Fleet Electrification Study

Vehicle Report

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ACRONYMNS

AC	Alternating Current	**kWh**	Kilowatt hour
BEV	Battery Electric Vehicle (See also *EV & PEV*)	**PEV**	Plug-in Electric Vehicle (See also EV & BEV)
DC	Direct Current	**PHEV**	Plug-in Hybrid Electric Vehicle
DCFC	Direct Current Fast Charge (DC Fast Charger)	**TBD**	To Be Determined
EV	Electric Vehicle	**TCO**	Total Cost of Ownership
EVSE	Electric Vehicle Supply Equipment (EV charger)	**V**	Volt
ICE	Internal Combustion Engine	**ZEV**	Zero-Emissions Vehicle
kW	Kilowatt		

EXECUTIVE SUMMARY

This report provides a systematic assessment of current City of San Luis Obispo-operated vehicles[1] with the primary goals of identifying vehicle electrification opportunities, establishing an electrification timeline based on vehicle replacements and the City's mandate for fleet electrification, and determining the costs and emissions benefits of fleet electrification. The analysis assessed relevant vehicle data in the City's records including data provided by the City's Fleet Services Supervisor. Available data included vehicle makes, models, ages, purchase date and price, fuel type, usage and costs, and miles travelled. Quantitative data was supplemented by interviews with appropriate City of San Luis Obispo staff to better understand how vehicles are used and the anticipated future mobility needs of each department.

The purpose of this report is to document the analysis of each fleet asset studied, and include the following research elements:

1) Fleet baseline summarizing vehicles studied, fleet composition, and categorization of fleet by electrification potential
2) Appropriate vehicle needs of each department to guide fleet electrification, including a schedule and recommendation for electrification of each analyzed vehicle, or category of vehicle.
3) Analysis of Total Cost of Ownership and capital budget needs associated with fleet electrification
4) Analysis of potential carbon emissions reductions associated with fleet electrification

KEY FINDINGS

- After accounting for non-street legal assets (trailers, generators, etc.) and vehicles that are already electric, **211** out of 325 total vehicles provided by the City were studied for electrification. Of this subset:
  - 76% can be replaced with equivalent electric vehicles that are currently commercially available, predominantly sedans, SUVs, and pickup trucks.
  - Most of the remaining vehicles (11% of 211) have potential electric candidates for replacement but challenges, primarily related to cost-effectiveness or operational requirements, remain.
  - About 6% of the vehicles studied do not have a potential candidate for electrification currently available or announced in the market.
  - The remaining 7% of the vehicles studied were requested not to be electrified by the City. This includes fire engines, four F-550s operated by the Fire Department, an undercover police vehicle, and some vehicles being phased out of operations.
- Electric vehicle range is not a barrier to vehicle electrification for the City of San Luis Obispo. For **100%** of the vehicles assessed, **the recommended EV option could satisfy 100%** of the existing vehicle's historical driving behavior.
- 161 of San Luis Obispo's fleet can be replaced with equivalent electric vehicles that are currently commercially available and likely to be cost-effective ("Best Fit" for Full Electrification). 64 of the vehicles in this category are in

[1] City of San Luis Obispo Transit vehicles were not included in the study.

the Police or Fire Departments and implementation will need to be phased to avoid compromising department operations.

- At current vehicle costs, excluding incentives, electrifying the subset of these vehicles coming due for replacement from 2022 to 2030 will **cost approximately $2.1 million** over the lifespan of the vehicles, approximately a 15% increase in operating costs. With known incentives and rebates, the City will observe savings of up to $912,174 over the lifespan of the vehicles, approximately a 6% reduction in operating costs. This estimate does not include the cost of installing and maintaining EV chargers.
- Today, incentives available to the City of San Luis Obispo for fleet electrification include Inflation Reduction Act (IRA) tax credits (up to $7,500 for light duty, and up to $40,000 for medium- and heavy-duty vehicles) and a Central Coast Community Energy (CCCE) rebate of $5,000 per vehicle. Additional incentives exist for EV charging infrastructure.
- The carbon emissions reductions corresponding with electrification of the City's "Best Fit" vehicles is an estimated **265 MTCO2 (31%)** from 2021 fleet-related emission levels by 2025 and **531 MTCO2 (63%)** by 2030. If the City expands its vehicle electrification efforts to include vehicles that are potentially electrifiable, it can achieve fleet carbon emissions reductions of **291 MTCO2 (34%)** from 2021 levels by 2025 and **643 MTCO2 (76%)** by 2030.
- Following the replacement schedule detailed in this report, SAN LUIS OBISPO can electrify **47%** of its light-duty vehicles by 2025 and **99%** by 2030 ("Best Fit" Electrification Scenario).
- Availability of medium- and heavy-duty electric vehicles is a challenge limiting SAN LUIS OBISPO's ability to electrify its fleet. None of these vehicles are electrifiable with currently available electric vehicles that do not have cost-effectiveness or operational concerns. Considering potentially electrifiable vehicles, **10%** can be electrified by 2025 and **48%** by 2030. However, to achieve this level of electrification the City will have to address operational and budget concerns during the purchasing process.

Under the Best Fit Electrification Scenario, vehicles in the Police Department represent the most cost-effective opportunity for carbon emissions reductions on a capital cost basis, with 36% of total fleet emissions coming from a department that has only 24% of the City's total fleet asset. Annual operational cost savings for the Police Department under the Best Fit scenario are estimated at $139,000.

CHALLENGES OF VEHICLE ELECTRIFICATION PLANNING IN A DYNAMIC MARKET

The electric vehicle market is highly dynamic. Purchase prices and available vehicle models included in this report have high levels of certainty through 2025, although supply chain and manufacturer delays may impact procurement. Thereafter, less certainty exists with respect to vehicle purchase prices and options, however based on Optony's professional opinion, cost comparable vehicles will be available for most of the City's needs through the end of the decade as described in detail in this report.

FLEET COMPOSITION

This section describes the data sources used in this report and summarizes the composition of San Luis Obispo's municipal fleet.

DATA SOURCES

The City of San Luis Obispo's fleet data was gathered from various data sources and a comprehensive database was compiled for further analysis. The data sources used in this project include the following:

- **City Fleet Inventory**: This database served as the primary data source for the vehicle study. The City's Fleet Inventory is an Excel-based database generated using data from AssetWorks, the City's fleet asset management software, maintained by the City's Fleet Services Supervisor that contains information on each vehicle, such as equipment ID, make, model, year, fuel type, power train, department, odometer reading, purchase year and purchase price. During the project, this database was updated in collaboration with City staff to remove vehicles that had been recently retired and add vehicles that had been recently purchased but not added to the inventory prior to project kick-off. Additionally, City staff indicated specific off-road assets that would be upgraded to electric street-legal assets in the future. The fleet inventory included data on assets besides vehicles (e.g., trailers, generators) but those items were not included in the study.

- **National Highway Traffic Safety Administration (NHSTA) Vehicle Identification Number (VIN) Decoder**: To supplement vehicle information included in the City Fleet Inventory, the NHSTA VIN Decoder, an online software tool that interprets VINs and provides an extensive list of characteristics corresponding to that VIN, was used to gather additional vehicle characteristics. Specifically, it was used to gather the Gross Vehicle Weight Rating (GVWR) and Body Type of each vehicle.

In addition to the above-mentioned data sources, qualitative data was collected through discussions with City Fleet and Facilities staff, such as vehicle duty cycles and emergency response requirements. In all, the data collection efforts described above led to the creation of a comprehensive fleet database, attached to this report as **Appendix A**, which served as the basis for all further analyses.

FLEET COMPOSITION AND CHARACTERISTICS

SUMMARY OF FLEET ASSETS

This section provides descriptive statistics to understand the current condition and composition of San Luis Obispo's fleet. The final fleet database included a total of 325 units, including light-, medium-, and heavy-duty vehicles. After reduction of the 114 vehicles that will not be electrified, 185 were included in the electrification analysis and are represented in the figures below.

Figure 1 depicts the breakdown of the fleet by vehicle type. Over half of the analyzed fleet falls under two vehicle categories: Pickup and Truck. The "Pickup" category includes light- and medium-duty vehicles ranging from smaller pickups such as the Ford Ranger to larger pickups such as the Ford F-350.

FIGURE 1. ENTIRE FLEET – COMPOSITION

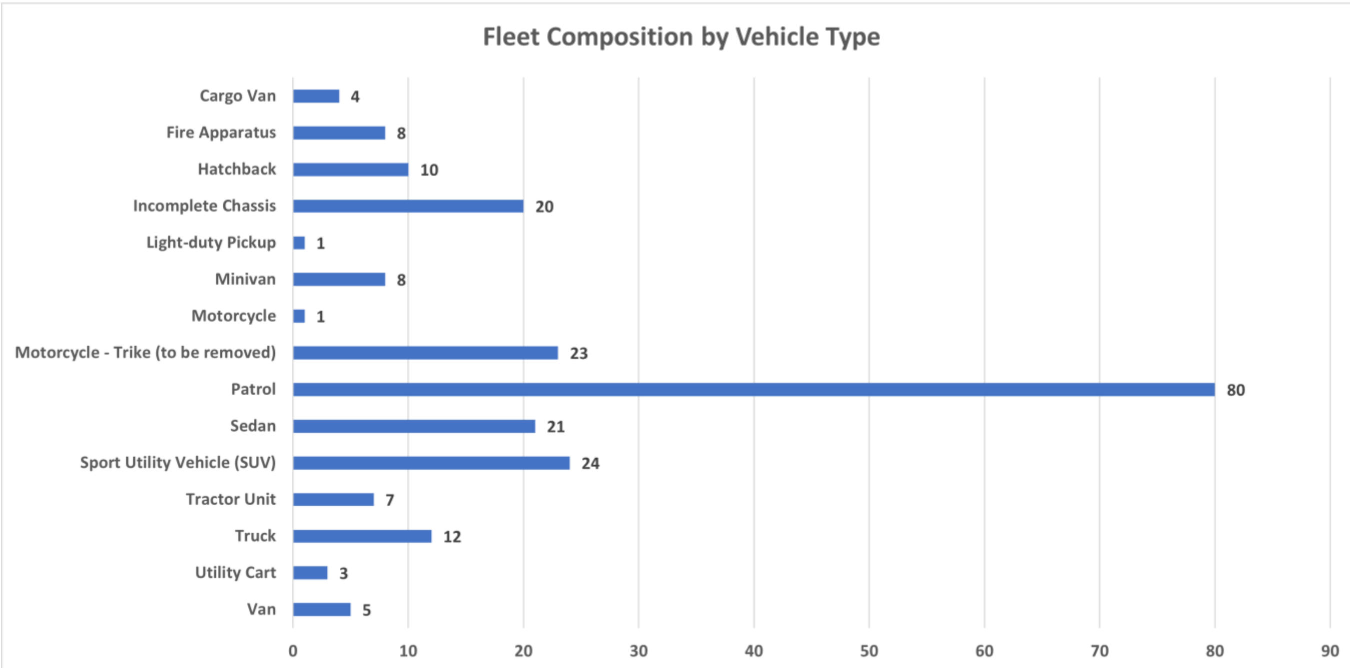
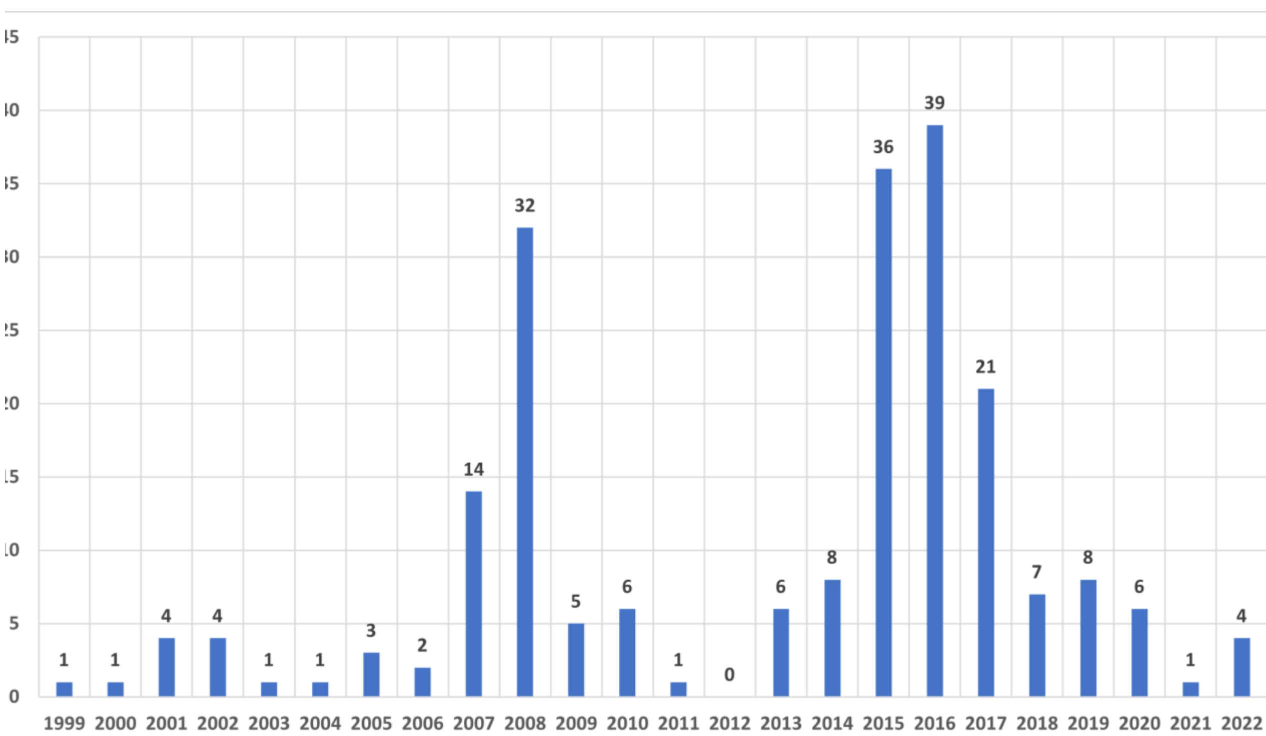


Figure 2 shows a count of all vehicles by their model year. Newest model years are shown first, followed by progressively older model years from left to right.

FIGURE 2. ENTIRE FLEET – AGE BY MODEL YEAR



In terms of the powertrain, the large majority (92.8%) of the studied fleet are internal combustion engines (ICE) followed by hybrids (3.8%) and battery electric vehicles (BEV or EV) (3.3%). Split out by fuel type in

Figure 3**,** the majority (83.4%) of the fleet use only unleaded gasoline, followed by renewable diesel (12.8%), and electricity (3.3%).[2]

FIGURE 3: STUDIED FLEET - DETAILED FUEL TYPE

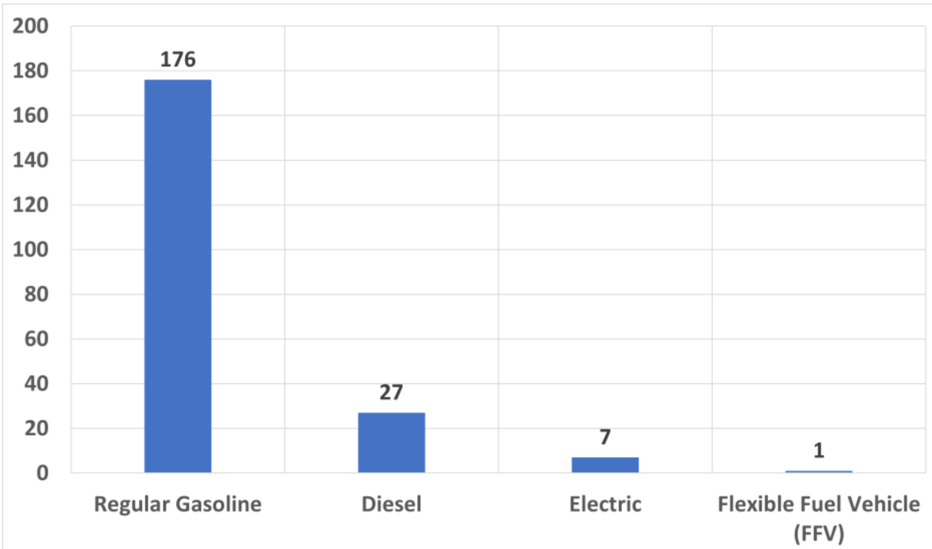


Table 1 summarizes the entirety of the City's fleet and includes the number of assets in each City department, total annual mileage, and average annual vehicle mileage by department. Among the City's various departments, the Public Works Department has the largest fleet with 68 vehicles, followed by Police (51 vehicles) and Utilities (46 vehicles).Error! Reference source not found. Notably, the Police Department vehicles account for nearly 40% of vehicles miles travelled by the City fleet but only make up 24% of the fleet.

TABLE 1: FLEET SUMMARY BY DEPARTMENT AND ANNUAL MILEAGE DRIVEN[3]

DEPARTMENT	NUMBER OF ASSETS	% OF TOTAL ASSETS	TOTAL ANNUAL MILES TRAVELED	ANNUAL MILES PER ASSET	% OF TOTAL ANNUAL MILES
POLICE PATROL	25	12%	304,330	12,173	27%
POLICE ADMIN	26	12%	145,904	5,612	13%
FIRE	28	13%	105,581	3,771	9%
UTILITIES	46	22%	211,767	4,604	18%
PUBLIC WORKS	68	32%	296,888	4,366	26%
IT	3	1%	12,278	4,093	1%
PARKS AND REC	8	4%	44,798	5,600	4%
COMMUNICATIONS	6	3%	21,293	3,549	2%
ADMIN	1	0%	4,842	4,842	0%

[2] Based on the fleet composition in 2022 and does not include any changes from expected 2023 replacements, which does include conversion of additional vehicles to EVs.
[3] Total and average annual usage are calculated from lifetime vehicle usage according to the City's fleet inventory

TOTAL	**211**	**1,147,681**	**-**

VEHICLE CATEGORIZATION

The fleet inventory provided by the City of San Luis Obispo consists of 325 assets. For this study, the database was further categorized into the following groups, as depicted in **Figure 4** and described below:

STUDIED FLEET

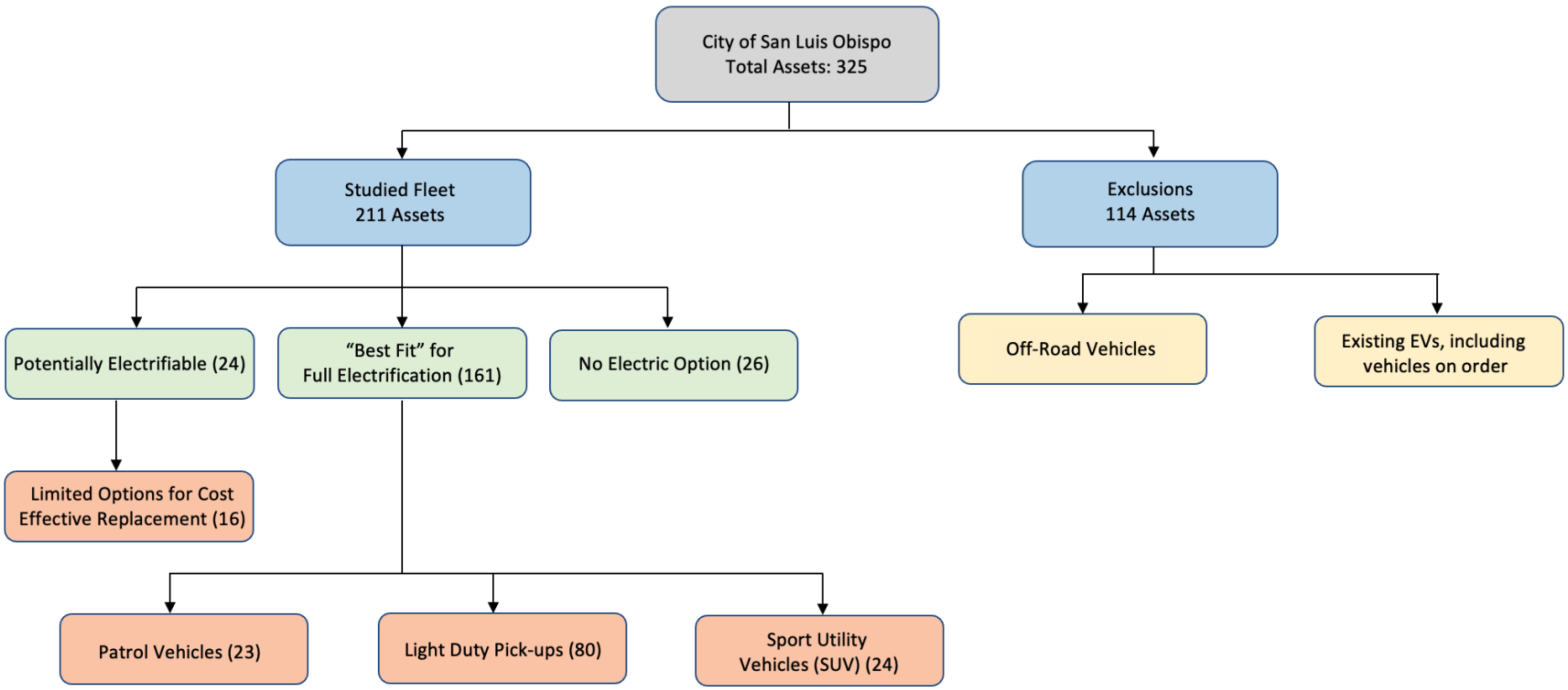
211 vehicles were studied in detail. However, not all of these vehicles can be fully electrified based on currently available technologies. Therefore, based on the vehicle body type (as will be discussed later), these fleet vehicles were further categorized into sub-categories:

- **"Best Fit" for Full Electrification:** 161 vehicles that can be fully replaced with an equivalent EV available on the market today. It is important to note that 64 of the vehicles in this category are in the Police or Fire Departments and implementation will need to be phased to avoid compromising department operations. Specific considerations related to vehicle selection for these departments are included under **Electric Vehicle Selection**.
- **Potentially Electrifiable:** 24 vehicles are potentially electrifiable using EVs available on the market today, but questions remain around cost-effectiveness, vehicle-specific operational and outfitting requirements and whether vehicle replacements that are not "like for like" are supported by internal stakeholders. Further analysis by City staff is needed prior to a purchasing decision being made. This category is further summarized below:
    - There are 16 medium-duty single chassis cab that have equivalent EV options available, but options may not be cost effective based on the current market prices.
    - There are 7 vehicles that have potential "like for like" vehicle options but may be cost prohibitive. Examples include all electric fire engines (e.g., Pierce Volterra Pumper), electric street sweepers (e.g., Global M3 Electric Sweeper) and heavy-duty trucks (e.g., Peterbilt 540EV).
    - There are 2 vans in the Police Department that, while electric options for the vehicle chassis are available, have extremely specialized uses (e.g., Crime Scene Investigation and Prisoner Transport) requiring continued vetting to determine if an EV option is available and suitable.
- **No Electric Option:** 26 vehicles in San Luis Obispo's fleet have no electric option currently available. This category includes specialty vehicles like heavy-duty dump trucks that the City converted to renewable diesel in 2017.

EXCLUSIONS

114 units were excluded from the detailed analysis. These exclusions were applied in cases where there was no need for further study because the asset was already electrified or had been replaced immediately prior to the project. This category includes units 0804 and 0806 (Toyota Priuses) which are being replaced in 2022 with Chevy Bolts that are already on order.

FIGURE 4. CITY OF SAN LUIS OBISPO'S FLEET COMPOSITION & ASSESSMENT APPROACH



VEHICLE ANALYSIS METHODOLOGY & RESULTS

After the initial assessment of the fleet and identification of the studied vehicles, the next step in the analysis was to analyze the data to identify specific electrification opportunities. The fleet electrification methodology consisted of the following major steps:

- **Step 1 - Electrification Timeline**: An electrification timeline was established based on expected replacement years for each vehicle provided by the City Fleet Services Supervisor and incorporated the City's adopted Climate Action Plan goal of 100% electric light-duty vehicles and 50% electric medium- and heavy-duty vehicles by 2030.
- **Step 2 - Electric Vehicle Selection**: EV options were identified and selected, either for complete replacement of vehicles based on the availability of equivalent EVs, or other electrification options such as partial electrification, powertrain replacement, or renewable diesel.
- **Step 3 – Range Suitability:** Existing vehicle use was analyzed, primarily focused on miles driven to determine whether each proposed EV replacement has sufficient battery range to meet existing driving behavior.
- **Step 4 - Total Cost of Ownership Analysis for a Fully Electrified Fleet**: Total cost of ownership (TCO) of conventional ICE vehicle replacements were compared to recommended EV models. This step included comparing a combination of capital costs (vehicle purchase price) and operating costs over the expected lifespan of the vehicle for each replacement option.

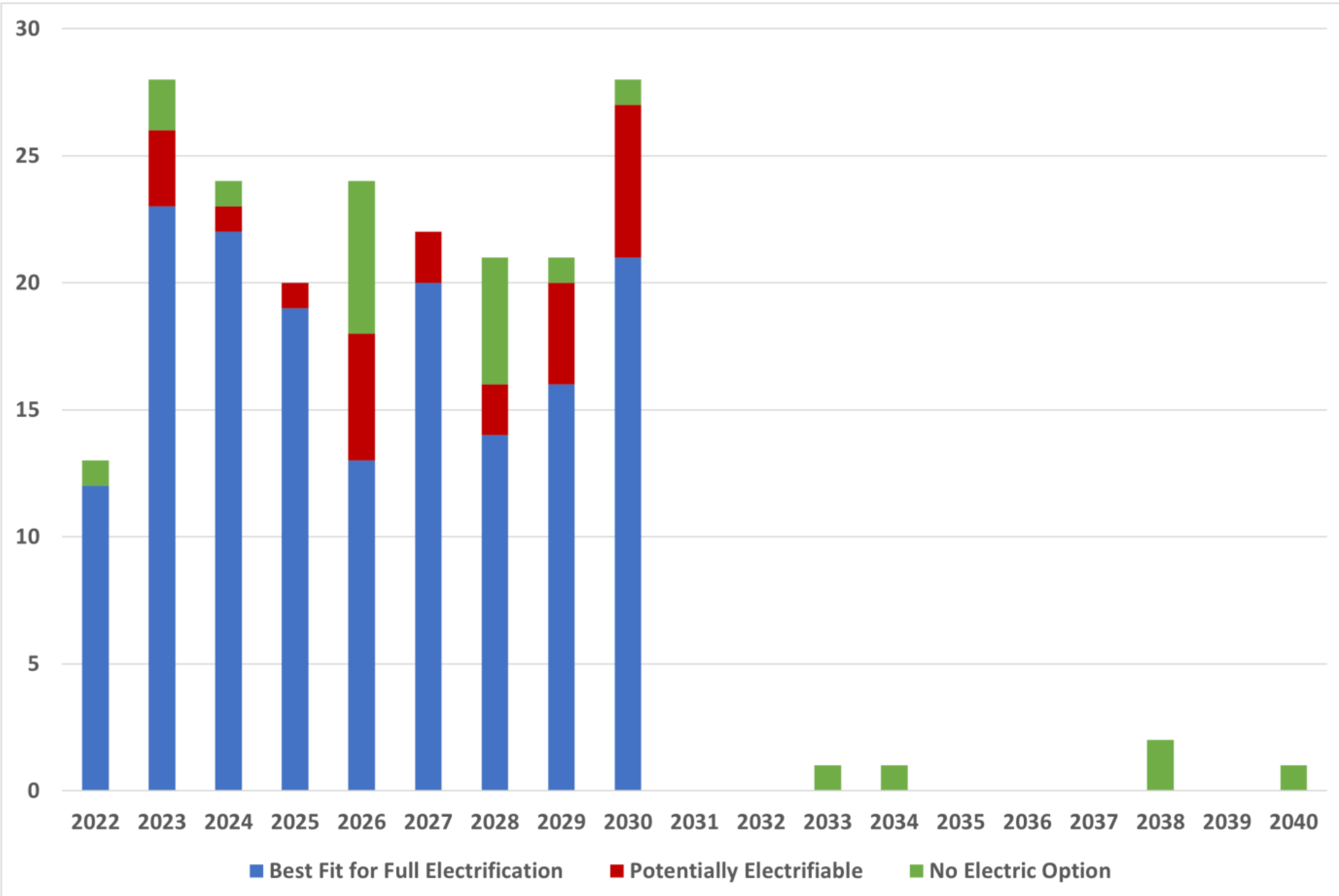
While the Fleet Electrification Methodology is presented as a linear process, in order to have the highest confidence in its procurement decisions and to adapt to an evolving market, it is recommended that Step 2 and Step 3 (above) are completed every-other year concurrent with the Financial Plan and Capital Improvement Program development process and as the vehicles in the electrification timeline come up for replacement and the City begins implementing fleet electrification.

ELECTRIFICATION TIMELINE

Figure 5 depicts the electrification timeline and the number of vehicles to be replaced and electrified each year over the next 19 years. Vehicles are split by the electrification potential categorization described under the **Vehicle Categorization** section**.** All vehicles analyzed are expected to be replaced by 2030.

It is important to note that the City can accelerate or delay this timeline based on available budget, but that delays require larger investments in later years.

FIGURE 5. FLEET ELECTRIFICATION TIMELINE



As electrification options for medium- and heavy-duty vehicles become increasingly available, the number of vehicles eligible for full electrification will increase. The potential impacts of this trend are demonstrated in Figure 13 under the Full Electrification Scenario.

ELECTRIC VEHICLE SELECTION

This analysis assigns at least one potential EV option to each existing vehicle in the City's fleet, while clearly defining which vehicles had "best fit" options and which had more uncertainty surrounding the suitability of the available EV options. The following discussion provides additional information on the current and expected market availability of EV options for various vehicle sizes, giving context to the limitations of the analyses presented in this report, and future opportunities that may enable the City to determine a clearer path toward electrification of its medium- and heavy-duty vehicles. A summary of all vehicles, ICE and Electric, included in the analysis can be found in **Appendix B.**

LIGHT-DUTY VEHICLE SELECTION

Sedans, SUVs & Light Duty Vans

As of 2022, there are a range of battery-powered vehicles suitable for municipal fleets currently priced in the range of $35,000 to $55,000 (not including sales tax) with a range greater than 100 miles. The most common choices are the Tesla Model Y or Chevrolet Bolt, both of which were considered as potential EVs for San Luis Obispo's fleet. Other light-duty electric vehicles available for immediate fleet purchase include the Chevrolet Bolt EUV; Ford Mustang Mach-E; Volkswagen ID4; Tesla Model 3; Hyundai Ioniq 5 & Kona; and Kia Niro. The EV models selected for inclusion in this analysis prioritized models and OEMs with which the City is familiar, which are easily purchased through existing procurement contracts and attempted to standardize across vehicle types in support of the City's efforts to standardize its fleet at large around preferred OEMs.

San Luis Obispo also operates 8 light-duty vans, ranging from smaller Ford Transit to Ford T-350s. The 2023 Ford eTransit is currently available and would be an appropriate replacement vehicle for this group of existing vehicles. An estimated 126 miles of range is more than sufficient for the daily driving needs of the City's vehicles. Ford is offering three different vehicle weights of the eTransit, as well as chassis cab and cutaway options, which make the eTransit an appropriate option to replace the larger light-duty vans, as well as potentially a portion of the medium-duty vans in the City's fleet.

Pickup Trucks

The City fleet includes 80 pickup trucks, mostly Ford Ranger, Ford F-150, Ford F-250, and Ford F-350. When considering electrification of the smaller pick-up trucks (1/2- and 3/4-ton trucks such as the F-150 and F-250), recent all-electric options have come to market including the Ford F-150 Lightning and Lordstown Endurance. With 10,000 pounds of towing capacity, range of 230-300 miles and a price point $60,000 to $75,000, the Ford F-150 Lightning is a promising option for municipal fleets and was included as the primary option in this analysis.

Alternative pickup trucks that could be appropriate for the fleet once proven are the Rivian R1T (starting at $75,000) and Lordstown Endurance (starting at $65,000), both of which are available on the market today. Other pickup trucks are also available or nearing production by companies like Bollinger, Chevrolet, GMC, and Toyota in 2023-2024.

For the 19 larger pickup trucks in San Luis Obispo's fleet, options remain limited and there are no equivalent all electric options on the market. The two options deemed to be the best fit were the SEA Electric Ford 450 and the Lightning Motors Ford 550, chassis conversion options. Considering these two options, there is no perfect path for electrification of these vehicles. Significant concerns exist related to a chassis conversion option like Lighting Motors, including upfront cost, warranty/repair issues and availability of parts in the future. 21 of the larger trucks were recommended to be downsized to a 1/2-ton option at the recommendation of the City's Fleet Services Supervisor, however, downsizing to a 1/2-ton option may not be possible across the board due to operational requirements like utility bodies.

There are additional companies besides Lightning Motors that offer EV chassis conversions that can be fitted with a utility body, such as Motiv Power Systems. Motiv's E-450 and F-450 options are also larger than the F-250 and F-350s the City commonly operates today. Any chassis conversion option can require long lead times for ordering and are often significantly more expensive to purchase.

Police Department

While admin vehicles in the Police Department can be replaced with standard light-duty options, the unique operational needs of patrol and special unit vehicles require additional consideration.

Police Departments throughout the country, such as Westport, Connecticut, Bargersville, Indiana and Fremont, California have deployed electric patrol vehicles, all manufactured by Tesla. The Fremont Police Department reports that their initial vehicle, a Tesla Model S, has behaved favorably in the role of a patrol vehicle despite not being pursuit-rated, with considerably less downtime than the Ford Explorer Utility Interceptor models which comprise the majority of their patrol vehicle fleet. Following this success, they purchased and deployed a Model Y in September 2021. Moving forward, the Model Y is likely to be the most appealing option as it provides a balance between size and purchase price.

However, as mentioned above, while the Tesla vehicles have the performance required in a police application, no models currently have an official pursuit rating from the Michigan State Police or LA Sheriff's Department, the two entities in the Country in charge of testing vehicles for police use. Prior to deployment, Fremont PD had to receive approval from the City's Risk Management department since the Tesla vehicle did not have an official pursuit rated designated. In light of this, another potential model for the Police Department to consider is the Mustang Mach E GT Performance, which received an official pursuit designation in September 2021 from the Michigan State Police. Similar to the Model Y, the Mach E is a crossover vehicle that should provide sufficient interior capacity, battery range, and performance at comparable pricing to Ford vehicles currently purchased.

As it is advantageous for special unit vehicles, such as those used by detectives or in undercover operations, to be a range of models, the analysis included a range of light-duty electric options matching the body type of the existing vehicles. However, it is understood that these vehicles must blend in with surrounding traffic and concerns exist that electrifying these vehicles ahead of the general market may limit this ability. Additionally, the lack of sufficient public fast charging infrastructure may limit these vehicles' ability to perform during extended deployments. As such, while a range of EV options could be suitable, piloting will be required by San Luis Obispo's police department to determine comfort with specific models.

Finally, the Police fleet includes 8 motorcycles which have potential for electrification. There are products on the market, such as the Harley Davidson Live Wire. Zero Motorcycles' police and security model was tested and determined to be too small for patrol applications.

MEDIUM- AND HEAVY-DUTY VEHICLES

Medium-duty and heavy-duty electric vehicle offerings are generally limited to OEM options approaching production but not yet available or semi-custom, electrified or hybrid versions of commercially available vehicle platforms such as the Ford and Izuzu chassis conversions Motiv, SEA and Lightning. Today's limited offerings will be augmented by increasingly numerous commercially available medium- and heavy-duty electrified vehicle platforms by manufacturers like Nikola, AVEAI, Mitsubishi, Daimler, and Tesla. In effect, numerous zero emission replacement options will be available for a significant percentage of diesel and gas-powered fleet components before 2030, though the timeline is difficult to accurately predict beyond manufacturers' announcements within the next two production years.

Fire Department

Fire trucks pose a particular challenge for fleet electrification. Stringent performance requirements mean that an EV option must be purpose built. Per the National Fire Protection Association (NFPA) classifications, electric options from fire truck Types 1-7 were researched. Two potential options for Type 1 fire trucks exist, the Rosenbauer Concept Fire Truck and the Pierce Volterra Pumper, neither of which are in full production as of writing but are expected by 2023. The Volterra Pumper is in service with the Town of Madison, Wisconsin[4] and the Los Angeles Fire Department entered a Rosenbauer RTX into service in May 2022[5]. Both vehicles cost on the order of $1.3-1.5 million which is more expensive than SAN LUIS OBISPO's existing fire engines with similar capability, although prices seem to be increasing. Purchase records from the City show that similar vehicles cost the City between $400,000 and $600,000, with a more recent mid-2022 purchase of a $900,000 engine.

No options were found for Types 2-7, although First Priority Group[6], a large upfitter of emergency and command center vehicles primarily operating on the East Coast, offers various emergency response and command center vehicle options in collaboration with another chassis conversion company Roush Cleantech.

Medium- and Heavy-Duty Trucks & Chassis Cabs

Excluding fire engines and ambulances, the City fleet has 21 vehicles (Class 3 or higher) that range from fire apparatuses to flatbed trucks to specialty heavy duty vehicles, operating primarily in the Public Works, Fire, and Utilities departments.

While all of the heavy-duty vehicles were identified as having no electric options, here are a limited number of all-electric options are offered by OEMs and chassis conversion companies. Options included in the analysis offered by OEMs include the Peterbilt 220EV and 520EV and the Global Environmental Products M3 Electric Sweeper. The purchase price of the EV options ($700,000) and low mileage of the existing vehicle precludes the EV options from being cost-effective, but the City could decide to purchase these vehicles, likely using incentive programs such as HVIP discussed in **Appendix A**, to achieve emissions reductions. Options included in the analysis from chassis conversion providers include SEA NPR EV, Lightning Motors Ford F550 and Motiv E450 Utility Truck. Motiv offers two different bodies, a box truck and a work truck, fit on a Ford E-450 chassis.

Overall, for the City's heavy-duty municipal fleet vehicle use cases, cost-effective EVs are likely still five-to-ten years away, even when accounting for incentives.

ANALYSIS PROCESS

In order to assign EV alternatives to existing vehicles, each existing vehicle was assigned a label based on its Gross Vehicle Weight Rating and Body Type (e.g., medium duty van). Up to five ICE replacement possibilities and five EV alternatives were assigned to each vehicle label for analysis and the selected replacements were applied to every vehicle with that label. Considering all the vehicle type and department specific considerations above, individual vehicles were updated manually to ensure that only relevant models were included in the comparison and a single model was designated as the

[4] https://www.wpr.org/madisons-fire-department-tests-out-fire-truck-runs-electricity
[5] https://www.lafd.org/news/lafd-chief-debuts-arrival-first-electric-fire-engine
[6] https://www.1fpg.com/electrified

primary option and used to inform that total cost of ownership and capital budget need calculations completed later in the analysis.

RANGE SUITABILITY

For every EV option assigned to an existing vehicle during the Vehicle Selection process, the **"EV Range Viability"** was calculated, comparing the range and battery capabilities of the EV option to the driving patterns of the existing vehicle. **"EV Range Viability"** is determined by doubling the average daily distance driven by each vehicle and confirming the EV replacement range exceeds the maximum daily distance. All of San Luis Obispo's "Best Fit" and "Potentially Electrifiable" vehicle recommendations (211 total assets) boast viable ranges based on the vehicles historical driving, so EV range is not a major barrier to electrification for the City's fleet. Most vehicles with EV alternatives falling below 100% of trips within range have Plug-in Hybrid Electric Vehicle (PHEV) options that would switch to gas once the battery was depleted, meaning that while the vehicle could not complete all trips on electric propulsion it would not become stranded on longer trips.

Accounting for Idling, Auxiliary Loads & Vehicle Weight Variations

EVs do not idle in the same way as ICE vehicles, but the equipment requiring idling (e.g., air conditioning) will still create a draw on the battery. A significant portion of the City's fleet is police vehicles, most of which idle for a large percentage of their daily operations. To account for idling of police vehicles, the daily kWh energy usage was adjusted to reflect the higher energy needs and was applied directly as a 25% reduction of the battery state-of-charge of the EV based on operations in police fleets similar in size to San Luis Obispo's.

The analysis did not require a reduction of the battery state-of-charge due to the added weight of auxiliary equipment because the City's police fleet is expected to be almost exclusively replaced by Ford F-150 Lightning Special Service Vehicles (SSVs), which are designed specifically for police departments and the equipment included by the manufacturer is accounted for in the vehicle specifications.

TOTAL COST OF OWNERSHIP (TCO) ANALYSIS

TCO METHODOLOGY

Total cost of ownership (TCO) refers to a calculation of adding capital and operating costs of an asset to determine the total cost of that asset over its lifespan. As part of the analysis, the TCO for two different scenarios of vehicle replacement was calculated: (1) an existing vehicle is replaced with an equivalent ICE vehicle and (2) that same existing vehicle is replaced with the equivalent, or nearly equivalent, EV determined the vehicle selection process. Given the age of some of the City's vehicles, the changing availability of vehicle models in the market and to simplify the analysis, a representative ICE vehicle replacement for each vehicle body type (e.g., Ford Escape for SUV) was used as the equivalent ICE replacement vehicle to create the scenarios in the TCO analysis. The "Representative ICE Replacement" was determined in collaboration with the City's fleet staff. For heavy-duty vehicles, the ICE replacement vehicle was deemed to be identical to the existing model. *It is important to note that the replacement ICE vehicle choice presented here is used to represent the approximate cost of replacing an existing vehicle with a new ICE vehicle and may not perfectly reflect the City's actual procurement choice to replace an existing vehicle.*

For both scenarios, the TCO is the sum of the following cost components:

- **Total purchase price**: The sum of the Manufacturer Suggested Retail Price (MSRP) and any auxiliary equipment. The MSRPs of the vehicles were discussed with the City of San Luis Obispo to ensure that the actual price paid by the City (incorporating fleet procurement discounts) of the proposed vehicles were factored into the analysis. Available incentives from the Inflation Reduction Act and Central Coast Community Energy were included in the calculation for total purchase price.
- **Annual fuel cost**: This was calculated based on the estimated annual mileage of the studied vehicle. For this calculation, unleaded gasoline is priced at $4.00 and renewable diesel at $5.45, according to the City's report on their fuel prices. Annual fuel cost for EVs was calculated using the cost of electricity at the domicile facility of the ICE vehicle being replaced. This cost was determined to be $0.26/kWh according to the City's electricity rate from PG&E (B19S) and does not include costs from any potential increase in demand charges. The potential impacts of escalations in fuel costs (liquid fuel and electricity) can be observed in the Fleet Electrification Pro-Forma provided to San Luis Obispo.
- **Annual Operations and Maintenance (O&M) cost**: The City of San Luis Obispo provided life-to-date maintenance costs for each vehicle in the fleet. For the TCO comparison, an average cost of $0.06 per mile was used for EVs.

The TCO calculations did not include the cost of Electric Vehicle Supply Equipment (EVSE), as that is being addressed in the Charging Infrastructure Report. All components included in the TCO calculations were calculated over the expected lifespan of the existing vehicle, which ranges from 6 to 20 years depending on the vehicle type.

The TCO calculations do not account for the possibility that electric police patrol vehicles could last longer that than the 6-year lifespan expected of the City's ICE police patrol vehicles. Initial indications from the City of Fremont's police patrol pilot project deploying a Tesla Model S as a pursuit vehicle have indicated that the reduced maintenance needs of EVs will likely result in an expected lifespan of longer than 6 years. Despite these indications, this assumption is still being proven through real-world application. Thus, TCO calculations for this project assumed a simple case where both ICE vehicles and EVs in the Police Department are owned for the same amount of time.

Resale Value

The resale value of the vehicle at the end of its lifecycle was not considered in the TCO analysis and was set to zero for both ICE vehicles and EVs. Due to the relatively short amount of time that EVs have been on the market, there is not robust data on the resale value of an EV in use for 10 years. Currently, the City returns revenue earned from sale of retired vehicles to the vehicle replacement fund (VRF) if the vehicle was originally purchased using general funds. Revenue from the sale of water, sewer, and parking vehicles is returned to the City's department-specific enterprise funds.

TCO BY DEPARTMENT & ELECTRIFICATION CATEGORY

To summarize the TCO calculations across the entire fleet, a summary of TCO by department is included below. Given the large number of vehicles analyzed, detailed TCO calculations for each vehicle are presented in **Appendix B**.

The following figures summarize the TCO for all expected vehicle electrification purchases by City departments over three time periods, from short-term (2023-2025), medium-term (2026-2030) and long-term (2031-2040). These figures only include City departments that are projected to have vehicle replacements in the given period.

Under each period, there are figures representing two scenarios. The first figure provides a TCO comparison for only the vehicles included in the Best Fit for Full Electrification category and the second figure provides a TCO comparison for all vehicles with a potential electrification option. Since this second scenario includes EV options that may not be cost effective, the TCO of the electric vehicles is generally higher than for the ICE vehicles.

The time periods segment vehicle purchases by purchase year, but the costs displayed include operating costs expected over the lifetime of the new vehicle stretching from the purchase date through the end of its lifespan. For example, an EV purchased in 2023 with a 10-year life span realizes annual savings for the City through 2033, compared to the alternative scenario of purchasing an ICE vehicle. Those savings are aggregated in the figures below. Dollar amounts are provided in nominal dollars.

FIGURE 6: TCO OF SHORT-TERM VEHICLE PURCHASES (2023-2025) – "BEST FIT" FOR ELECTRIFICATION

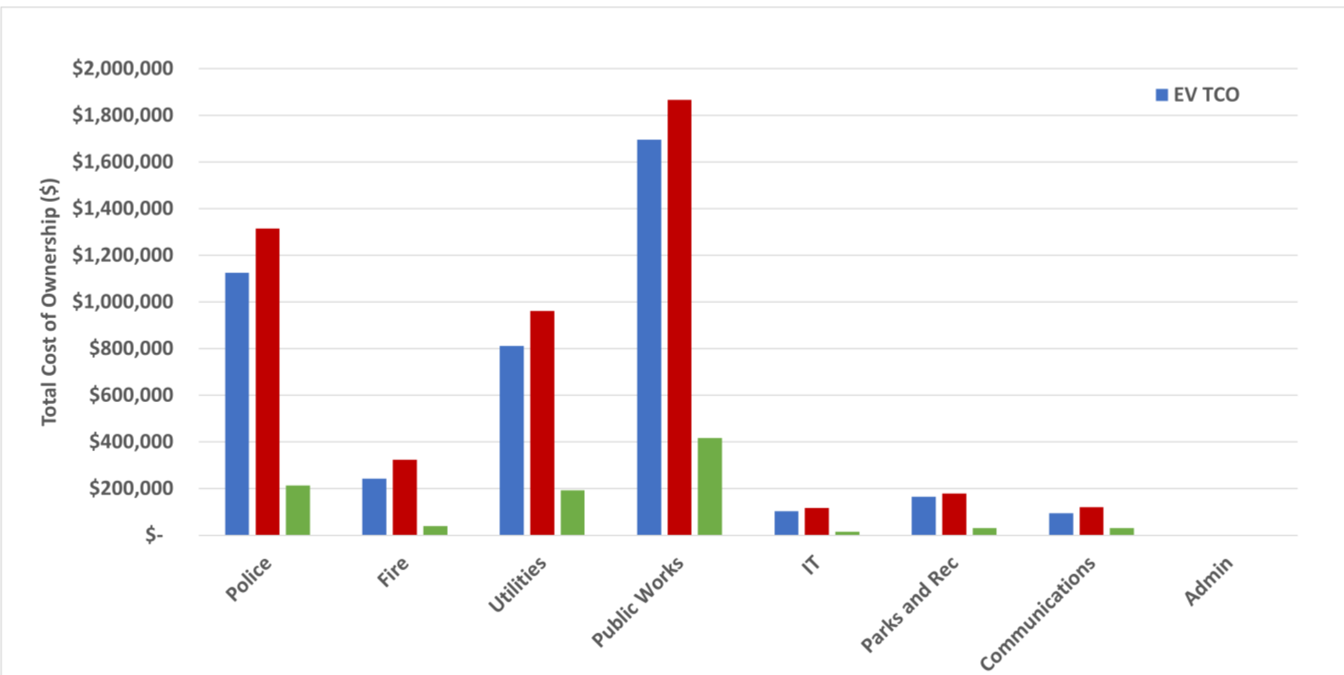


TABLE 2: TCO OF SHORT-TERM VEHICLE PURCHASES (2023-2025) – "BEST FIT" FOR ELECTRIFICATION

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)	INCENTIVE TOTAL ($)
POLICE	$1,124,560	$1,314,269	$214,000
FIRE	$242,285	$323,318	$39,500
UTILITIES	$811,896	$962,338	$193,000
PUBLIC WORKS	$1,695,761	$1,867,344	$417,500
IT	$103,741	$116,767	$16,000
PARKS AND REC	$165,603	$179,614	$30,500
COMMUNICATIONS	$94,891	$119,811	$31,000
ADMIN	$-	$-	$-
TOTAL	**$4,238,736**	**$4,883,462**	**$941,500**

FIGURE 7: TCO OF SHORT-TERM VEHICLE PURCHASES (2023-2025) – POTENTIAL ELECTRIFICATION

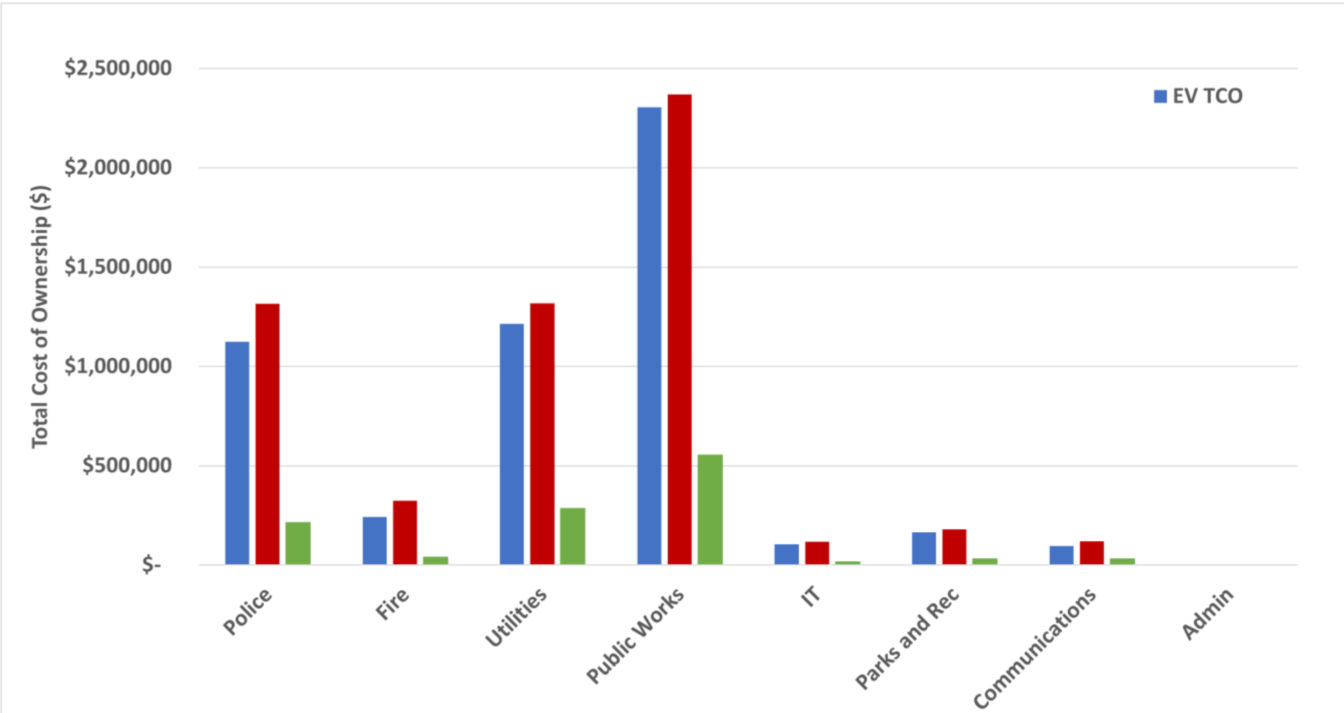


TABLE 3: TCO OF SHORT-TERM VEHICLE PURCHASES (2023-2025) – POTENTIAL ELECTRIFICATION

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)	INCENTIVE TOTAL ($)
POLICE	$1,124,560	$1,314,269	$214,000
FIRE	$242,285	$323,318	$39,500
UTILITIES	$1,214,812	$1,317,395	$283,000
PUBLIC WORKS	$2,304,390	$2,369,253	$552,500
IT	$103,741	$116,767	$16,000
PARKS AND REC	$165,603	$179,614	$30,500
COMMUNICATIONS	$94,891	$119,811	$31,000
ADMIN	$-	$-	$-
TOTAL	**$5,250,282**	**$5,740,428**	**$1,166,500**

FIGURE 8: TCO OF MID-TERM VEHICLE PURCHASES (2026-2030) – "BEST FIT" FOR ELECTRIFICATION

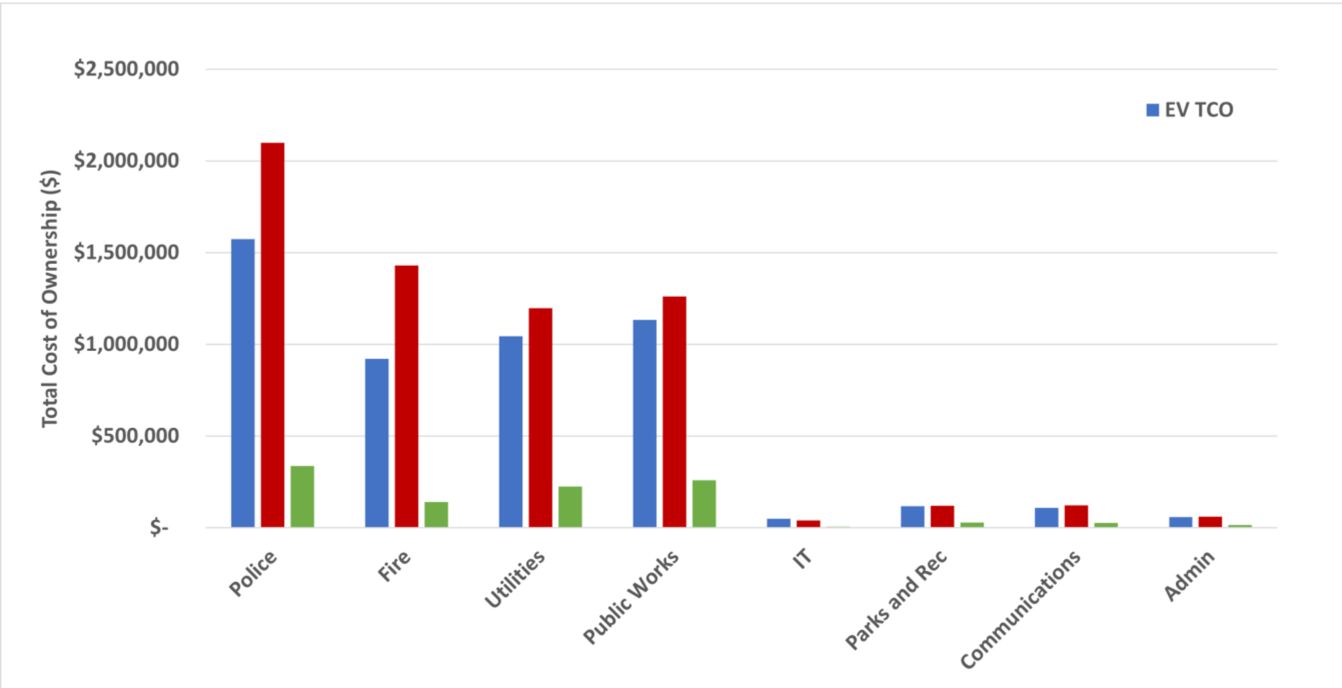


TABLE 4: TCO OF MID-TERM VEHICLE PURCHASES (2026-2030) – "BEST FIT" FOR ELECTRIFICATION

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)	INCENTIVE TOTAL ($)
POLICE	$1,573,061	$2,099,446	$337,378
FIRE	$921,867	$1,430,136	$141,000
UTILITIES	$1,044,723	$1,197,615	$225,000
PUBLIC WORKS	$1,132,371	$1,260,147	$258,500
IT	$49,416	$39,401	$7,000
PARKS AND REC	$118,579	$120,137	$29,000
COMMUNICATIONS	$108,926	$122,090	$27,000
ADMIN	$59,169	$59,843	$14,500
TOTAL	**$5,008,112**	**$6,328,816**	**$1,039,378**

FIGURE 9: TCO OF MID-TERM VEHICLE PURCHASES (2026-2030) – POTENTIAL ELECTRIFICATION

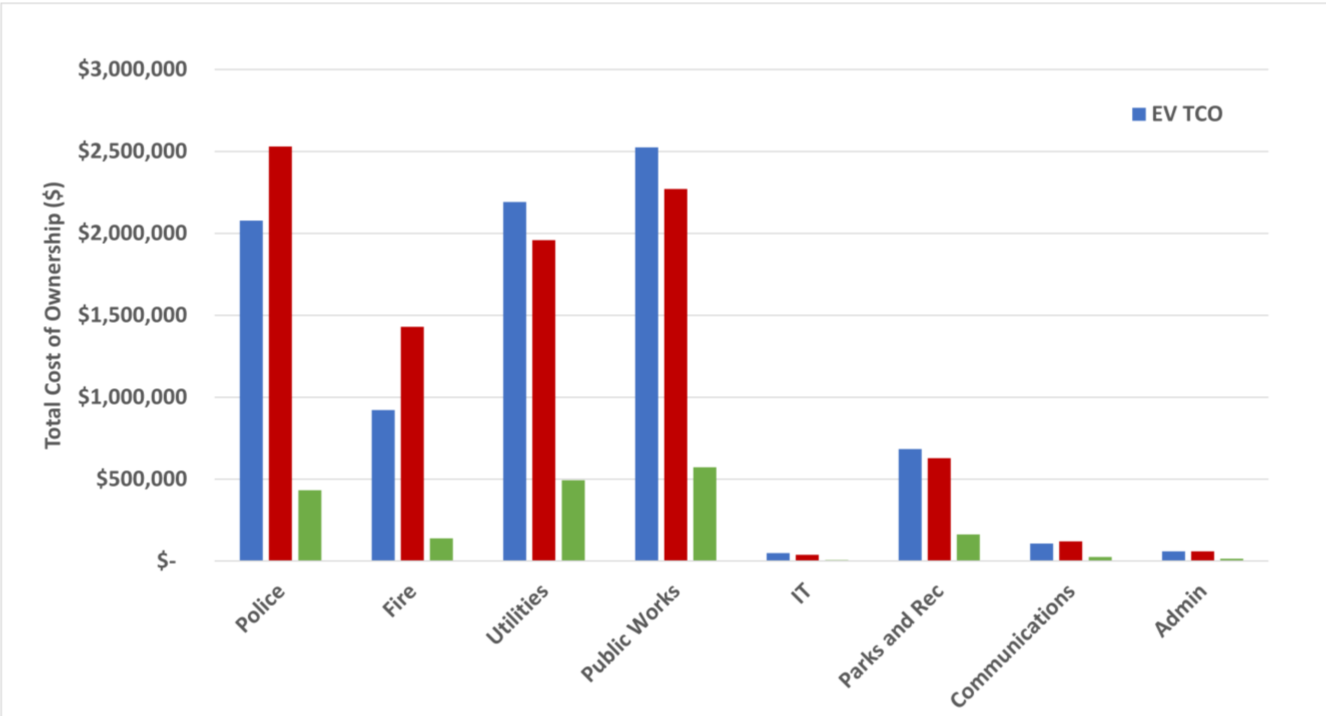


TABLE 5: TCO OF MID-TERM VEHICLE PURCHASES (2026-2030) – POTENTIAL ELECTRIFICATION

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)	INCENTIVE TOTAL ($)
POLICE	$2,077,471	$2,530,398	$432,378
FIRE	$921,867	$1,430,136	$141,000
UTILITIES	$2,190,899	$1,958,113	$495,000
PUBLIC WORKS	$2,526,052	$2,271,946	$573,500
IT	$49,416	$39,401	$7,000
PARKS AND REC	$685,124	$629,024	$164,000
COMMUNICATIONS	$108,926	$122,090	$27,000
ADMIN	$59,169	$59,843	$14,500
TOTAL	**$8,618,923**	**$9,040,951**	**$1,854,378**

When only considering the Best Fit scenario, over the lifespan of the vehicles purchased, near-term electrification is estimated to increase costs for the City ($100,000 more expensive) without incentives and mid-term electrification has the potential to save the City about $300,000 without incentives. Under the Potential Electrification scenario, near-term electrification is estimated to cost the City about $600,000 over the lifetime of the vehicles and mid-term electrification is expected to cost the City about $1,400,000. The Potential Electrification scenario is more expensive for the City primarily due to the current cost differences between ICE and EV heavy-duty options, including fire engines. TCO calculations in the long-term do not include any assumptions for reduced purchase prices of EV models over the next 10 years, which are likely to change the financial outlook. There are a few uncertain factors that could impact these savings estimates, as described below:

- If purchased EVs last longer than current ICE vehicles, the estimated savings will increase.
- If purchased EVs last less than current ICE vehicles, the estimated savings will decrease.
- If it is determined that EV Police pursuit vehicles can consistently outlast the expected 6-year lifespan of ICE pursuit vehicles, savings in the Police Department could increase significantly.

Overall, falling MSRPs of long-range EVs, lower fuel costs and lower maintenance costs combine to enable EVs to provide cost savings, as well as emissions reductions, to the City's fleet. This is particularly true for vehicles with high mileage, such as the Police Department where high fuel and maintenance costs represent additional room for cost savings.

ESTIMATED CAPITAL BUDGET NEEDS FOR VEHICLE REPLACEMENT

Despite the potential for TCO savings resulting from vehicle electrification, in most cases, based on current market prices, replacing an existing vehicle with an electric option will require higher upfront capital costs than replacing the same vehicle with an ICE option. **Figure 10** and **Figure 11** include estimated annual capital budget required to purchase EVs for the City's fleet. The total size of the green and blue bars combined is the capital cost that would be necessary without incentives; the blue bar in isolation is the capital cost that will be required with incentives. Savings are observed in the total cost of ownership due to fuel and maintenance savings making up the gap between the blue and red bars over the lifetimes of the vehicles.

FIGURE 10: ESTIMATED CAPITAL BUDGET NEEDS – "BEST FIT" FOR ELECTRIFICATION

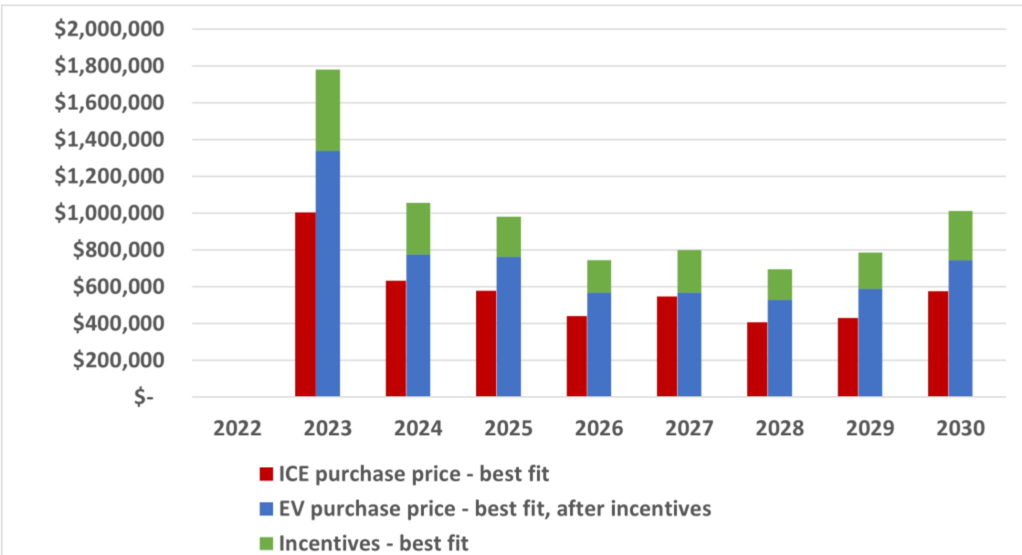
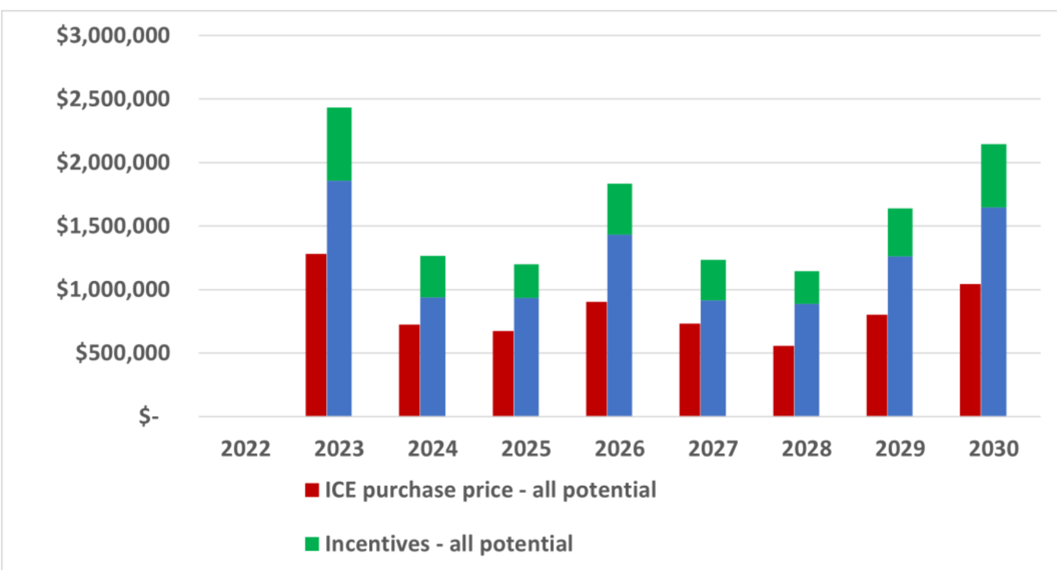


FIGURE 11: ESTIMATED CAPITAL BUDGET NEEDS – POTENTIAL ELECTRIFICATION



It is important to note that the budget needs included in

Figure 11 include EV options that may not yet be in full production or are chassis conversions requiring custom building, both of which increase purchase costs. For example, the Pierce Volterra Pumper is an all-electric fire engine option that, while deployed in at least one real-world application in the U.S., has not reached widespread adoption and costs approximately $1.2 million to purchase. It should be expected that capital budget requirements for models like the Volterra will fall between now and when the City is required to make replacement decisions in the outer years.

DISCUSSION OF OWNERSHIP MODELS: OWNED VS LEASED

The City traditionally purchases fleet assets and that is the ownership structure that was assumed throughout this analysis. **The City of San Luis Obispo should continue to purchase and own vehicles because it is the most cost-effective approach for the fleet.** Leasing electric vehicles, particularly light-duty options, is an increasingly available ownership model with the potential to further reduce the burden of vehicle maintenance. Leasing opportunities for municipal fleets are offered through Sourcewell and the Climate Mayors EV Collaborative.[7]

There are two common types of leasing: fleet leasing or lease financing. Fleet leasing refers to a contract that enables vehicle leasing, often a large number of vehicles, that encompasses maintenance costs, fuel costs and other services. It is appealing for fleets that do not have in-house maintenance operations and are interested in outsourcing a significant portion of fleet management. Lease financing refers to a contract that provides a vehicle without fleet management services and is similar to the structure of a lease for a personal vehicle. Within lease financing, there are two common types: closed- and open-ended leases. Closed-ended leases have a set term, after which the City returns the vehicle. Closed-ended leases enable fleets to phase new vehicle models into their fleet quickly and monthly payments are often lower than other options, but the City does not retain ownership of the asset at the end of the lease.[8] Open-ended leases

[7] https://driveevfleets.org/wp-content/uploads/2018/09/NCL_OneSheet_ClimateMayors.pdf

[8] Saving Money with Electric Vehicle Leasing: A Case Study of City Fleets, Electrification Coalition, November 2020

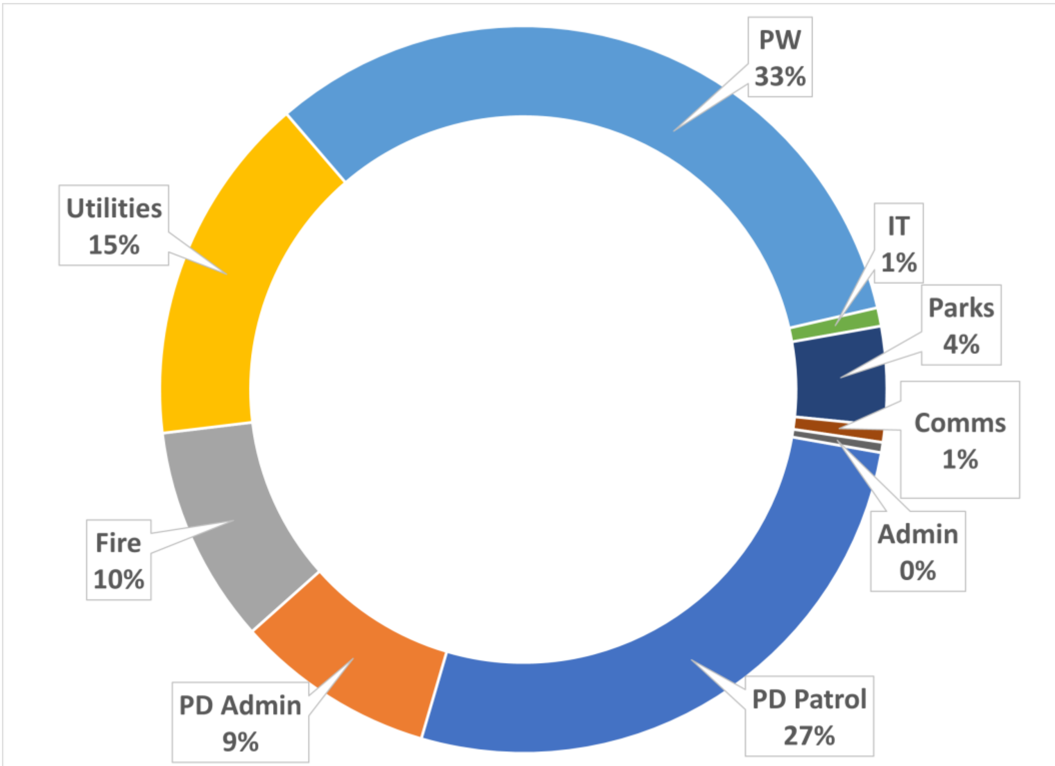
are essentially a financing mechanism allowing the City to pay down the cost of a vehicle over the term of the lease, often down to a $1 buy out, enabling the City to maintain ownership of the asset at the end of the lease term.

Historically, a public agency such as the City of San Luis Obispo may have chosen to lease EVs from a 3rd party in order to realize incentives that were not available to entities that are tax-exempt. As of the time this report is being developed, the EV rebates available from the federal government through recent bills have been extended to City governments and other public agencies.

CARBON REDUCTIONS FROM FLEET ELECTRIFICATION

Figure 12 summarizes total, annual carbon emissions from the City's fleet by percent contribution of each department. To account for the impacts of COVID-19 on vehicle use, fuel usage from 2019 and 2021 was used to calculate baseline carbon emissions. The total carbon emissions associated with the City's fleet is 845 $MTCO_2$.[9]

FIGURE 12: ANNUAL CARBON EMISSIONS OF VEHICLE FLEET BY DEPARTMENT- 2021



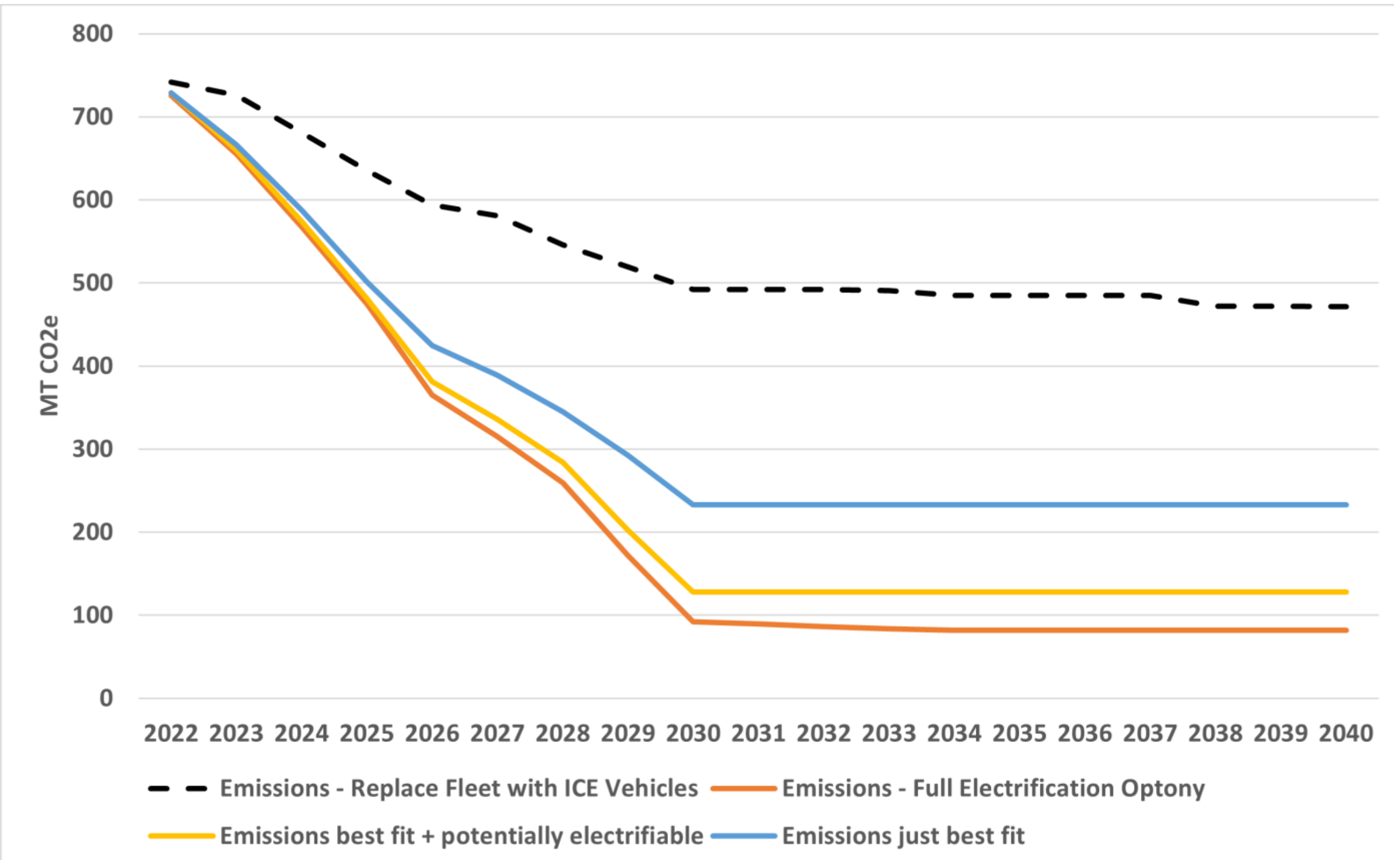
The expected carbon reductions from fleet electrification are presented below based on the Fleet Replacement and Electrification Timeline. **Figure 13** includes projected carbon reductions under three electrification scenarios matching those discussed previously in this report.

- **"Best Fit" for Full Electrification (Current Technology):** The first scenario considers the electrification of only vehicles that can be fully electrified based on current technology (i.e., those vehicles categorized as "Best Fit" for Full Electrification).
- **"Potential Electrification" (Current Technology Plus):** This scenario considers the electrification of all "Best Fit" vehicles as well as the Potentially Electrifiable vehicles.
- **Full Electrification**: The final scenario includes all vehicles in the previous scenarios as well as the full electrification of all vehicles identified as having no electric option currently available in the market, including full electrification

[9] This is calculating emissions of the 211 studied vehicles. Eight vehicles (3745, 5446, 5458, 5470, 8327, 8328, 2827, 7106) did not have fuel usage provided and estimated annual GHG emissions were calculated based on vehicle mileage.

of vehicles that are currently only candidates for partial electrification via an ePTO. *This is included as a representative scenario and does not specify vehicle models/technologies used to achieve electrification but assumes sufficient technology advancement to electrify every vehicle that comes up for replacement through 2040.*

FIGURE 13: EMISSION REDUCTION SCENARIOS THROUGH 2040



By 2030, the **Best Fit** scenario (blue line), above, represents a 63% reduction in carbon emissions, the **Best Fit + Potential** scenario (yellow line) represents a 76% reduction in carbon emissions and the **Full Electrification** scenario (orange line) represents an 88% reduction in carbon emissions. Extending the **Full Electrification Scenario** leads to a 93% reduction in carbon emissions from the City fleet by 2040.

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While the past few years have witnessed significant growth in the availability and adoption of consumer electric vehicles, the electromobility industry is in a period of rapid growth. While many additional models are expected to become available in the next few years, municipal fleets like the City of San Luis Obispo's are typically comprised of significant numbers of specialty vehicles including medium and heavy-duty vehicles for which few electric substitutes are currently available from mass-market suppliers. In cases where electric substitute vehicles will not be commercially available through standard procurement mechanisms in the near-term, several other options may be worth considering, including:

- **Partial electrification**: One way to reduce emissions on ICE vehicles for which cost-effective EV substitutions are not available is the electrification of auxiliary loads with stored energy using mobile batteries. Several aerial bucket trucks in the Utilities department have been identified as potential candidates. Under this option, traction power would still be provided by gas or diesel engines, but batteries could be used to reduce idle times, saving fuel and cutting emissions.

NEXT STEPS

IMMEDIATE (2023-2025) ELECTRIFICATION OPTIONS & TOTAL COST OF OWNERSHIP

A summary of the identified EV alternatives and associated total cost of ownership for immediate vehicle replacements (2023-2025) is included to guide immediate action by the City of San Luis Obispo. **Table 6** summarizes the total upfront investment and TCO for the ICE and the best fit EV alternative for all vehicles to be replaced for each year. This table also identifies the total number of vehicles to be electrified, which is consistent with the numbers presented in the Electrification Timeline. **This table only includes vehicles that were identified as a "Best Fit" for Full Electrification.** The number of vehicles to be electrified could be increased if the City confirms feasible models for vehicles in the Potential Electrification category.

TABLE 6: UPFRONT COST & TCO SUMMARY FOR IMMEDIATE VEHICLE ELECTRIFICATION

REPLACEMENT YEAR	# OF VEHICLES TO BE ELECTRIFIED	ICE VEHICLE		RECOMMENDED EV ALTERNATIVE		
		MSRP	TCO	MSRP	TCO	TCO REDUCTION FROM VEHICLE ELECTRIFICATION
2023	33	$979,603	$2,090,883	$1,314,722	$1,882,257	$208,626
2024	22	$632,998	$1,390,270	$775,028	$1,160,097	$230,173
2025	15	$448,400	$1,071,686	$587,514	$905,274	$166,412
TOTAL	**70**	**$2,061,001**	**$4,552,839**	**$2,677,265**	**$3,947,628**	**$605,211**

The recommended vehicle replacement timeline detailed in this report aims to ensure the City achieves its goal of reaching full electrification of light-duty vehicles and 50% electrification of medium- and heavy-duty vehicles by 2030. This is considered the best-case scenario for the City and may be modified during implementation to account for procurement challenges and budget limitations. The City may modify the vehicle replacement timeline by editing the replacement year of each vehicle in the Fleet Electrification Pro Forma, which is a separate Excel-based deliverable.

OTHER NEAR-TERM VEHICLE REPLACEMENTS

About one tenth of the vehicles studied in this analysis do not have a clear electric option currently available in 2023 or imminently available in 2024 and the City will need to reassess the electrification potential of each of those vehicles as they come up for replacement. Depending on the vehicle, the City can either pursue an alternative electrification or emissions reduction option or delay the vehicle replacement and wait for an equivalent EV to become available, even if it means extending a vehicle's service life beyond what is optimal.

In 2023 and 2024 there are 6 vehicles that will come up for replacement that are categorized in the Potential Electrification or No Electric Options category. For these vehicles, the City can consider the following options to determine the appropriate course of action.

- **Option 1 – Reassess the Market**: The City can search for available equivalent options to identify any new models/technologies that have entered the market since the end of 2023.
- **Option 2 – Vehicle Downsizing:** In some cases, the City is already implementing vehicle downsizing, but there is potential to expand that practice to more vehicles in the fleet. For example, 21 Ford F-250 pick-ups will be replaced with Ford F-150 Lightnings. Through conversations with City staff operating the pickup trucks, it can then be determined whether an individual vehicle can be downsized, or if specific operational requirements prevent that.
- **Option 3 – Delayed Replacement:** If no suitable EV option is identified and vehicle downsizing is not an option, the City can consider keeping the vehicle in the fleet for a year or two more to wait for a viable EV option. The budget for replacing the existing vehicle could be earmarked for an appropriate EV replacement if it becomes available during the delay time.
- **Option 4 – Pilot Chassis Conversion Technology or Less Cost-effective OEM Offering:** In cases where there is a suitable electric option, but that option may be from an aftermarket vendor or is a new EV model that is significantly more expensive than its ICE counterpart, the City may still want to purchase the EV option to meet environmental goals and pilot new technologies within the fleet.

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APPENDIX A: VEHICLE INCENTIVES

APPENDIX A: VEHICLE INCENTIVES

The City of San Luis Obispo's efforts toward fleet electrification and installing EV charging infrastructure are eligible for rebates from the Inflation Reduction Act and the City's community choice aggregator, Central Coast Community Energy (CCCE). This section summarizes those funding opportunities.

INFLATION REDUCTION ACT

New plug-in battery electric vehicles (EVs) purchased in 2023 or after may be eligible for a tax credit from the Internal Revenue Service (IRS). The Inflation Reduction Act includes a Commercial Clean Vehicle credit, which applies to both businesses and tax-exempt organizations (such as local governments). For EVs, this credit equals the lesser of 30% the vehicle's price or the incremental cost of the vehicle, up to $7,500 for light-duty vehicles under a GVWR or 14,000 pounds and $40,000 for vehicles above. There is no limit on the number of credits that can be claimed. There are a few additional requirements, including minimum battery sizes (7 kWh for light-duty and 15 kWh for medium- and heavy-duty), vehicle use case (the vehicle must be used primarily in the United States and must not be for resale), and manufacturer. A list of qualified manufacturers may be found here: https://www.irs.gov/credits-deductions/manufacturers-for-qualified-commercial-clean-vehicle-credit, while more information on the tax credits available to commercial fleets as a whole may be found here: https://www.irs.gov/credits-deductions/commercial-clean-vehicle-credit.

CENTRAL COAST COMMUNITY ENERGY (CCCE)

For as long as funds are available, purchase of fleet EVs (light, medium, and heavy duty) are eligible for direct rebates under CCCE's Electrify Your Fleet program. The City of SAN LUIS OBISPO is eligible for up to $150,000 in rebates through the program.[10]

Rebates

Rebates will be awarded on a first-come, first-served basis. Rebates may be claimed as a **"post-purchase *rebate*"** or reserved as a **"pre-purchase *reservation*."** A Member Agency is eligible for **up to $150,000**.

Class	GVWR Weight in lbs.	Per Measure Incentive
Electric Motorcycles	<6,000	$1,000
Class 1	<6,000	$5,000
Class 2	6,001 – 10,000	$7,000
Class 3	10,001 – 14,000	$12,000
Class 4 and Class 5	14,001 – 19,500	$25,000
Class 6 and Class 7	19,500 – 33,000	$50,000
Class 8	>33,000	$100,000

[10] https://3cenergy.org/rebates/electrify-your-fleet-2/

HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP)

Purchasers of EVs and PHEVs, including local governments, can access grant funding provided by California Air Resource Board (CARB) on a first-come, first-served basis. For FY22-23, the total program funding is $250M. Eligible vehicles can be found using the online HVIP catalogue. Base funding amounts per gross vehicle weight rating (GVWR) are included in the table below.[11]

FY22-23 Zero-Emission Funding Table

Vehicle Weight Class	Base*
Class 2B	$7,500
Class 3	$45,000
Class 4-5	$60,000
Class 6-7	$85,000
Class 8	$120,000

*The public School Bus Set-Aside and ISEF have separate voucher amounts. Visit the purchasers' page for more information.

[11] https://californiahvip.org/

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APPENDIX B: FLEET DATABASE & TOTAL COST OF OWNERSHIP

APPENDIX B: FLEET DATABASE & DETAILED TCO ANALYSIS (EXCEL ATTACHMENT)

The detailed results of the Total Cost of Ownership calculations have been provided to the City separately from this document in an Excel spreadsheet. This comprehensive vehicle database allows the City to sort results by any category necessary including Department and Replacement Year.

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APPENDIX C: COST OF CARBON ABATEMENT

APPENDIX C: COST OF CARBON ABATEMENT CALCULATIONS

To provide guidance for the City's budget towards the most cost-effective vehicles for emissions reductions, the following tables summarize the marginal cost, or savings, of vehicle electrification on a capital cost and total cost of ownership basis, the associated carbon reductions, and the cost of carbon abatement on a dollar per ton basis. Incentives and rebates are included in marginal cost values. The incremental cost of carbon reductions is calculated for 2023–2030 under the Current Technology and Potential Electrification scenarios described above.

TABLE 7: INCREMENTAL COST OF CARBON REDUCTION – "BEST FIT" SCENARIO

DEPARTMENT	# OF VEHICLES	CARBON REDUCTIONS (MTCO_2)	MARGINAL CAPITAL COSTS ($)	MARGINAL TOTAL COST OF OWNERSHIP ($)	COST OF ABATEMENT – CAPITAL COST ($/MT$CO_2$)	COST OF ABATEMENT – TCO ($/MT$CO_2$)
2023 – 2025 VEHICLE REPLACEMENTS						
POLICE	18	142.14	$123,400	-$189,710	$868	-$1,335
FIRE	4	2.97	$41,271	-$81,033	$13,884	-$27,260
UTILITIES	16	35.26	$121,473	-$150,442	$3,445	-$4,266
PUBLIC WORKS	30	92.90	$318,715	-$171,582	$3,431	-$1,847
IT	2	5.86	$22,300	-$13,026	$3,808	-$2,224
PARKS AND REC	3	4.87	$35,971	-$14,011	$7,392	-$2,879
COMMUNICATIONS	3	1.84	-$3,928	-$24,920	-$2,133	-$13,531
ADMIN	0	0.00	$0	$0	INF	INF
2026 – 2030 VEHICLE REPLACEMENTS						
POLICE	29	127.68	-$1,740	-$526,385	-$14	-$4,123
FIRE	12	25.73	$113,828	-$508,269	$4,424	-$19,753
UTILITIES	17	41.25	$186,357	-$152,892	$4,518	-$3,707
PUBLIC WORKS	19	79.20	$223,371	-$127,777	$2,820	-$1,613
IT	1	0.46	$17,000	$10,015	$37,361	$22,010
PARKS AND REC	2	6.21	$27,343	-$1,558	$4,404	-$251
COMMUNICATIONS	3	3.80	$15,900	-$13,164	$4,179	-$3,460
ADMIN	1	1	3.50	$13,671	-$674	$3,905

TABLE 8: INCREMENTAL COST OF CARBON REDUCTION – POTENTIAL ELECTRIFICATION SCENARIO

DEPARTMENT	# OF VEHICLES	CARBON REDUCTIONS ($MTCO_2$)	MARGINAL CAPITAL COSTS ($)	MARGINAL TOTAL COST OF OWNERSHIP ($)	COST OF ABATEMENT – CAPITAL COST ($/$MTCO_2$)	COST OF ABATEMENT – TCO ($/$MTCO_2$)
2023 – 2025 VEHICLE REPLACEMENTS						
POLICE	18	142.14	$123,400	-$189,710	$868	-$1,335
FIRE	4	2.97	$41,271	-$81,033	$13,884	-$27,260
UTILITIES	18	45.49	$273,623	-$102,583	$6,015	-$2,255
PUBLIC WORKS	33	103.28	$560,141	-$64,862	$5,423	-$628
IT	2	5.86	$22,300	-$13,026	$3,808	-$2,224
PARKS AND REC	3	4.87	$35,971	-$14,011	$7,392	-$2,879
COMMUNICATIONS	3	1.84	-$3,928	-$24,920	-$2,133	-$13,531
ADMIN	0	0.00	$0	$0	INF	INF
2026 – 2030 VEHICLE REPLACEMENTS						
POLICE	32	132.31	$156,910	-$452,926	$1,186	-$3,423
FIRE	12	25.73	$113,828	-$508,269	$4,424	-$19,753
UTILITIES	23	62.50	$714,733	$232,786	$11,435	$3,724
PUBLIC WORKS	26	121.80	$832,222	$254,106	$6,833	$2,086
IT	1	0.46	$17,000	$10,015	$37,361	$22,010
PARKS AND REC	5	28.98	$242,368	$56,099	$8,363	$1,936
COMMUNICATIONS	3	3.80	$15,900	-$13,164	$4,179	-$3,460
ADMIN	1	1	3.50	$13,671	-$674	$3,905