100% Class 4 and a mix of Class 2 and 4, respectively). Several factors were considered in choosing these replacement models, such as vehicle availability, seating and wheelchair capacity, battery capacity, range, and cost, as well as CDL requirements for drivers. The fleet will save a significant amount of money over the vehicles' 7-year lifecycle with the replacement models under both scenarios.

The TCO calculation was run using Michigan's average gasoline fuel cost at the time of the report ($3.34/gallon) and calculated vehicle efficiencies, Consumers GSTU highest off-peak electricity cost ($0.067811/kW), and average daily miles for the fleet broken down by class and fuel type. It is important to note that Vehicle 14 in the fleet is a spare vehicle, therefore zero miles were used in the average calculations. The savings baseline calculations are based on one vehicle deployment of a BEV replacing a fossil fuel-powered (gasoline) bus. All assumptions used in the calculations are shown in each of the TCO sections below.

The TCO baseline savings does not account for the cost of infrastructure nor for driving in extreme weather conditions that will impact energy efficiencies by about 20% (30% in worst case scenarios). This fleet electrification plan works to protect inefficiencies and plans for future growth and higher power battery storage solutions by including Level 2 16.8 kW chargers, which is called out within the infrastructure plan and charging strategy sections of this plan.

Scenario 1: Class 4 Battery-Electric Shuttle Bus TCO

The fleet currently runs 260 and 312 days annually. In calculating the baseline cost savings for the conversion of the entire Class 4 gasoline vehicle fleet to battery-electric, these operating days were considered. At the time of this report, seven of the fleet's vehicles are operating at 260 days per year and the remaining two vehicles are operating 312 days per year.

Class 4 Battery-Electric Shuttle Bus 260 Days/Year TCO

Vehicles 1, 2, 7, 8, 9, 12, and 14 in the fleet all currently operate at 260 days annually when in use. Below in **Table 16** are the assumptions utilized in the TCO calculation:

Table 16. Lightning eMotors E-450 TCO Assumptions (Revenue Vehicle)

Current Bus Fuel	Gasoline
Replacement Bus Fuel	Battery-Electric
Vehicle Type	Shuttle Bus 14,000 - 19,500lbs
Gasoline Fuel Cost (MI Average)	$3.34/gal
Energy Cost	$.067811/kWh
Estimated Bus Life	7 years
Average Miles Per Day	53.57
Days in Operation (Annual)	260
Gasoline Bus Price (Avg)	$200,000
Local Match Cost (Gasoline)	$40,000
BEB Bus Price (CA State Contract)	$300,000
Local Match Cost (Battery-Electric)	$60,000
Baseline Maintenance Cost	$0.099
Clean Vehicle Efficiency	0.8 kWh/mile
Gasoline Fuel Efficiency	7.0 miles/gallon

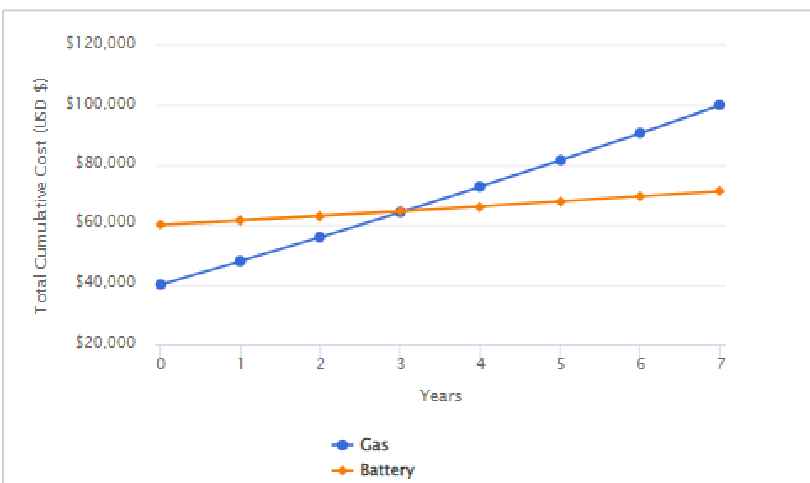

Figure 5. Lightning eMotors E-450 TCO Payback Period Clean vs. Baseline Results (Real Cash Flow)

Using the assumptions above (**Table 16**), the estimated payback period accounting for the local cost share amount of 20% for the purchase of a transit bus would be in 3.05 years, assuming the bus is driven 53.57 miles daily and operates 260 days of the year (**Figure 5**). With the operational savings in expenses, there is significant savings that can be realized over the estimated 7-year lifetime of the vehicle: an estimated $28,847 including the purchase price of the vehicle (**Figure 6**).

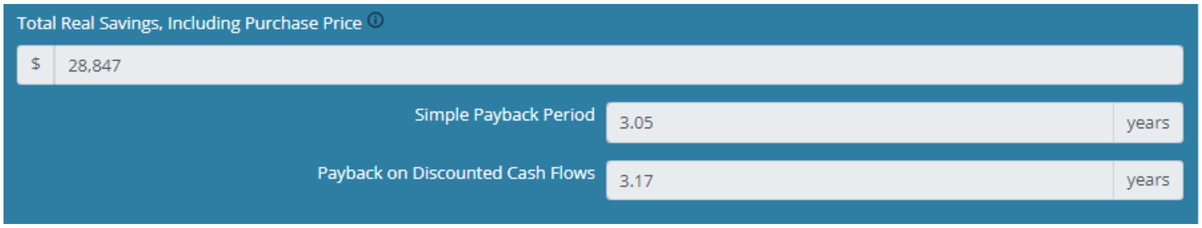

Figure 6. Lightning eMotors E-450 TCO Total Real Savings

The savings are divided across four categories: vehicle capital expense, fuel costs, maintenance and insurance, and overall total real cost. Based on the TCO calculations, the largest savings is in fuel cost, with a reduction estimated at 88% or $6,261/vehicle annual savings. Maintenance costs come in at an estimated 48% or $717/vehicle annual savings, resulting in a total estimated lifetime savings of $48,847 (not including purchase price) for each vehicle deployed compared to its gasoline counterpart (**Figure 7 and Figure 8**). This results in an overall lifetime savings estimate of $341,929 if all seven Class 4 gasoline vehicles were replaced.

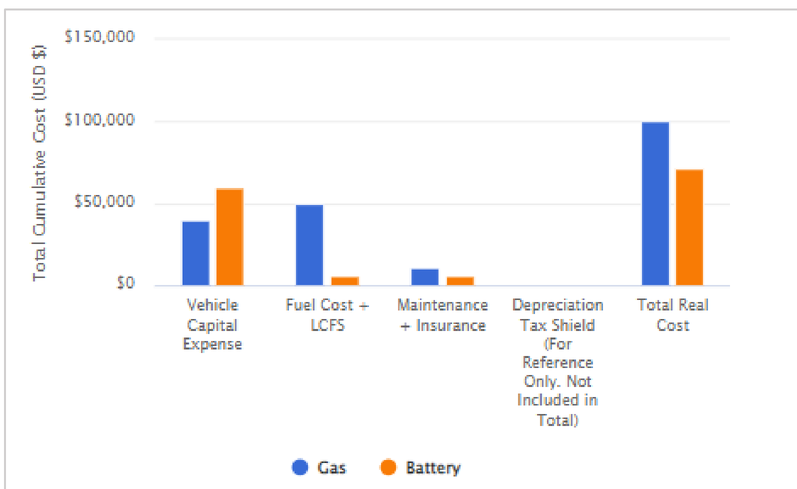

Figure 7. Lightning eMotors E-450 TCO Cost Breakdown

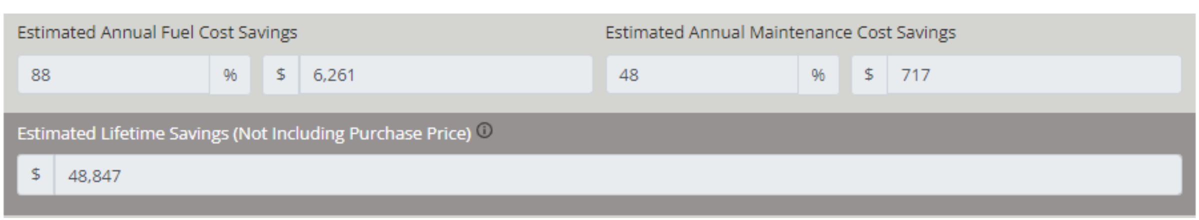

Figure 8. Lightning eMotors Estimated Lifetime Savings (Not Including Purchase Price)

Class 4 Battery-Electric Shuttle Bus 312 Days/Year TCO

The remaining two vehicles, 4 and 6, both operate currently at 312 days annually when in use. Below in **Table 17** are the assumptions utilized in the TCO calculation:

Table 17. Lightning eMotors E-450 TCO Assumptions (Revenue Vehicle)

Current Bus Fuel	Gasoline
Replacement Bus Fuel	Battery-Electric
Vehicle Type	Shuttle Bus 14,000-19,500lbs
Gasoline Fuel Cost (MI Average)	$3.34/gal
Energy Cost	$.067811 / kWh
Estimated Bus Life	7 years
Average Miles Per Day	55.00
Days in Operation (Annual)	312
Gasoline Bus Price (Avg)	$200,000
Local Match Cost (Gasoline)	$40,000
BEB Bus Price (CA State Contract)	$300,000
Local Match Cost (Battery-Electric)	$60,000
Baseline Maintenance Cost	$0.24
Clean Vehicle Efficiency	0.8 kWh/mile
Gasoline Fuel Efficiency	7.0 miles/gallon

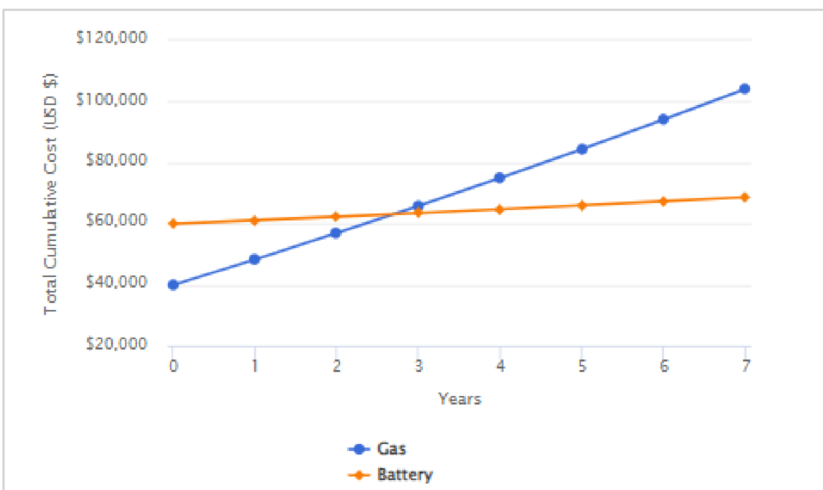

Figure 9. Lightning eMotors E-450 TCO Payback Period Clean vs. Baseline Results (Real Cash Flows)

Using the assumptions above (**Table 17**), the estimated payback period accounting for the local cost share amount of 20% for the purchase of a transit bus would be in 2.70 years, assuming the bus is driven 55.00 miles daily and operates 312 days of the year (**Figure 9**). With the operational savings in expenses, there is significant savings that can be realized over the estimated 7-year lifetime of the vehicle: an estimated $35,496 including the purchase price of the vehicle (**Figure 10**).

Total Real Savings, Including Purchase Price		
$	35,496	
Simple Payback Period	2.70	years
Payback on Discounted Cash Flows	2.80	years

Figure 10. Lightning eMotors E-450 TCO Total Real Savings

The savings are divided across four categories: vehicle capital expense, fuel costs, maintenance and insurance, and overall total real cost. Based on the TCO calculations, the largest savings is in fuel cost, with a reduction estimated at 88% or $7,714/vehicle annual savings. Maintenance costs come in at an estimated 47% or $214/vehicle annual savings, resulting in a total estimated lifetime savings of $55,496 (not including purchase price) for each vehicle deployed compared to its gasoline counterpart (**Figure 11 and Figure 12**). This results in an overall lifetime savings estimate of $110,992 if each of these two Class 4 gasoline vehicles were replaced.

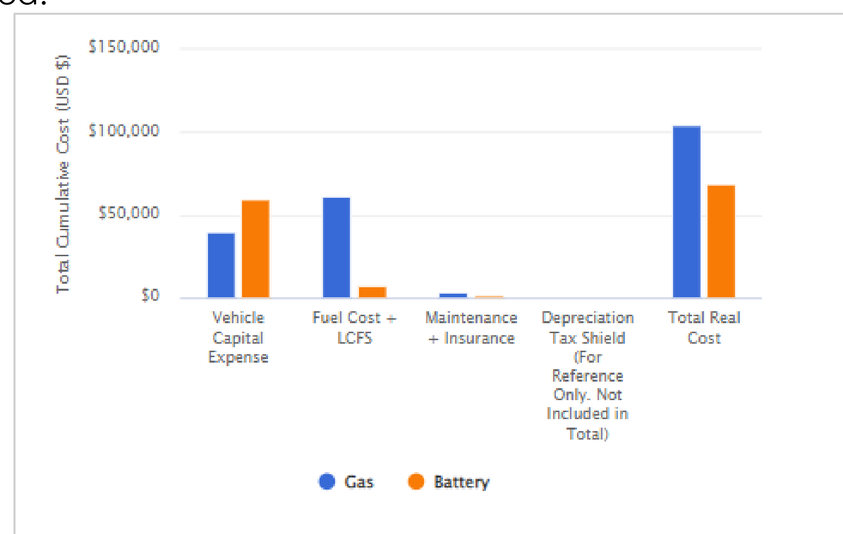

Figure 11. Lightning eMotors E-450 TCO Cost Breakdown

Estimated Annual Fuel Cost Savings				Estimated Annual Maintenance Cost Savings			
88	%	$	7,714	47	%	$	214
Estimated Lifetime Savings (Not Including Purchase Price)							
$	55,496						

Figure 12. Lightning eMotors Estimated Lifetime Savings (Not Including Purchase Price)

In Scenario 1, the total estimated overall 7-year lifetime savings in operating costs from utilizing zero-emission vehicles (ZEVs)—including fuel and maintenance costs but excluding vehicle purchase price when converting all nine vehicles in the fleet from fossil fuel-powered to Class 4 battery-electric is estimated at $452,921.

Scenario 2: Class 2 and 4 Battery-Electric Shuttle Bus TCO

In calculating the baseline cost savings for the conversion of the entire Class 4 gasoline vehicle fleet to a mix of the Class 2 Ford E-Transit Connect and the Class 4 Lightning eMotors E-450 vehicles, the number of operating days was again factored into the TCO calculations.

Class 2 Battery-Electric Shuttle Bus 260 Days/Year TCO

Vehicles 1, 2, 7, and 8 in the fleet all currently operate at 260 days annually when in use. Below in **Table 18** are the assumptions utilized in the TCO calculation:

Table 18. Ford E-Transit Connect TCO Assumptions (Revenue Vehicle)

Current Bus Fuel	Gasoline
Replacement Bus Fuel	Battery-Electric
Vehicle Type	Truck 8,501 – 10,000 lbs.
Gasoline Fuel Cost (MI Average)	$3.34/gal
Energy Cost	$.067811/kWh
Estimated Bus Life	7 years
Average Miles Per Day	62.50
Days in Operation (Annual)	260
Gasoline Bus Price (Avg)	$200,000
Local Match Cost (Gasoline)	$40,000
BEB Bus Price (Published MSRP)	$43,295
Local Match Cost (Battery-Electric)	$8,659
Baseline Maintenance Cost	$0.072
Clean Vehicle Efficiency	0.346 kWh/mile
Gasoline Fuel Efficiency	7.0 miles/gallon

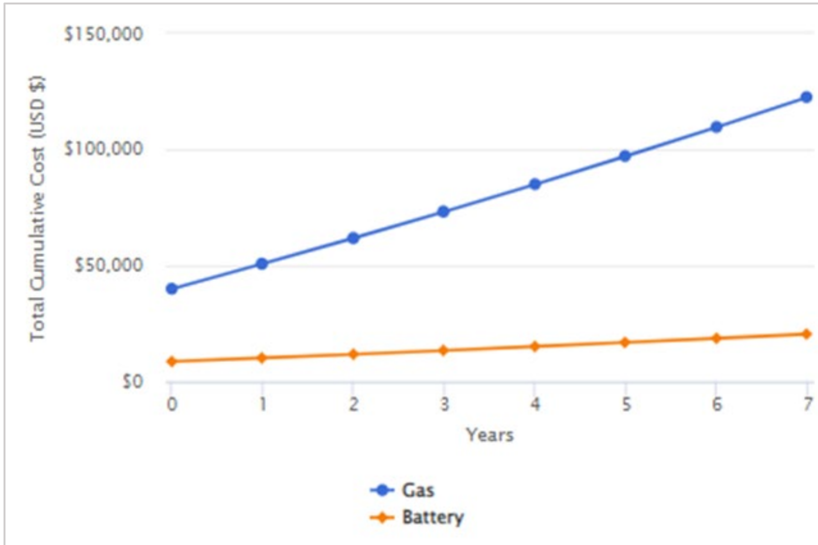

Figure 13. Ford E-Transit Connect TCO Payback Period Clean vs. Baseline Results (Real Cash Flows)

Using the assumptions above (**Table 18**), the estimated payback period accounting for the local cost share amount of 20% for the purchase of a transit vehicle is immediate due to the nature of the class 4 to class 2 replacement plan, assuming the vehicle is driven 62.5 miles daily and operates 260 days of the year (**Figure 13**). With the operational savings in expenses, there is significant savings that can be realized over the estimated 7-year lifetime of the vehicle: an estimated $102,069 including the purchase price of the vehicle (**Figure 14**).

Figure 14. Ford E-Transit Connect TCO Total Real Savings

The savings are divided across four categories: vehicle capital expense, fuel costs, maintenance and insurance, and overall total real cost. Based on the TCO calculations, the largest savings is in fuel cost, with a reduction estimated at 95% or $8,101/vehicle annual savings. Maintenance costs come in at an estimated 61% or $2,003/vehicle annual savings, resulting in a total estimated lifetime savings of $70,728 (not including purchase price) for each vehicle deployed compared to its gasoline counterpart (**Figure 15 and Figure 16**). This results in an overall lifetime savings estimate of $282,912 if these four Class 4 gasoline vehicles were replaced with a Class 2 Ford E-Transit Connect.

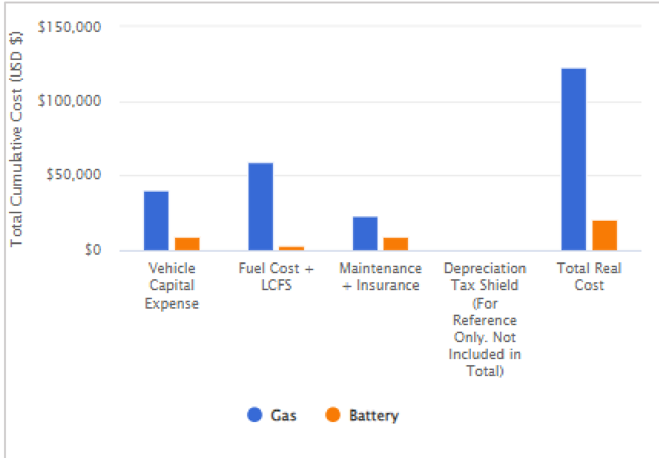

Figure 15. Ford E-Transit Connect TCO Cost Breakdown

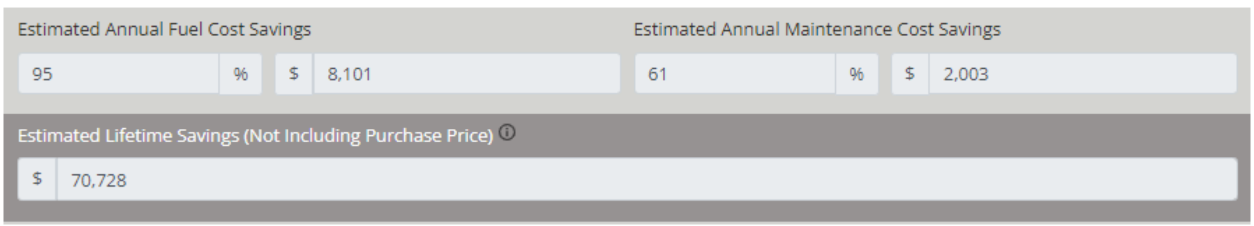

Figure 16. Ford E-Transit Connect Estimated Lifetime Savings (Not Including Purchase Price)

Class 4 Battery-Electric Shuttle Bus 260 Days/Year TCO

Vehicles 9, 12, and 14 all operate currently at 260 days annually when in use. Below in **Table 19** are the assumptions utilized in the TCO calculation:

Table 19. Lightning eMotors E-450 TCO Assumptions (Revenue Vehicle)

Current Bus Fuel	Gasoline
Replacement Bus Fuel	Battery-Electric
Vehicle Type	Shuttle Bus 14,000-19,500 lbs.
Gasoline Fuel Cost (MI Average)	$3.34/gal
Energy Cost	$.067811/kWh
Estimated Bus Life	7 years
Average Miles Per Day	41.66
Days in Operation (Annual)	260
Gasoline Bus Price (Avg)	$200,000
Local Match Cost (Gasoline)	$40,000
BEB Bus Price (CA State Contract)	$300,000
Local Match Cost (Battery-Electric)	$60,000
Baseline Maintenance Cost	$0.16
Clean Vehicle Efficiency	0.8 kWh/mile
Gasoline Fuel Efficiency	7.0 miles/gallon

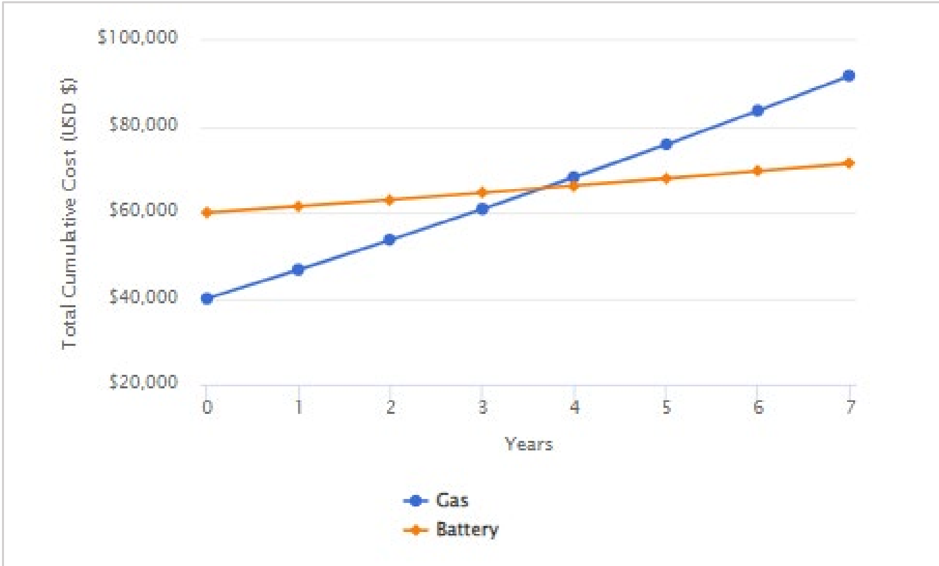

Figure 17. Lightning eMotors E-450 TCO Payback Period Clean vs. Baseline Results (Real Cash Flows)

Using the assumptions above (**Table 19**), the estimated payback period accounting for the local cost share amount of 20% for the purchase of a transit bus would be in 3.65 years, assuming the bus is driven 41.66 miles daily and operates 260 days of the year (**Figure 17**). With the operational savings in expenses, there is significant savings that can be realized over the estimated 7-year lifetime of the vehicle: an estimated $20,392 including the purchase price of the vehicle (**Figure 18**).

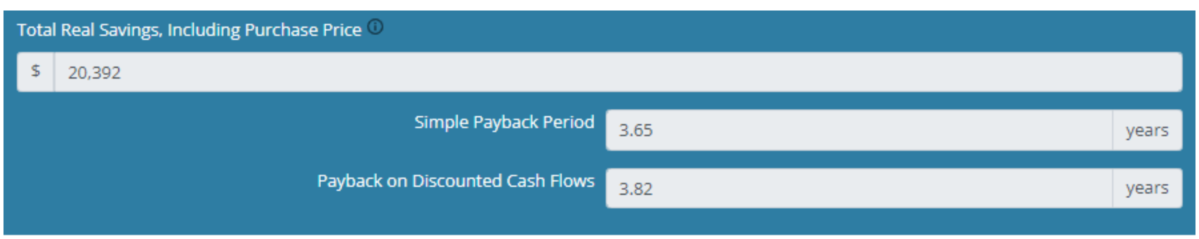

Figure 18. Lightning eMotors E-450 TCO Total Real Savings

The savings are divided across four categories: vehicle capital expense, fuel costs, maintenance and insurance, and overall total real cost. Based on the TCO calculations, the largest savings is in fuel cost, with a reduction estimated at 88% or $4,869/vehicle annual savings. Maintenance costs come in at an estimated 47% or $901/vehicle annual savings, resulting in a total estimated lifetime savings of $40,392 (not including purchase price) for each vehicle deployed compared to its gasoline counterpart (**Figure 19 and Figure 20**). This results in an overall lifetime savings estimate of $121,176 if these three Class 4 gasoline vehicles were replaced.

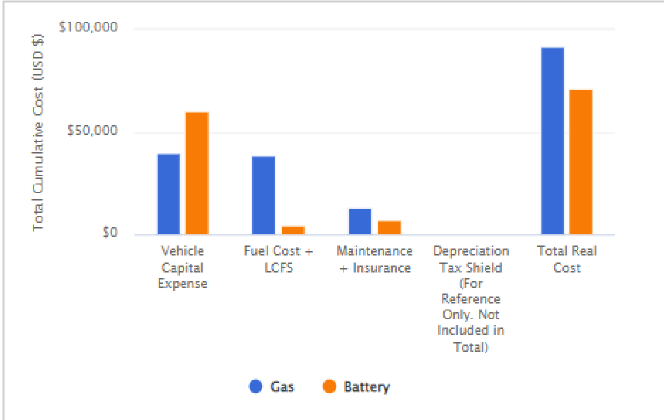

Figure 19. Lightning eMotors E-450 TCO Cost Breakdown

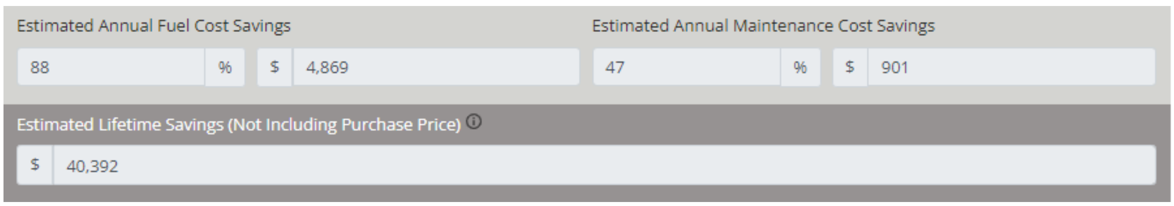

Figure 20. Lightning eMotors Estimated Lifetime Savings (Not Including Purchase Price)

Class 4 Battery-Electric Shuttle Bus 312 Days/Year TCO

The remaining two vehicles 4 and 6 operate currently at 312 days annually when in use. Below in **Table 20** are the assumptions utilized in the TCO calculation:

Table 20. Lightning eMotors E-450 TCO Assumptions (Revenue Vehicle)

Current Bus Fuel	Gasoline
Replacement Bus Fuel	Battery-Electric
Vehicle Type	Shuttle Bus 14,000-19,500 lbs.
Gasoline Fuel Cost (MI Average)	$3.34/gal
Energy Cost	$.067811/kWh
Estimated Bus Life	7 years
Average Miles Per Day	55.00
Days in Operation (Annual)	312
Gasoline Bus Price (Avg)	$200,000
Local Match Cost (Gasoline)	$40,000
BEB Bus Price (CA State Contract)	$300,000
Local Match Cost (Battery-Electric)	$60,000
Baseline Maintenance Cost	$0.24
Clean Vehicle Efficiency	0.8 kWh/mile
Gasoline Fuel Efficiency	7.0 miles/gallon

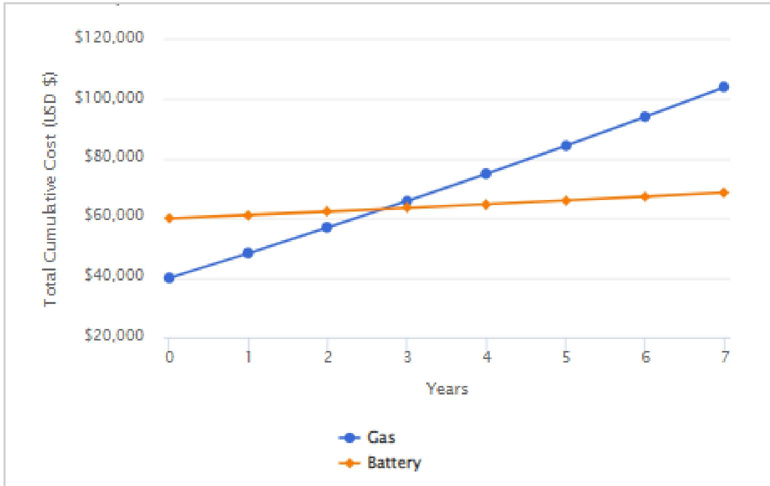

Figure 21. Lightning eMotors E-450 TCO Payback Period Clean vs. Baseline Results (Real Cash Flows)

Using the assumptions above (**Table 20**), the estimated payback period accounting for the local cost share amount of 20% for the purchase of a transit bus would be in 2.70 years, assuming the bus is driven 55 miles daily and operates 312 days of the year (**Figure 21**). With the operational savings in expenses, there is significant savings that can be realized over the estimated 7-year lifetime of the vehicle: an estimated $35,496 including the purchase price of the vehicle (Figure 22).

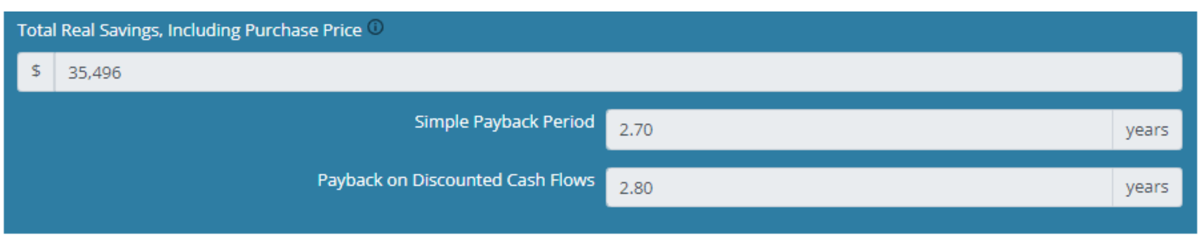

Figure 22. Lightning eMotors E-450 TCO Total Real Savings

The savings is divided across four categories: vehicle capital expense, fuel costs, maintenance and insurance, and overall total real cost. Based on the TCO calculations, the largest savings is in fuel cost, with a reduction estimated at 88% or $7,714/vehicle annual savings. Maintenance costs come in at an estimated 47% or $214/vehicle annual savings, resulting in a total estimated lifetime savings of $55,496 (not including purchase price) for each vehicle deployed compared to its gasoline counterpart (**Figure 23 and Figure 24**). This results in an overall lifetime savings estimate of $110,992 if these two Class 4 gasoline vehicles were replaced.

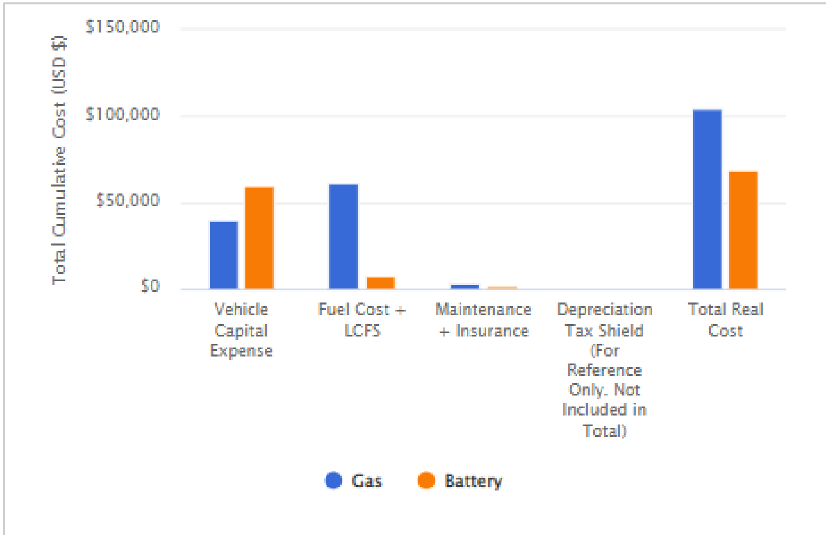

Figure 23. Lightning eMotors E-450 TCO Cost Breakdown

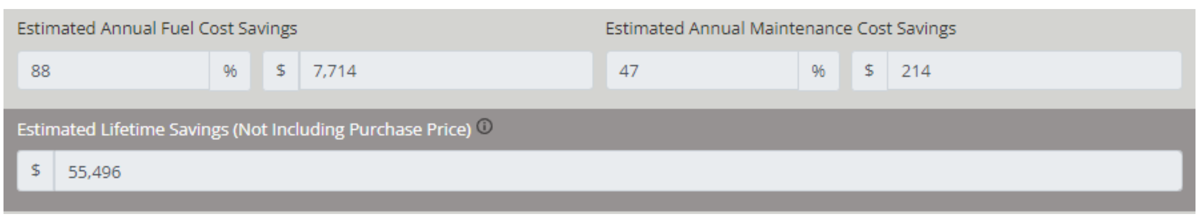

Figure 24. Lightning eMotors Estimated Lifetime Savings (Not Including Purchase Price)

In Scenario 2, the total overall 7-year lifetime savings in operating costs from utilizing zero-emission vehicles (ZEVs)—including fuel and maintenance costs but excluding vehicle purchase price when converting the fleet from fossil fuel-powered to four Class 2 and five Class 4 BEVs is estimated at $515,080. This is an increase in savings of an estimated $62,159 compared to Scenario 1, which has an estimated savings of $452,921.

In Scenario 1, to fully execute the vehicle and infrastructure deployment plan, the costs to 100% electrify the nine-vehicle fleet is an estimated $2,876,620.5. Of this total, $45,000 in funding has been identified as immediately available through Consumers Energy's PowerMIFleet program, with $2,265,296.4 eligible for FTA funding. In Scenario 2, to fully execute the vehicle and infrastructure deployment plan, the costs to 100% electrify the fleet's nine vehicles is an estimated $1,841,800.5. Of this total, $45,000 in funding has been identified as immediately available through Consumers Energy's PowerMIFleet program, with $1,437,440.4 eligible for FTA funding.

Under the PowerMIFleet program, Consumer Energy will cover the costs of all the electrical upgrades needed up to the meter, a cost that was not built into this plan. Under the FTA's Low-No program, $566,324.10 could be covered by an MDOT local match of 20% or more under Scenario 1, and $359,360.10 could be covered by the local match of 20% of more under Scenario 2, if the fleet is funded under an FTA program where 80% of the cost for the vehicle and infrastructure are covered by the FTA and 20% funded by local match. Currently, the fleet is not in the position to take advantage of Volkswagen (VW) Settlement funding, as they have no diesel vehicles currently in service.

The estimated overall vehicle and infrastructure investment into 100% electrification of the fleet's nine vehicles makes for a positive business case. Based on TCO calculations, the fleet could save an estimated $452,921.00 in lifetime savings for converting to BEVs over a projected 7-year vehicle lifetime in Scenario 1 and $515,080.00 in Scenario 2.

Impact of Full Fleet Electrification

Transitioning to a 100% electric fleet provides a significant impact on our climate and the air we breathe. Transportation accounts for 32% of Michigan's carbon dioxide (CO2) emissions, where Michigan ranks 10th of 50 states in total CO2 emissions and 30th in energy consumption for all sectors per capita. Transit accounts for less than 10% of the overall transportation sector but is responsible for up to 66% of greenhouse gas (GHG) emissions. When the fleet successfully electrifies their entire fleet to 100% BEVs, the impact on the environment is substantial. The replacement of 100% of the fleet's fossil fuel-powered (gasoline) buses with modern BEBs will significantly reduce emissions from bus operations. Emission reductions occur because BEBs produce zero tailpipe emissions. In addition, BEBs use electricity for fuel, displacing gasoline and propane. Since the production of electricity has fewer upstream emissions than the production of fossil fuels, this results in further emission reductions.

To calculate the tailpipe reductions for the vehicles currently operating, CALSTART used the 2017 EMFAC Model, v1.07, which calculates the average tailpipe emissions of each bus per mile, based on their model year for the fleet's gas vehicles. This figure was then multiplied by the average annual mileage for each vehicle and the average lifetime of the medium sized shuttle buses (seven years). This results in the tailpipe emissions of each vehicle, which are summed together to get the total emissions of the fleet's vehicles. It is assumed that the BEVs produce no tailpipe emissions. Therefore, the average lifetime emissions are equal to the tailpipe emissions reduced by replacing all the vehicles with BEVs. The results of these calculations are presented in **Table 21** below. Each emission measure is reported in kilograms (kg).

Table 21. Total Emissions Reduction Calculation

Year	Type	Count	Fuel	N2O	CO	NOx	PM10	PM2.5	CO2	SOx
2020	MD Truck	3.00	Gas	3.62	65.15	34.89	0.47	0.43	612,610.59	6.06
2019	MD Truck	2.00	Gas	2.87	51.61	27.61	0.38	0.34	485,203.32	4.80
2018	MD Truck	2.00	Gas	2.35	43.20	23.21	0.29	0.26	379,051.21	3.75
2017	MD Truck	1.00	Gas	0.90	16.19	8.64	0.11	0.10	151,743.49	1.50
2013	MD Truck	1.00	Gas	0.76	15.61	6.98	0.05	0.045	165,135.86	1.63
Totals		**9**		**10.50**	**191.76**	**101.32**	**1.29**	**1.19**	**1,793,744.47**	**17.75**

An investment in transitioning the fleet to 100% electric provides GHG savings of greater than 1,793,744 kg of CO2, which is the equivalent CO2 reduction to what 11,816 trees would consume over seven years (Keystone 10 Million Trees Partnership, n.d.). These environmental benefits occur in addition to estimated savings of more than 72% in fuel costs over the life cycle of these vehicles and 47% in maintenance costs compared to the fleet's current gasoline vehicles.

Funding Opportunities

Available Funding Sources

As detailed in **Table 22**, there are several funding opportunities available to provide support for transitioning to zero-emission transportation and offset the costs for vehicles and infrastructure.

Table 22. Available Funding Sources

PROGRAM	SPONSOR	TRANSIT VEHICLE ELIGIBLE	EVSE ELIGIBLE	AVAILABLE FUNDING (Most recent)	NOTES
Alternative Fuel Vehicle (AFV) Emissions Inspection Exemption	State of Michigan	Yes	No	Varies	• Michigan Compiled Laws 324.6311 and 324.6512
Charge Up Michigan	State of Michigan (EGLE)	No	Yes	Up to $70,000	• EV Charger Funding Opportunities • Charge Up Michigan Fleet funding for local government fleets for Level 2 chargers.

PROGRAM	SPONSOR	TRANSIT VEHICLE ELIGIBLE	EVSE ELIGIBLE	AVAILABLE FUNDING (Most recent)	NOTES
Diesel Emissions Reduction Act (DERA)	EPA	Yes	No	Varies	• Michigan Clean Diesel Program • FY22 RFP closed on Feb. 18, 2022.
Volkswagen (VW) Environmental Mitigation Trust	State of Michigan (EGLE)	Yes	No	$64.8M	• Funding is being released across several rounds. • VW Environmental Mitigation Trust
PowerMIDrive	Consumers Energy	No	Yes	$5k LVL2 $70k LVL3	• PowerMIDrive
PowerMIFleet	Consumers Energy	No	Yes	$5k LVL2 $35k/$70k LVL3	• PowerMIFleet
Buses & Bus Facilities (5339)	USDOT/FTA	Yes	Yes	$372M FY22	• FTA Grants for Buses and Bus Facilities FY2022 Notice of Funding
Low-No (5339c)	USDOT/FTA	Yes	Yes	$1.1B FY22	• FTA Low or No Emission Vehicle Program - 5339(c)
Electric Vehicle Rebate Program	State of Michigan	No	Yes	TBD	• This is a Governor Whitmer proposal and at the time of this report, it has not been introduced to the Michigan State Legislature. • If submitted and passed, the legislation would allow for a $2500 rebate per light-duty vehicle

State Incentives

Alternative Fuel Vehicle (AFV) Emissions Inspection Exemption

Dedicated AFVs powered by compressed natural gas, propane, electricity, or any other source as defined by Michigan Department of Transportation are exempt from emissions inspection requirements. (Reference Michigan Compiled Laws 324.6311 and 324.6512.)

Charge Up Michigan Placement Project

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) provides funding for public or private organizations for the installation of DC fast chargers, site preparation, and networking fees and signage. Applicant must be enrolled in a utility EV program. Grants are equal to the lesser of 33.3% of the total cost of the project or a direct match of the electric utility funding, up to $70,000. For more information, including eligibility requirements and application, see the EV Charger Funding Opportunities website.

As part of the Charge Up Michigan program, the Charge Up Michigan Fleet provides funding for Level 2 chargers for local government electric fleets. Program funding is currently closed, but check Charge Up Michigan program page or Charge Up Michigan Fleet Application for updates.

Diesel Emissions Reduction Act (DERA)

As a result of U.S. EPA regulations, diesel engines manufactured today are cleaner than ever before. But because diesel engines can operate for 30 years or more, millions of older, dirtier engines are still in use. Reducing exposure to diesel exhaust from these engines is especially important for human health and the environment. EPA offers funding for projects that reduce diesel emissions from existing engines. For more information visit Michigan Clean Diesel Program.

- **MI Clean Diesel Program:** Please note that the 2022 RFP closed on Feb. 18, 2022.

Volkswagen (VW) Environmental Mitigation Trust

In 2017, Michigan was allocated $64.8 million as part of a national settlement with VW. The settlement resolved allegations of excess oxides of nitrogen (NOx) emissions from passenger vehicles. The settlement funds, managed by the Michigan EGLE, are being used to support projects which:

- Reduce NOx emissions from qualifying mobile sources;

- Maximize the air quality benefits statewide, focusing on urban areas and those designated as being in non-attainment with the National Ambient Air Quality Standards;
- Reduce emissions from school buses; and
- Increase the adoption of ZEVs and AFVs and equipment.

Vehicles must be registered and operate only within state lines and replace an operational 2009 Model Year or older powertrain.

The Michigan EGLE offers grants for eligible on- and off-road vehicles and equipment. Projects must reduce nitrogen oxide emissions, improve air quality, and increase adoption of ZEVs and AFVs and equipment. Eligible vehicles and equipment include local freight vehicles (medium- and heavy-duty trucks and port drayage trucks), shuttle and transit buses, port cargo handling equipment and forklifts, airport ground support equipment, and more. The program is funded by Michigan's portion of the VW Environmental Mitigation Trust. For more information, including available requests for proposals, see the EGLE Fuel Transformation Program website.

Utility Incentives

Consumers PowerMIDrive

PowerMIDrive is a program designed to increase EV charging capability and make it easier to charge vehicles. The program will also help improve the grid and control rates for all customers. It is a major step toward the future of the energy grid and the rapidly evolving way people travel. For more information visit PowerMIDrive.

- Up to $5,000 for commercial customers installing a public Level 2 charger. Act fast to receive a rebate – the total number available is limited.
- Up to $70,000 for commercial customers installing a public DCFC. Act fast to receive a rebate – the total number available is limited

Consumers PowerMIFleet

PowerMIFleet is a program designed to help businesses transition their fleets to EVs. The program includes consultation about EV charging for businesses and local governments and rebates of up to $70,000. For more information visit PowerMIFleet.

- Rebates of up to $5,000 per Level 2 Charger port
- Rebates of up to $35,000 per non-public DCFC
- Rebates of up to $70,000 per public use DCFC

After utilizing maximum Level 2 and Level 3 rebates, please consult Consumers Energy for any additional Level 2 or Level 3 funding opportunities.

Grant Sources

Buses and Bus Facilities (5339)

Grants for the Buses and Bus Facilities Program is designed to assist in the financing of buses and bus facilities capital projects, including replacing, rehabilitating, purchasing, or leasing buses or related equipment, and rehabilitating, purchasing, constructing, or leasing bus-related facilities. Additionally, recipients are permitted to use up to 0.5% of their requested grant award for workforce development activities eligible under federal public transportation law (49 U.S.C. 5314(b)) and an additional 0.5% for costs associated with training at the National Transit Institute. $372 million is available in FY22. For more information, please visit Grant for Buses and Bus Facilities Program.

FTA Low-No (5339c)

The Low or No Emission competitive program provides funding to state and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities. In FY21, $182 million in funding was awarded to low- and no-emission buses and facilities that support them. The funding levels vary each year, and it is expected that the funding levels will continue to increase year over year, with $1.1 billion available for FY22. For more information, please visit Low or No Emission Vehicle Program.

Other Grant/Funding Programs

The U.S. Department of Transportation releases funding each year for EV infrastructure projects through several grant opportunities, some of which transit agencies are eligible to apply, including the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) program, Discretionary Grant Program for Charging and Fueling Infrastructure, and the newly released National Electric Vehicle (NEVI) Formula Program. For a full list of transit-eligible EV infrastructure programs, see Appendix B: DOT Funding and Financing Programs with EV Eligibilities.

Federal Tax Incentives

Qualified Plug-In Electric Vehicle (PEV)

A tax credit of $2500 - $7500 is available for the purchase of a new qualified PEV. The amount of tax credit is determined by the vehicle's battery capacity and gross vehicle weight rating up to 14,000 lbs., as well as other qualifying standards. Each EV manufacturer is eligible for 200,000 PEV credits, and at the time of this report, only General Motors and Tesla have expended their allotted credits. Please consult a tax professional for eligibility for any light-duty fleet EVs. (Reference Alternative Fuels Data Center).

Alternative Fuel Infrastructure Tax Credit

EV infrastructure eligible for tax credit up to 30%, not including permitting and inspection fees. The tax credit expired December 31, 2021, but is expected to be retroactively extended as has been done in previous years. Please consult a tax professional to determine eligibility after purchase of charging station. (Reference Alternative Fuels Data Center).

Innovative Financing Mechanisms

Industry is responding to the critical need to help finance the higher costs currently associated with vehicle electrification. Many new business models or offerings have come into play, and several organizations have developed new financing mechanisms to support the acceleration of vehicle electrification. Charging-as-a-service (CaaS) is one of these new models. Typically, transit agencies would need to finance all costs associated with the construction and deployment of infrastructure and then pay a utility for the electricity used as fuel to charge the bus. Under CaaS, an outside company, the utility, or vendor provides turn-key project management services for the construction and installation of infrastructure. The company or vendor then owns, operates, and maintains the infrastructure. The transit agency is then only responsible to pay the company or vendor a flat fee per kWh or miles driven.

CaaS is an attractive option because it allows transit agencies to avoid the high upfront capital expenditures required to install infrastructure, the resources needed to secure outside funds, and the unpredictability of winning grants or issue bonds to fund infrastructure construction. In many cases costs incurred by transit agencies include utility demand charges—the Consumers Energy GSTU rate does not have demand charges—and the responsibility of maintaining infrastructure. It also provides the transit agency with more certainty for the operational costs of the fleet.

Laws and Regulations

Plug-In Electric Vehicle (PEV) Fee

In addition to standard registration fees, PEVs, including all-electric vehicles and plug-in hybrid electric vehicles (PHEVs) with a minimum battery capacity of 4 kWh, are subject to an annual fee (**Table 23**). EV fees will increase by $5.00 per $0.01 that the state motor fuel tax exceeds $0.19. (Reference Michigan Compiled Laws 257.801.)

Table 23. Michigan Standard EV Registration Fees

VEHICLE TYPE	GROSS VEHICLE WEIGHT RATING	FEE
EV	8,000 lbs. or less	$100
EV	> 8,000 lbs.	$200

Fleet Electrification Ecosystem Needs

Bus Mechanic and Operator Training

Training is typically provided by the vendor or original equipment manufacturer (OEM) and included in the vehicle quote as a separate, clearly defined line item. BEBs have different maintenance needs and operational best practices than their traditional ICE counterparts. BEBs have significantly fewer moving parts and more electrical systems and sub-systems, such as batteries and battery packs, DC to DC converters, and electric motors. Some BEBs have electric motors on each wheel axle called e-axles that operate as range extenders. These electrical systems and subsystems are high voltage and thus introduce not only strict safety protocols but the need for personal protection equipment (PPE).

It is important that mechanics and operators become trained and proficient in high voltage safety and proper use of PPE to minimize the risk of electrical shock or arc flashes. Mechanics should consider obtaining the NFPA 70E: Standards for Electrical Safety in the Workplace and High Voltage OSHA 1910.269 8 Hour Qualified Training Course certificates. Local first responders need to receive training in EV safety so they can effectively respond in the event of an accident. Maintenance technicians will also need to become proficient in bus inspection, preventative maintenance, and how to handle removed battery systems to effectively maintain the buses. Mechanics will also need to learn how to troubleshoot basic bus charger problems.

BEBs also do not drive like their ICE counterpart, so it is important that bus drivers are trained as well. This training is focused on optimizing performance and extending the range of the vehicle as much as possible, which includes slow and steady acceleration and deceleration to take advantage of regenerative braking. Inefficient driving habits can reduce vehicle ranges by up to 20% or more. Therefore, operator training is a critical component of operational success and reduces any concerns over whether sufficient battery power to complete a daily route.

Maintenance Tools

Servicing a BEB requires the proper tools and facilities. Many of these tools are used to service traditional ICE vehicles, so a fleet should have most of these items already available, except for specialized equipment needed to handle high voltage systems and subsystems such as batteries, battery packs, wiring, DC to DC convertors, and electric motors. Below is a list of some of the critical tools to have on hand:

- Onboard Diagnostic Tool
- Insulated everyday tools (screwdrivers, pilers, wrenches)
- PPE, such as but not limited to the following:
    - Class 0 rubber high voltage gloves
    - Insulated dielectric boots
    - Welding face shields
    - Rubber aprons
    - Electrical rescue hook and grounding gear
- High impedance multimeters
- Insulated cranes to lift/move batteries
- OEM specific tools

Resiliency and Energy Storage

BEVs still require fuel to operate—in this case electricity rather than fossil fuels. Power outages are always a possibility, regardless of grid advancements. Fleets need plans for keeping operations running when the power does go out. Today's BEBs do not necessarily require electricity from the grid to be available to properly fuel. There are means of fueling BEVs using energy storage solutions, which are safer than storing flammable fossil fuels on site.

Electricity can be generated on site with solar and microgrid based solutions, taking advantage of both sun and wind sources. In most circumstances, power outages interrupt solar and microgrid systems as well, but capturing this power and storing the energy allows for power storage that is disconnected from the grid. This same electricity can be used to power charging stations, so they may never lose power when running off the energy storage.

Fire Suppression Systems

Current building codes do not address the addition of BEBs to a bus depot or garage. Most BEBs utilize lithium-ion batteries, which have been known to experience fire problems especially when performing outside their normal operating range. Should a fire situation occur, these batteries internally develop fuel and oxygen that continue to feed the fire. Lithium-ion batteries can progress into thermal runaway and produce an extremely hot fire that is difficult to put out. For this reason, batteries are designed with battery maintenance systems to help maintain the battery in a safe condition, both from a temperature and charge/discharge perspective. However, it is still important that the fleet meets with local responders early on to identify what fire suppression system should be installed to mitigate any issues well ahead of deployment.

Appendix A: 24-Hour Load (Managed Charging)

Table A-1 and **Table A-2** below reference the managed charging schedules for overnight charging, between the hours of 11:00 p.m. and 7:00 a.m. the next morning, for all nine vehicles in both scenarios.

Table A-1. Scenario 1: 24 Hour Load (Managed Charging)

HOUR	Veh #7	Veh #9	Veh #8	Veh #12	Veh #1	Veh #14	Veh #2	Veh #4	Veh #6	TOTAL kW BY HR
0:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19
1:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
2:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
3:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
4:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
5:00	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
6:00**	5	0.00	2.67	7.5	8	0	7	0	6.50	36.66666667
7:00**	0	0	0	0	0	0	0	0	0	0
8:00	0	0	0	0	0	0	0	0	0	0
9:00	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	0	0	0
12:00	0	0	0	0	0	0	0	0	0	0
13:00	0	0	0	0	0	0	0	0	0	0
14:00	0	0	0	0	0	0	0	0	0	0
15:00	0	0	0	0	0	0	0	0	0	0
16:00	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0
23:00*	5.00	5.71	5.33	7.50	8.00	0.00	7.00	5.14	6.50	50.19047619
TOTALS (Off-Peak)	40	40	40	60	64	0	56	36	52	**388** kW
TOTALS (Opportunity)	0	0	0	0	0	0	0	0	0	**0** kW
Daily TOTAL	40	40	40	60	64	0	56	36	52	**388** kW

Table A-2. Scenario 2: 24 Hour Load (Managed Charging)

HOUR	Veh #7	Veh #9	Veh #8	Veh #12	Veh #1	Veh #14	Veh #2	Veh #4	Veh #6	TOTAL kW BY HR
0:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81
1:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
2:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
3:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
4:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
5:00	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
6:00**	2	0.00	1.15	7.5	3.46	0	3.0275	0	6.50	23.80333333
7:00**	0	0	0	0	0	0	0	0	0	0
8:00	0	0	0	0	0	0	0	0	0	0
9:00	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	0	0	0
12:00	0	0	0	0	0	0	0	0	0	0
13:00	0	0	0	0	0	0	0	0	0	0
14:00	0	0	0	0	0	0	0	0	0	0
15:00	0	0	0	0	0	0	0	0	0	0
16:00	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0
23:00*	2.16	5.71	2.31	7.50	3.46	0.00	3.03	5.14	6.50	35.81380952
TOTALS (Off-Peak)	17.3	40	17.3	60	27.68	0	24.22	36	52	**274.5** kW
TOTALS (Opportunity)	0	0	0	0	0	0	0	0	0	**0** kW
Daily TOTAL	17.3	40	17.3	60	27.68	0	24.22	36	52	**274.5** kW

Appendix B: DOT Funding and Financing Programs with EV Eligibilities

	FY 2022[1] AMOUNT	Construction and installation of EV charging infrastructure	Workforce development	EV acquisitions	Planning	Freight charging infrastructure	Transit charging infrastructure
FORMULA PROGRAMS							
National Highway Performance Program (NHPP)	$28.4 B[2]	✓	✓				✓
Surface Transportation Block Grant Program (STBG)	$12.5 B[2,3]	✓	✓		✓	✓	✓
Congestion Mitigation & Air Quality Improvement Program (CMAQ)	$2.5 B[2]	✓	✓	✓		✓	✓
National Highway Freight Program (NHFP)	$1.4 B[2]			✓	✓	✓	
State Planning and Research (SPR)	$983.3 M[4]				✓		
Metropolitan Planning (PL)	$438.1 M[2]				✓		
Carbon Reduction Program	$1.2 B[2,5]	✓	✓	✓	✓	✓	✓
National Electric Vehicle (NEVI) Formula Program	$685 M[2,5,6]	✓	✓		✓	✓	✓
DISCRETIONARY PROGRAMS							
Rebuilding American Infrastructure with Sustainability and Equity (RAISE) (formerly known as BUILD)	$1.5 B	✓			✓	✓	✓
Infrastructure for Rebuilding America (INFRA) Grant Program	$1.64 B[2,7]	✓			✓	✓	
Advanced Transportation and Technologies and Innovative Mobility Deployment	$60 M[2]	✓					✓
Discretionary Grant Program for Charging and Fueling Infrastructure	$300 M[2,5]	✓	✓		✓	✓	✓
Rural Surface Transportation Grant Program	$300 M[2,5]	✓	✓		✓	✓	✓
Reduction of Truck Emissions at Port Facilities Program	$80 M[2,5,7]	✓		✓		✓	
OTHER ALLOCATED PROGRAMS							
Federal Lands and Tribal Transportation Program (FLTTP)	$1.3 B[2,8]	✓	✓	✓	✓	✓	✓
Puerto Rico Highway Program (PRHP)	$173 M[2]	✓	✓	✓	✓	✓	✓
Territorial Highway Program (THP)	$46 M[2]	✓	✓		✓	✓	✓
INNOVATIVE FINANCE PROGRAMS							
State Infrastructure Banks (SIBs)	Varies	✓	✓	✓	✓	✓	✓
Transportation Infrastructure Financing and Innovation Act (TIFIA)	$250 M[2]	✓	✓	✓	✓	✓	✓

LEGEND

Construction and installation of EV charging infrastructure including parking facilities and utilities.	Workforce development and training related to EV infrastructure.	EV acquisitions and engine conversions - cars or trucks.	Planning for EV charging infrastructure and related projects.	Construction and installation of EV charging infrastructure to support operational, resiliency, national energy security, environmental, and community goals for freight transportation.	Installation of EV charging infrastructure as part of transit capital projects eligible under chapter 53 of title 49, United States Code.

Figure B-1. DOT Funding and Financing Programs with EV Eligibilities (FHWA, 2022)

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